HIGHWAYS AGENCY

Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

CHARM

Operational Concept Description ATMS

Version 2.0
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distribution This document will be distributed to participants of the CHARM tender.

source documents This document is based on many studies, documents and interviews that have been produced in the exploration phase of the CHARM program.

1. Introduction

1.1. Document overview

document

This document provides an operational concept description (OCD) for an Advanced Traffic Management System (ATMS) as agreed on in the CHARM project.

project

The CHARM project name is an acronym for Common Highways Agency Rijkswaterstaat Model. The project is a joint effort by the traffic agencies that manage the motorways in England and the Netherlands. The first phase of the project concluded that the processes and challenges of the participating agencies are very similar. The second phase of the project is a joint procurement process for renewal of the operational systems. For further information see the project's public website http://www.rws.nl/CHARM.

purpose

The OCD will be used as an overarching document that provides context, motivation and expectations about the operations of the ATMS, together with examples, both for Highways Agency (HA) and Rijkswaterstaat (RWS). It is the main document for communicating the Agencies' intentions regarding the operational use of an ATMS to suppliers and should help them in answering the tender questions. This document does not provide formal requirements to the ATMS.

readers guide

The following guidance should be taken into account when reading this document:

1. All acronyms and blue underlined terms used in this document are explained in the glossary. The glossary definitions underpin the meaning expressed in this document.
2. This document provides high level context for the details described later in the ATMS CHARM procurement process.
3. The diagrams contain some typical examples but are not intended to provide a complete or exhaustive listing.
4. The words 'process', 'capability', 'function' and 'service' are related concepts that are used in the following way:

- A service is a unit of functionality that is meaningful from the point of view of the environment and realised by one or more processes that are performed by the business roles. In this document we only refer to business services. Therefore the word service is synonymous with a business service.
- A capability is a set of related functions, processes and services that the ATMS system needs to offer to deliver the business objectives.
- A process groups behaviour based on an ordering of activities (workflow). For the CHARM ATMS process may be specific for an implementation site.
- A function is a grouping of behaviour at the business and application level to realise one or more application services.
- An application service is a self-contained unit of functionality offered by the ATMS.

5. This document is under version control and may be updated based on new insights or feedback.
6. For your convenience Appendix D provides an index based on the glossary.

1.2.CHARM Mission

keywords

The general nature of the system is characterised by the following keywords: software system, information processing, traffic management, control room, data validation, data monitoring, decision support system, predictive analytics.

sponsor

The CHARM consortium is an initiative of the Highways Agency (HA) in England and Rijkswaterstaat (RWS) in the Netherlands. The Flemish *Ministerie van Mobiliteit en Openbare Werken* is a 'preferred partner' of the consortium. The consortium is partly financed by the European Commission. Both agencies are collaborating or plan to collaborate with other road authorities.

vision

The agencies have the following combined mission statement:

Safe roads, smooth traffic, reliable journeys and informed travellers.

The agencies wish to accomplish this by implementing technologies fit for the present and the future.

objective

Migration to a new, integrated Advanced Traffic Management System (ATMS) should support current and future business processes for network management. The initial ATMS must be able to incorporate new technologies and interface with both current and future systems.

approach

The collaborating agencies will be looking for a proven, commercially available software package, requiring minimal product development that fulfils all of the following criteria:

- is a modern, flexible, modular software package;
- is available as a standard and integrated product;
- is highly and easily configurable;
- supports software localization;
- can be serviced by independent service providers.

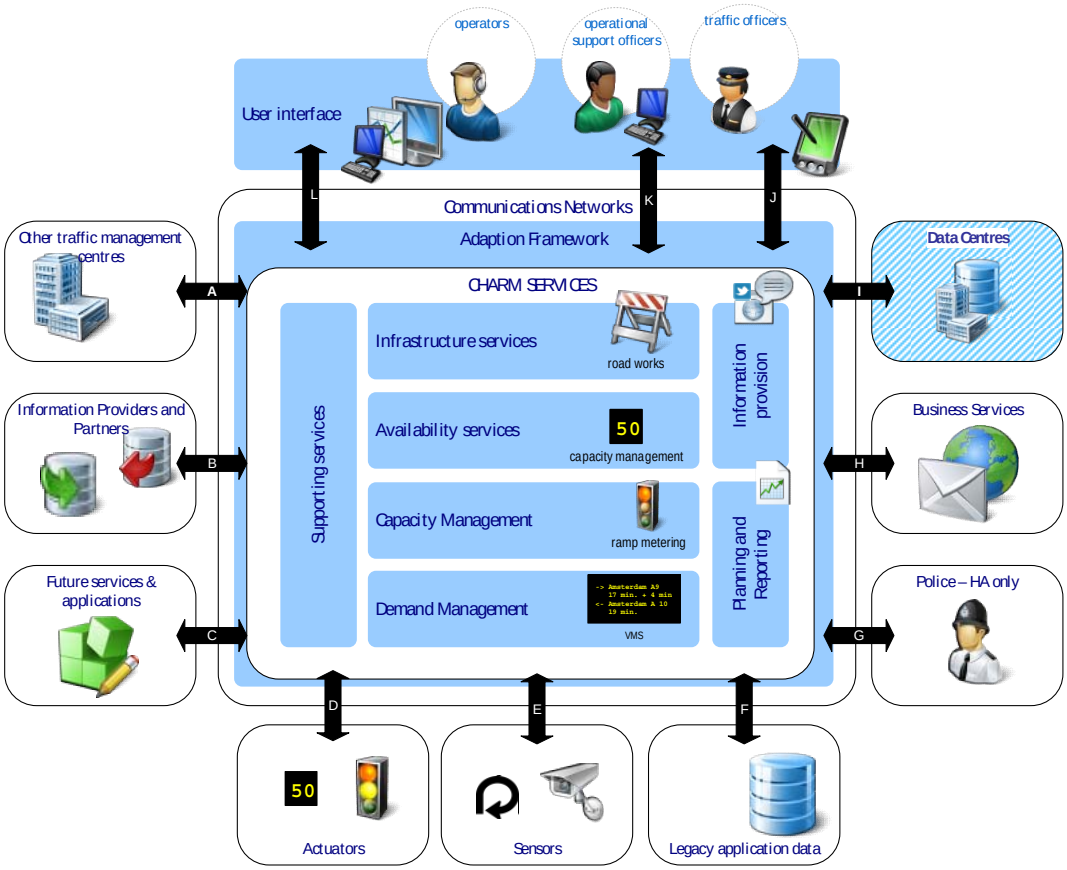
1.3.System scope

scope diagram

The following diagram is a schematic overview of the CHARM ATMS scope[1]. A description of the named services is provided in chapter 5.3.

[1] See chapter 5.3.5 for an explanation of the legend A - L.

Figure 1 schematic scope overview



in scope

Functionality that must be considered **in-scope** of the initial ATMS:

- The ATMS must collect, store and process data from internal and external sources.
- The ATMS must present tailored information to operators and customers, allowing access to more detailed data on demand.
- The ATMS must provide functions to monitor the road network (common operational picture[2]).
- The ATMS must support the logging of incident information.
- The ATMS must log actions, including sign and signal settings.
- The ATMS must recommend and execute response plans.
- The ATMS must provide functions to control roadside devices[3].
- The ATMS must provide functions to deploy, track and trace on-road resources.
- The ATMS must provide functions to exchange information and service requests with operational partners.

[2] This includes the ability to share a common operational picture with TMCs that control regional or urban roads.

[3] That already exist in the current infrastructure.

- The ATMS must provide functions to disseminate tailored information to customers.
- The AMTS must generate reports and statistics.
- The ATMS must provide functions to retrieve, process and display historical data.
- The ATMS must support workload transfer between TMCs.
- The ATMS must support continuity of operations in the event of technology failure.

out of scope

Functionality that must be considered **out-of-scope** of the initial ATMS:

- The sensors that collect network performance data and the means to distribute this information.
- The actuators that are involved in displaying or responding to control information (and sometimes also collect sensor data).
- The hardware used by the ATMS or an operator to perform the monitoring task in an effective way.
- The hosting environment for the ATMS, including IT infrastructure, networking connectivity and end user IT.
- Functionality to control which tasks are to be performed at a control desk[4].
- Specific features (such as queue length for a traffic light) for traffic management at the regional or urban level.
- The operational control of tunnels and bridges.

capabilities

The following capabilities are referred to as the 'must haves' of the CHARM ATMS:

- information provision
- dynamic traffic management
- incident management
- resource management
- event planning
- contact management

1.4.System environment

users

The CHARM ATMS will be used daily by operators in a Traffic Management Centre (TMC). The information produced by the CHARM ATMS will be used by the Agencies as well as travellers. Traffic officers that operate from the roadside use the CHARM ATMS to exchange information with the operator. Finally, users with special roles (like the Operational Support Officers) update the configuration of the ATMS so that the ATMS environment aligns with the operational process.

data input

The CHARM ATMS receives different types of data from diverse sensors and systems in different environments. These data may be redundant[5], incomplete and even conflicting at some point in time. It is expected that data feeds may be added or removed during the deployment of the system.

[4] In the Netherlands this application that performs this task has the general name 'process manager'.
[5] For some road segments similar data may be collected by different sensors.

data output

The CHARM ATMS will produce different kinds of information that will be distributed by multiple channels to be processed by different systems or partners based on standard or non-standard protocols. The output may directly control the behaviour of other systems (e.g. road signs). The output may indirectly control the behaviour of travellers by informing them or other parties (e.g. police, media, etc.). It is expected that information channels may be added or removed during the deployment of the system.

GUI output

All relevant input and output should be aggregated into meaningful information[6] and presented to an operator for the purpose of monitoring, validation and control of the data feeds.

events

Operators should be supported in their objective to guide and inform travellers in response to events so that a traveller's journey is reliable and safe. Typical events that may ask for a response by an operator are:

- (expected or unexpected) traffic congestion
- incident
- road work
- weather and seasonal variations
- crowd generating event (such as a football match or concert)

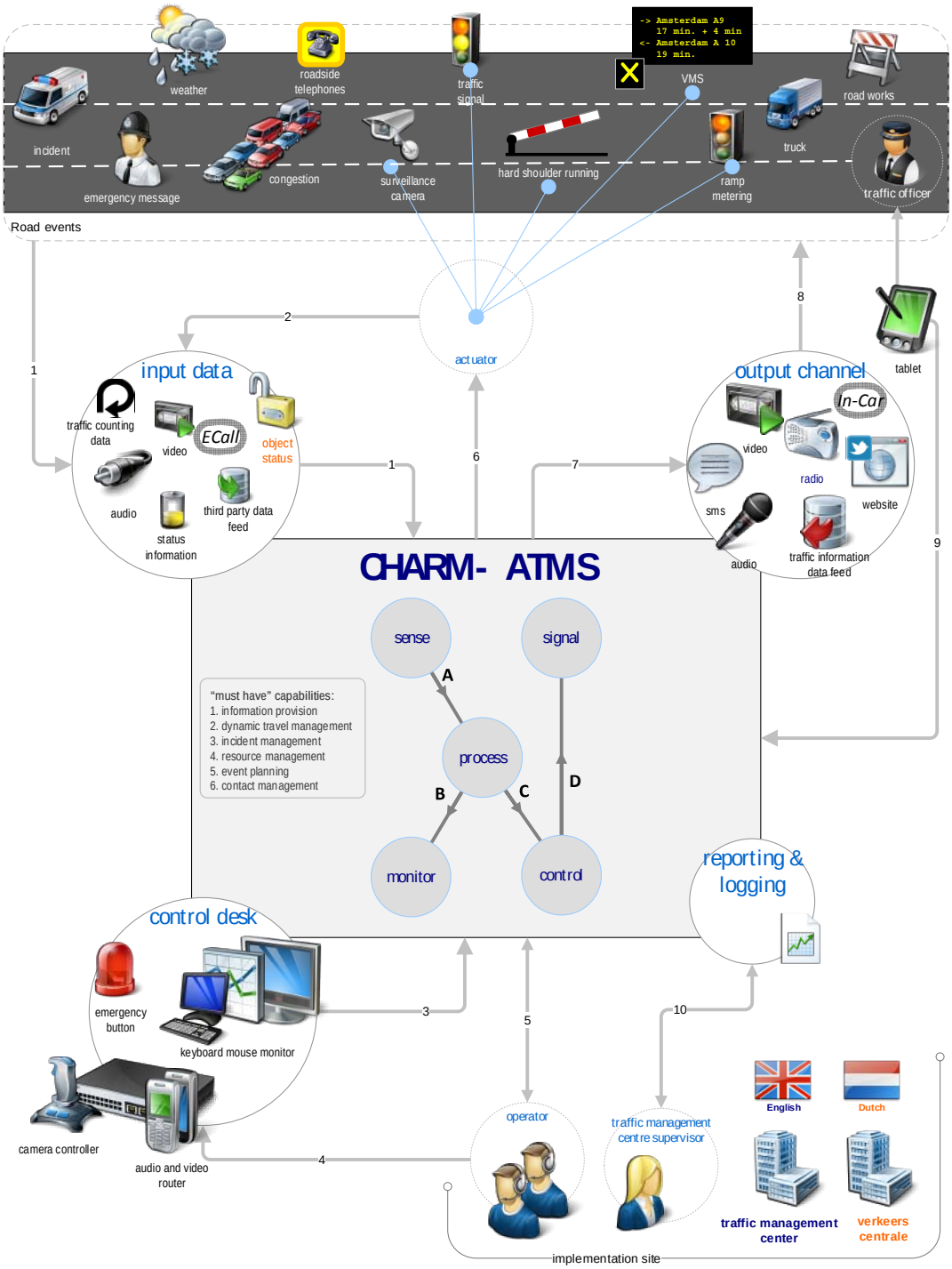
The ATMS should be able to automatically detect events although some events remain to be detected by the operator.

control

The detection of events is controlled by rules and heuristics that are based on policy and experience. The rules and heuristics should be configurable by the Operational Support Officer for a specific Traffic Management Centre. The response to events is also controlled by rules and heuristics that are based on policy and experience. A response plan should be configurable by the Operational Support Officer of a traffic control centre.

[6] An example of data aggregation into meaningful information is the transformation from velocity to traffic time on a road segment.

Figure 2 context diagram operational use



context diagram

The context diagram in Figure 2 context diagram operational use defines the boundary between the ATMS and its environment, showing the type of things that interact with it. This diagram shows the environment of the ATMS when used by an operator in a TMC . The diagram contains some typical examples of things to interact with but is not intended to provide a complete or limiting listing.

explanation

The context diagram shows all context in relation to the operational[7] CHARM-ATMS. The interfaces are numbered and are defined as follows:

1. Data about the traffic situation, from diverse sensors and systems, is input for the ATMS.
2. The functioning (e.g. status) of an actuator is also used as input data for the ATMS.
3. The ATMS will use control desk hardware, provided by the agencies.
4. An operator interacts with the ATMS through control desk hardware with an ergonomic user interface that integrates functionality for all supported processes.
5. An operator approves a response plan (if required by the response plan definition).
6. The operator may directly influence the signal of an actuator through the ATMS.
7. The ATMS disseminates information about the traffic situation through different channels.
8. The purpose of the information in the response plan is to influence the behaviour of road users and hence improve the traffic situation.
9. An on road resource may receive deployment instructions from the TMC and update information based on their observations using mobile devices.
10. The supervisor creates management reports and analyses logs to answer questions about the operational activities.

high level functions

The required functionality of the CHARM-ATMS can be broken down into four high level functions[8]:

A. The ATMS receives data input from different sources.
B. The ATMS processes data and presents a Common Operational Picture to an operator to monitor the network.
C. The ATMS manages the traffic network through predefined or dynamic response plans, or algorithms and heuristics (control strategy) that suggest actions to an operator.
D. The ATMS distributes data via diverse channels[9] to communicate relevant control measures.

1.5. System maintenance

adaptability

The desired **adaptability** of the ATMS includes:

- The ATMS must support the integration of different types of current and future sensors that collect different types of sensor data in different ways and different actuators to control the traffic.
- The ATMS must support the implementation of the different types of current and future channels that distribute different types of data in different ways.

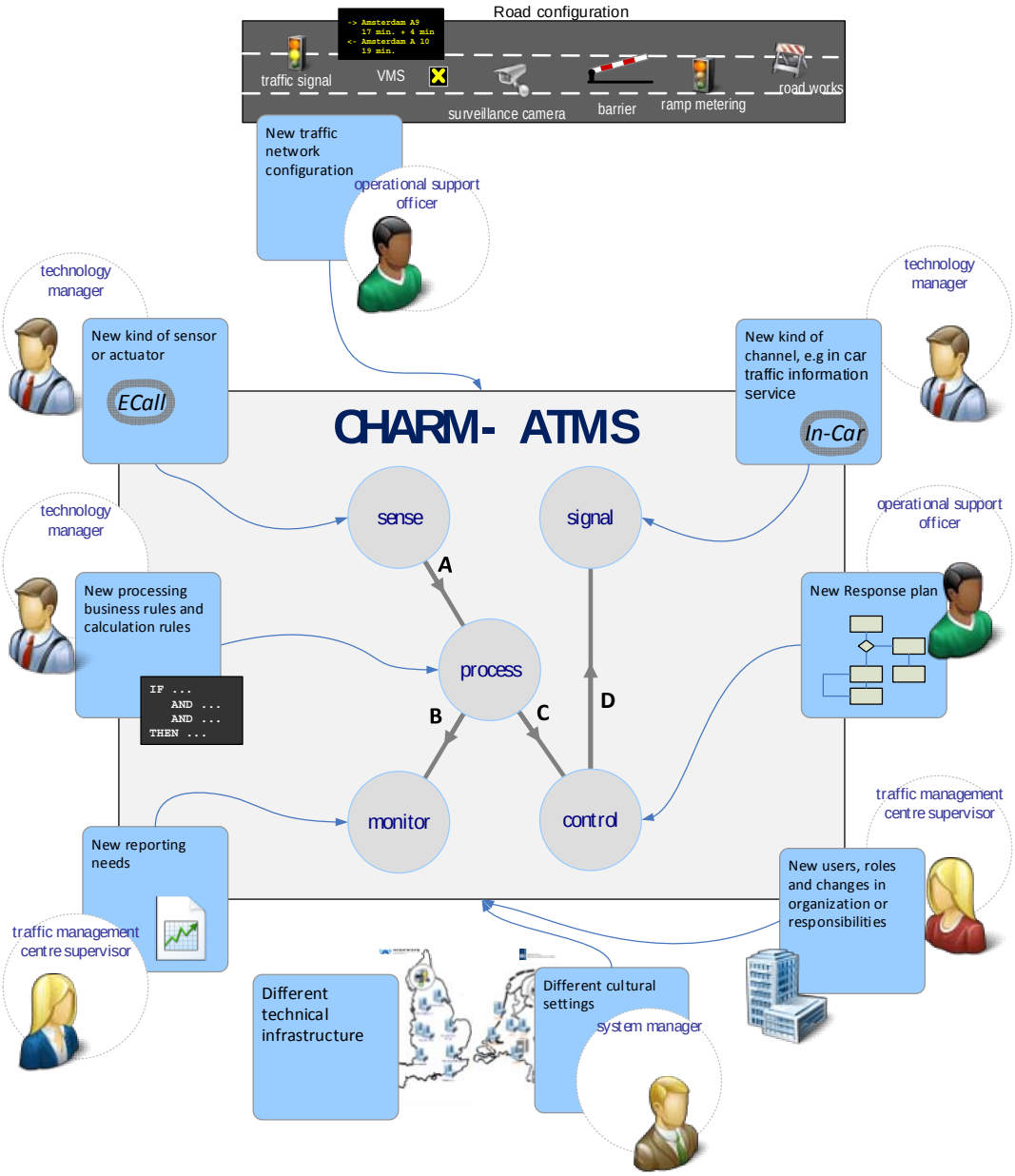
[7] In contrast to a CHARM-ATMS that is in training or maintenance mode.
[8] The characters A, B, C, D in the list correspond to the lines in the context diagram with the same letter.
[9] Note that the provision of these channels is outside the ATMS scope.

- The ATMS must support the definition, maintenance and configuration of response plans.
- The ATMS must be able to run on different operating sites with different IT infrastructures, languages and cultural settings.
- The ATMS must support dynamic changes in traffic network configuration
- The ATMS must support the definition and change of business rules that influence the transformation from data to information or the selection of response plans to handle an event.
- The ATMS must support the generation of different kinds of reports based on the day to day needs of the traffic management supervisor and support officer.
- The ATMS must support the set-up of users, user roles, authorisation levels, task allocation, teams, and a team's geographical responsibility.
- The ATMS must provide the ability to add new modules to deliver new functionality to support requirements changes from the business.

systemmanagement

In Figure 2 *context diagram operational use* on page 9 defines the boundary between the ATMS and its environment, showing the type of things the ATMS interacts with during operational use. The next diagram shows the environment of the ATMS during maintenance e.g. in response to changes in the ATMS environment or requirements.

Figure 3 context diagram system management



1.6. Operating sites

implementation

The ATMS must be installed in at least two centralised, resilient data centres in each country. The system will support the Traffic Management Centres (TMCs) in the Netherlands (6)[10] and in England (8)[11].

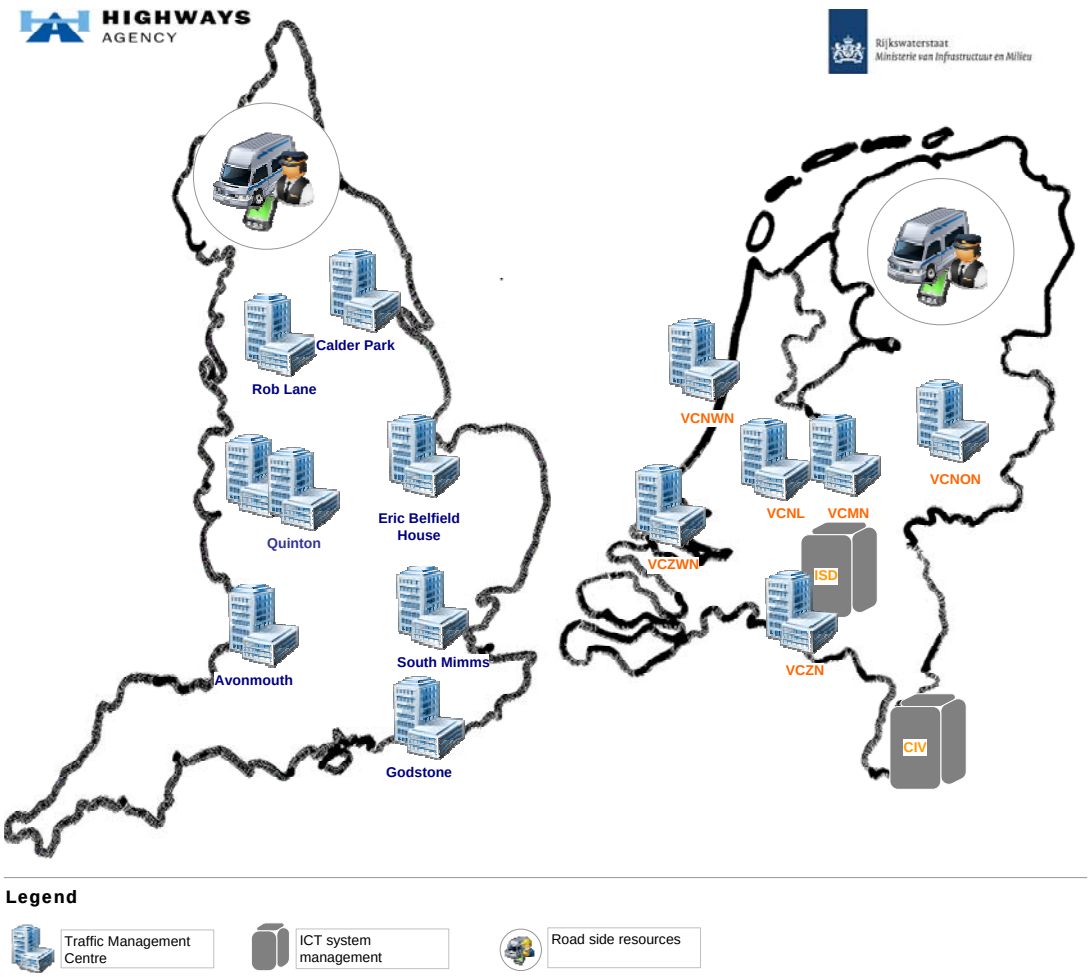


Figure 4 operating sites

localization

The ATMS software must be the same for both installation sites but the software will be installed on a different IT infrastructure and must be configurable such that

[10] Rijkswaterstaat intends to man a Unified Service Desk to cover all Mission Critical Systems on their own ICT system management site (ISD and CIV).

[11] Although the HA is not intending to support integration with tunnel and bridge systems in the initial deployment this decision is likely to be reviewed over the life of CHARM and so it must be possible to add this capability and consequently extend to other sites.

it follows all standards of the operating site. Localisation per operating site has impact on the following aspects of the ATMS:

- cultural aspects like driving regulations, metrics and language;
- infrastructure aspects like the road layout and locations of road side sensors and actuators;
- operational aspects like the configuration of business rules, calculation rules, parameters and response plans;
- technical aspects like the use of standards and protocols for the incoming and outgoing data;

organisational aspects like the size and responsibilities of teams, definition of roles and responsibilities and the availability of resources.

2. Current system or situation

2.1. Background and objectives

Rijkswaterstaat and Highways Agency have been operating several Traffic Management Centres (TMCs), covering the national road networks of the Netherlands (NL) and England (ENG), respectively. Jointly, these TMCs are responsible for approximately 10,000km of network. This equates to 7,000 km. of motorway and all-purpose trunk roads (APTR) in ENG and 3,000 km. of motorway in NL. Additionally we clear over 400,000 (300,000 EN and 100,000 NL) incidents each year.

challenges

Both organisations share similar problems and challenges in relation to the technology within their TMCs, such as: labour intensive systems; constrained business and technology flexibility and operational resilience; vendor lock-in; and increasing cost of ownership. CHARM aims to address these issues.

objective

The common objective for CHARM is to provide a modern and open technology platform that is both flexible and scalable, enabling resilient, efficient and effective operation of a road network now and well into the future, supported by an effective supply chain solution.

scope

The project scope includes processes related to traffic management performed within the regional, national and other non-Agency TMCs operated by Rijkswaterstaat, and the regional TMCs operated by Highways Agency.

differences

Although the background, objectives and scope definition are very similar for both agencies there are also differences. These differences relate to:

- the interface standards or data exchange formats for moving data between roadside equipment and the TMCs;
- the infrastructure;
- the distribution of responsibilities for processes over different organisational units; and
- the priorities for software capabilities.

Chapter 3.3 elaborates on these differences and similarities.

2.2. Operational policies and constraints

Relevant HA policies

- Highways Agency Future Operating Model

  The Future Operating Model (FOM) is an ongoing initiative endeavouring to maintain the service level to travellers in a way that reduced the service delivery costs to the 2010 Spending Review level. To achieve this, the Traffic Management Directorate (TMD) centralised common non-operational functions and standardised operational and non-operational processes and procedures within the TMCs.

- TMD10+

  The Highways Agency future strategy for effective customer service through traffic management across the strategic road network.

- Government ICT Strategy

  The Government ICT Strategy sets out how government ICT will enable the delivery of public services in very different ways to the past. The approach is characterised by a strong centre and continued commitment to greater transparency through regular and open reporting.

Relevant RWS policies

- Business Plan 2015 (Dutch: Ondernemingsplan 2015)

  A business improvement programme aimed at uniting the former regional TMCs by business process. Another relevant element is increased cooperation with other (traffic managing) agencies and a significant reduction in staff.

- Long-term perspective of Traffic Management and Traffic Information

  A programme for the long-term development of traffic management and traffic information, originally named VMI, now known as "Beter geïnformeerd op weg" (translation: "Better informed road users"). It states that the collaboration between RWS and the industry must be intensified and that the industry will play a crucial role to satisfy the information needs of the road user in the future. Traffic management should be a mix of private and public services in which the national, regional and urban perspective must be united.

- Rijkswaterstaat's policy on TMC system management

  A policy for TMC system management formulated by the RWS ICT directorate (CIV). Key elements of this policy are:
  1. RWS will continue to operate its TMCs with its own staff;
  2. CIV is responsible for the RWS ICT environment and RWS generic ICT building blocks (e.g. data centres, communication networks, Enterprise Service Bus, access tools, identification / authentication mechanisms, etc.).

These policies result in the following general principles for the CHARM-ATMS:
- Needed staffing must not increase,
- Service to users and customers must not degrade,
- Collaboration with the industry and other Traffic Management Agencies must be supported,
- Support and maintenance of the application must be a transparent and open process.

2.3. Description of current system or situation

The road networks managed by HA and RWS are, together with those of the Scandinavian countries, among the safest in the world. One of the factors contributing to this position is the attention paid to road safety in traffic management processes and systems. Significant parts of both networks have

automated queue protection. A new system may not have any detrimental effect on road safety.

Both networks have similar and high traffic densities (about 20 million vehicle kilometres per motorway kilometre per year) over the whole network, with (much) higher densities in metropolitan areas. Inductive loop detectors and matrix traffic signals are used extensively. In The Netherlands, distances between junctions and interchanges are short, and speed limits are not uniform.

The current operational environment consists of:
- 7 Regional Control Centres within the Highways Agency
- 5 Regional Control Centres within the Rijkswaterstaat
- 1 National Traffic Management Centre within the Highways Agency (NTOC)
- 1 National Traffic Management Centre within the Rijkswaterstaat (VCNL)

RWS and HA also expect to operate the CHARM ATMS from other locations to meet operational needs.

Appendix B provides more detailed information regarding the number of roadside devices for the two operational environments.

2.3.1. Description of generic environment and functions

The work of a Traffic Operator is supported by many separate applications that have been developed largely independently over time. The following is a categorised list of application[12] functions that are used by the Traffic Management Centres.

A. Functionality to **monitor and control** the status of one or more of the following instruments or measures:
   - opening and closing lanes;
   - queue (protection);
   - start and stop hard shoulder running;
   - roadside signs and signals;
   - variable message signs (VMS), fog detectors and ambient light monitors;
   - roadside outstations;
   - weather stations;
   - tunnel devices, such as ventilation and lane control signals;
   - traffic lights status;
   - motorway lighting;
   - ramp metering & queue length;
   - video viewing and control;
   - traffic information; and
   - voice communications.

[12] The intention is to replace most of these applications by services in the CHARM ATMS.

B. Applications that function as a **switch or bridge** (with some local functions) to the following equipment:
   - voice recording equipment;
   - large screen displays;
   - video imagery from cameras to displays and other outputs;
   - tetra radio network for Traffic Officers;
   - motorway telephones;
   - public telephone network;
   - call recording equipment; and
   - CCTV cameras.

C. **Databases** that store or validate configuration data about:
   - locations; and
   - locations of instruments and equipment.

D. Functionality to **log** information about incidents, operational actions, system actions, faults, status changes and other input/output data and allow operators to record information about the actions they have taken in response to incidents.

E. Functionality of existing applications (or one command and control system) that provide a wide range of functions to support the **workflow** of the operator and provide interfaces to other systems, specifically police forces and national vehicle recovery operator.

F. Functionality to configure a system (**configuration**) by updating business rules that control authorisation, data validation and configuration.

G. Functionality to create standard and ad-hoc reports (**reporting**) about events and activities.

H. Functionality to collect data (**data collection & aggregation**) from road side devices and transform it into meaningful information that can be used by the operator or system to define traffic measures.

manual process

Many Traffic Officer tasks dealing with managing staff have to be undertaken manually[13] using business applications and browser-based services. The list below is not exhaustive but it illustrates the range of tasks and information sources:

- rostering personnel;
- rostering vehicles;
- briefing and information gathering;
- debriefing in order to review incident handling use many information sources;
- transferring tasks between RCCs as a result of failure or workload balancing;
- communicating with certain organisations interested in traffic;
- reporting;
- system configuration; and
- (extensive) use of telephony.

[13] The intention is to support these operational processes with automated support in the CHARM ATMS.

in scope applications

The applications that will be replaced by CHARM ATMS meet all of the following criteria:

- it is an application (thus not a system), middleware, office software or a hardware subsystem;
- it provides only CHARM functions;
- it is either 'in development' or 'operational'.

2.3.2. Description of HA as-is application landscape and IT infrastructure

The HA has seven Regional TMCs, called Regional Control Centres (RCC) that contain IT infrastructure to support the regional business processes. At present, the seven centres each have their own equipment room (data centre). In addition, two data centres support the systems used for incident recording, resource dispatch, radio and telephony. The national TMC, called the National Traffic Operations Centre (NTOC) near Birmingham, has the IT infrastructure to support consolidation of the information of the regional TMCs, in addition to its own roadside devices. NTOC then publishes traffic and travel information on behalf of the HA through subscriber services and dedicated websites. The national TMC has two data centres, one on site and a fall-back data centre in Darlington.

Note that the data centres mentioned above will not be used for CHARM, rather the CHARM system will be sited in a national data centre, with connectivity, facilities, IT infrastructure and service management procured separately by the HA.

in-scope application

The present traffic centres run more than 50 applications that will be replaced by CHARM and have:

- 12 types of interfaces to roadside systems and devices; and
- 10 types of interfaces to information systems providers, other TMCs or users.

2.3.3. Description of RWS as-is application landscape and IT infrastructure

Rijkswaterstaat has five Regional TMCs that contain IT infrastructure to support the business processes. The national TMC (VCNL) in Utrecht has the IT infrastructure to support consolidation of the information of the regional TMCs. ICT system management is distributed over three locations offering management support, first level support, tactical support (configuration services) and application hosting for test purposes. A computer centre (RWS CC)[14] hosts operational, tactical, strategic and office applications.

in-scope application

The present traffic centres run more than 44 applications. Some of these applications will be replaced or decommissioned in the coming 3 years. Existing applications (27) of RWS that will be replaced by CHARM have:

[14] The RWS CC is not the Rijksdatacentre (RDC) but will be moved to RDC in the short term.

- 15 types of interfaces to roadside systems and devices; and
- 16 types of interfaces to systems of information providers, other TMCs or users.

For some systems the business logic (now processed in the TMC) is within scope of CHARM and the roadside logic and control is out of scope for CHARM.

2.3.4. Differences between RWS and HA organisation, processes and technology

- RWS is more proactive than the HA in how it undertakes Dynamic Traffic Management, using pre-defined response plans[15] to keep road users moving.
- The RWS national TMC is currently unable to set signs (VMS) at the regional level and does not intend to do so in the future. The HA national TMC is able to set signs at the regional level and, if they adopt response plans, would like the flexibility within the system for the National TMC to do whatever the Regional TMC can do and vice versa.
- HA provides traffic information directly to the travellers whereas in the Netherlands, RWS only provides information to value-added service providers (via the National Data Warehouse) who undertake the function of providing information to the public.
- The responsibility for activities at regional, national or roadside level differs between HA and RWS. For example: in some circumstances, the HA can control traffic lights around junctions at the regional level, whilst in the same situation RWS needs to send a request to a regional traffic centre because they are not authorised to control traffic lights at the regional level. Also the level of integration and collaboration between the RWS and urban traffic authorities is significant in terms of business process, technology usage and information exchange, whereas in the HA there is no technology integration with urban traffic authorities and very limited process integration and information exchange.
- HA has a central contact centre for calls, whereas RWS have several contact centres for different types of incoming calls.
- Both the roles assigned to a person and the way personnel collaborates in a team differs between HA and RWS.
- Both agencies have applications with different proprietary interfaces to similar technology.
- The adoption of non-proprietary standards (like Datex-2, Shapefile, DVM-Exchange, OpenLR) differs per agency.
- Both HA and RWS intend to provide and manage the IT infrastructure for CHARM. RWS will use its own, existing, equipment while the HA will use other contracts to provide the infrastructure.
- The HA has a data interface with local police forces whilst the RWS does not.

15 The word 'scenario' is commonly used in the Netherlands for a response plan but RWS has decided to adopt the more accurate term 'response plan' within the CHARM program and in this document.

- RWS has its own service desk as single point of contact (manned with RWS personnel), whereas HA has outsourced this function.

2.4. Users or involved personnel

internal

The internal users are actors that have a direct access to CHARM ATMS from the premises of a National or Regional Traffic Centre, or roadside. Below is a description of the various actors and the different roles they can have[16].

- **National Traffic Operator** is responsible for accessing updated incident information to assess the strategic response required, setting strategic signs and signals with one of the following roles: Strategic Traffic Operator, National Liaison Officer or National Rostering Team Member.
- **Regional Traffic Operator** is responsible for all incoming and outgoing information for a regional traffic centre (incidents, radio, signs, signals, on road crews, calls from the public) potentially having a special focus expressed by one of the following roles: Emergency Operator, Tunnel Operator, Bridge Operator or Call Handler.
- **(Regional) Traffic Management Centre Supervisor** responsibilities include but are not limited to:
  1. Allocation of roles to Regional Control Centre Operators at the start of each shift.
  2. Management of day to day operations of a team of Traffic Operators in a Regional Control Centre.
  3. Coordinating execution of workload sharing and transfer.
  4. Brief and debrief of Regional Control Centre Operators.
  5. Management and decision making for escalated incidents.

- **Operational Support Officer** is responsible for evaluating, reporting and improving the procedures and system configuration for the Traffic Operator having one or more of the following roles: Transport Planner, Road Network Operator, Traffic Predictions Operator, Event Planner or Environment Management Operator.
- **Traffic Officer** operates from a roadside location with one of the following roles: Traffic Officer or Officer of Duty.
- **Traffic Officer Supervisor** allocates roles and tasks to individuals on shift and provides information about on-road Traffic Officers booked on and off shifts.

external

The external users that will have access to the information provided by the CHARM ATMS are:

- **travellers** with one of the following roles: Static Traveller or Dynamic Traveller;
- third parties, service providers; and
- other TMCs.

[16] The list is based on an analysis of the roles and responsibilities used at HA and RWS there is a mapping between the role names used by the HR department of HA and RWS and the role names described here.

support

The **System Manager** is a user involved in System Management Support and has direct access to CHARM ATMS in order to manage and maintain the CHARM ATMS with one of the following roles: Technology Manager, Technology Maintainer, Service Manager or Service Provider User.

Check the glossary for full definitions of roles.

2.5.Support concept

The systems that are used for the processes that are in scope for CHARM have different support levels and different SLA contracts varying from 24/7 support to support for office hours.
For each system the support procedure may also differ. In all cases a multi-tiered technical support process is implemented involving potentially different suppliers. There is no overall approach to handling system failure(s) and one system failure may lead to several issues with multiple systems.

3. Justification for, and nature of changes

3.1. Justification for change

legacy

Both the Highways Agency (HA) in England and Rijkswaterstaat (RWS) in the Netherlands manage their highway networks via a series of technologies employed by the Traffic Management Centres , some of which date back to the 1970s.

drawbacks

These technologies have a number of significant drawbacks:

- They are becoming increasingly difficult to support and maintain.
- They have been developed over time so that various functions are controlled individually rather than in an integrated fashion.
- There are numerous maintenance contracts in place, which are inflexible and costly.
- The existing systems have difficulty coping with the current and planned improvements to the network.
- The current systems cannot cater for emerging technology requirements e.g. 'in car systems'.

evolution

Recent policy changes with respect to service levels, delivery costs and innovation are difficult to implement with the current technology.

3.2. Description of changes needed

The list below present the changes needed:

1. An software system that is highly configurable by authorised and trained personnel (Operational Support Officer) without the need to upgrade or update the software package.
2. A software system with one consistent user interface that integrates the following capabilities:

- information provision;
- dynamic travel management;
- incident management;
- resource management;
- event planning; and
- contact management.

3. A clear distinction between the responsibilities of the software package supplier, the roll-out contractor, the service provider and the client formulated in a contract (SLA) (for more information see paragraph 4.8).
4. Lower cost of ownership.

3.3. Other changes considered

procurement strategy

The following alternative ways to deal with the changes needed have been considered and rejected:

- Maintain the existing systems (because it is too expensive);
- Continue to develop the existing systems (because of uncontrollable costs and delays);
- Buy a core + modules (because the agencies lack expertise);
- Buy a managed service (because there are no candidate suppliers);
- Build a solution specific to HA / RWS requirements under the responsibility of HA / RWS and by HA / RWS personnel (because RWS and HA have not been successful in this area the past).

3.4. Assumptions

existing package

After conducting two rounds of market consultation, the CHARM programme reached the conclusion that the procurement of a common software package for an ATMS is realistic. This ATMS must integrate all required capabilities and must be implemented and serviced for other customers. Localisation will be done through configuration of the package. Bespoke facilities (i.e. customisation) need to be kept to a minimum.

cost savings

Full implementation of CHARM is expected to realise significant savings on software maintenance costs. Moreover we expect that the ATMS will enable the Agencies to achieve with fewer staff in the TMCs.

faster response

CHARM is expected to deliver economic benefits through faster resolution of incidents, as a result of automation both within and between TMCs, and between TMCs and Traffic Officers and service providers on road. Economic benefit is also expected from:

- improved journey times;
- improved journey time reliability;
- improved safety; and
- reduced estate costs.

4. Concept for a new system

4.1. Capabilities of the ATMS

The ATMS needs to support the following capabilities:

- **Information Provision**: provides the capability for the organisation to collect, process and disseminate information to both internal and external stakeholders through the following high level functions:
  A. Input from traffic monitoring equipment and external systems will be processed to create high level information about the (actual and predicted) traffic and road conditions based on calculation rules and decision logic.
  B. The traffic and road conditions will be presented to an operator who monitors the information and checks the validity.
  C. Based on control logic or an operator's judgement, information will be combined into events. The operator validates the events and controls which events are disseminated to which stakeholder by what means.
  D. The derived information and event information is transformed into the agreed format (data feed) and disseminated to the appropriate stakeholders.
- **Dynamic Traffic Management**: provides the capability for the organisation to monitor the road network and to manage the demand and capacity on the road network through traffic measures, by the following high level functions:
  A. Input from traffic monitoring equipment will be processed to create high level information (including impact analysis) about the actual traffic conditions based on calculation rules and decision logic.
  B. The actual traffic conditions, status information and recommended traffic measures will be presented to an operator who monitors the information and checks the validity.
  C. Based on control logic defined in a response plan or an operator's judgement, actions are taken to improve the traffic flow, improve traffic safety or inform travellers. The operator validates the recommended actions that may not be automatically activated.
  D. Actions are transformed into the agreed information format (data feed) for the agreed output channel(s) or into new signals for actuators (e.g. commands).
- **Incident Management**: provides the capability for the organisation to manage the response to incidents that occur on the road network from discovery through to restoration of normality, by the following high level functions:
  A. The input from road emergency contractors, emergency services and general public will be processed to create high level information[17] about an incident and establish its impact based on calculation rules and decision logic.

[17] The input is ongoing as information is received throughout the lifecycle of an incident.

B. The location of incidents, status, severity and impact on traffic conditions will be presented to an operator who monitors the information and checks the validity.
C. The operator defines a response plan to improve the traffic situation, improve traffic safety or inform road users.
D. The response plan is transformed into the agreed format (data feed), actual signals for actuators or instructions for on road resources.

- **Resource Management**: provides the capability for the organisation to manage its internal resources (i.e. personnel & staff), by the following high level functions:
  A. Input about upcoming events and network performance in the past will be processed to create an event forecast and network demand forecast based on calculation rules and decision logic.
  B. The forecast will be presented to the Operational Support Officer who checks the validity and makes recommendations for needed resources.
  C. The Traffic Management Centre supervisor defines needed staffing levels, on road resource positioning and allocated shifts to support the expected demand. A resource allocation is created based on business rules and judgement of the Resource Manager.
  D. The information is disseminated to operators as a pre-shift briefing and resource plan.
- **Event Planning**: provides the capability to plan the response to forecast events notified to the highways authority, by the following high level functions:
  A. The event forecast and network demand forecast will be processed to establish the impact of an event based on decision logic.
  B. The events will be presented on a time line to the Operational Support Officer who checks the validity and looks for conflicts.
  C. The Operational Support Officer defines a response plan to minimise the impact of events on the road network and makes sure all stakeholders reach a mutual agreement.
  D. The response plan for the events is transformed into operational instructions for operators and the ATMS.
- **Contact Management**: provides the capability for the organisation to manage the interactions with its contacts (general public, police etc.) about traffic and road conditions, by the following high level functions:
  A. All contact will be registered and the information about an event (event notification) will be entered in the ATMS system.
  B. The new event information will be presented to a user (operator) who checks the validity.
  C. The operator may merge the new information with existing information, look for conflicting information and decide which stakeholders need to be aware of the new information.
  D. The event information is transformed into the agreed format (data feed), disseminated to the appropriate stakeholders and a function controls that the information is received by the stakeholder.

4.2. Business Services of the ATMS

The capabilities support the following groups of business services:

- **Infrastructure services** that are focused on making the physical road network infrastructure available.
  e.g. all services directly related to roadworks.
- **Availability services** that make the network infrastructure available for use by road users.
  e.g. all services directly related to influencing safe and compliant infrastructure like lane closure, speed limit, warning and guidance to slow moving vehicle.
- **Capacity management services** that are based on the availability services and control the available capacity of the road network.
  e.g. all services directly related to influencing the network access (ramp metering), network flow (tidal flow control) and activities to minimise the influence of incidents.
- **Demand management services** that influence and control driver behaviour and choices to regulate the demand on the road network.
  e.g. all services directly related to influencing the travellers' route like diversion routes, delay and travel time.
- **Information provision services** that collect, process and disseminate information that can be used for (operational) traffic management and delivery of traffic information to external parties.
  e.g. all services directly related to informing travellers like congestion information, cause, traffic data and the expected impact.
- **Planning and reporting services** that allow the agencies to plan a response to known and expected events on the road network and report performance.
  e.g. all services directly related to planning like traffic forecasting, response plan development, crowd generating events, road work planning.
- **Supporting services** that, whilst not directly operating the road network, allow for the operational functions to be delivered in an optimal manner.
  e.g. all services related to system functioning like workflow, authorization, help, training, task allocation.

The following table indicates for each process the services that will be used for executing the process.

Service Group	information provision	dynamic traffic management	incident management	resource management	event planning	contact management
Infrastructure services		x	x	x	x	
Availability services	x	x	x			
Capacity management services		x	x			
Demand management services		x	x			
Information provision services	x					
Planning and reporting services		x	x	x	x	
Supporting services	x	x	x	x	x	x

See Appendix C for a breakdown of the operational services into level 3 services to illustrate details of the expected behaviour and configuration of the ATMS.

4.3. ATMS Information processing

input

The services use the following data from road side equipment, information providers or partners:

- Traffic Monitoring Equipment, e.g. data from induction loops.
- Status data, e.g. out-of-order and function level of actuator.
- Closed Circuit Television Cameras, e.g. video streams received from a PTZ router.
- Audio Signal, e.g. audio streams received from an audio router / telephony.
- Emergency Service data, e.g. police, fire & rescue service, medical service.
- Weather Monitoring Equipment, e.g. wind, fog, and ice detection.
- Events data, e.g. On Road Emergency Contractor.
- Events data forecast information, e.g. forecast crowd-generating events.
- Vehicle Recovery data, e.g. from Vehicle Recovery Contractor.
- Status of Roadworks data, e.g. from Maintenance Contractor.

events

The system's input is related to current and planned events. Current events (events that actually take place) are classified as emergency events (such as accident, attack or calamity) and non-emergency events, of types:

- Traffic events, such as congestion, stopping a vehicle, vehicle presence (refuge area).
- Incursions, such as human incursions, animal incursion, debris, hazardous spillage.
- Ambient environmental conditions, related to fog, ice, rain, temperatures, snow, wind.

Examples of planned events are crowd generating events, road works, extreme weather forecast and rush hour.

history — Both historic and actual data may be used by the business services.

multi-layered — The input and output of the ATMS may be related to locations in the national, regional or urban network, also known as a multi-layered network. It is expected that the CHARM ATMS offers the same functionality for monitoring and responding, irrespective of the network layer it is related to.

information — These data may be used to create higher level information that is used for decision making and monitoring. The transformation of data to information must follow the business rules and calculation rules of the operating site. The information produced includes but is not limited to:

- Travel time, e.g. for a trip or route.
- Traffic delay, e.g. for a trip or route.
- Traffic changes, e.g. traffic flow against expected profiles.
- Actual road condition, e.g. combining several sources.
- Network demand forecast information, e.g. based on events.
  Events should be detected on all roads that impact the road network that fall under the responsibility of the TMC that the ATMS supports.
- Event Detection, e.g. automatic detection or detection by staff.
- Impact of event.
- Messages about events, e.g. information from general public and service providers.
- Optimal resources.
- Status and location of on-road resource unit.
- Staff availability.

internal products — The ATMS will create and store internal information products. All internal information products may change over time. Such changes should be versioned and logged. The following is a list of the most important internal information products:

- The response plan is an internal product to communicate control strategies for actual or planned traffic events between stakeholders[18]. The control plan combines services to improve traffic flow and safety. Typical services are: lane closure, speed limit, diversion route, warning, and ramp metering control. All services should be predefined in the ATMS such that an operator may select the service and configure it for a specific situation and location;
- The (Pre-)shift briefing information consists of all relevant information that may affect a shift and must be shared between operators;
- The allocation of resources consists of a planning for the allocation of resources to cover shifts.
- The incident log consists of time stamped information about an incident.

output — The ATMS produces information products and data for partners or roadside equipment. Examples of the ATMS output data include;

- Commands to actuator (e.g. signal, variable message sign, ramp metering, traffic signal or change to object status).

[18] Stakeholders may be responsible for a municipal road

- Traffic information.
- Service requests to other TMCs.
- Requests to on road resources.
- Incident logs and management information.

channels

ATMS output is expected to be structured in such a way that it can be used as a single source for distribution over different channels[19]. The following channels are in use:

- websites and social media;
- radio;
- audio to audio router[20] / alarm signal;
- PTZ instructions to PTZ router;
- SMS messaging; and
- in-car data and mobile device applications.

level of automation

The transformation from input data to output data involves different levels of automation. The level of automation required is dependent on the business service that is executed, and on the task and situation at hand. The Agencies distinguish the following levels of automation:

- Manual: a person does the whole task, e.g. talk to supervisor.
- Operator control: a person does the task up to the point of turning it over to the computer for implementation e.g. control camera and select image screen.
- Decision support: a computer helps to determine options and suggests one, which the user need not accept, e.g. trigger based on a response plan.
- Automated after approval: a computer selects an action and implements it upon user approval, e.g. execution of a response plan.
- Autonomous with notification: a computer does whole task and informs the user of the action taken, e.g. AID; and
- Autonomous: a computer does whole task and informs the user what it did only if the user asks explicitly, e.g. travel times for different routes on VMS.

The ATMS should support these different levels of automation that are configurable depending on the task at hand and the (severity) of the situation that is being managed.

level of integration

The ATMS will receive data from different sources and produce different kinds of information for different tasks at hand. The Agencies distinguish the following levels of integration for data and information:

1. None: The user integrates information from different applications.
2. User Interface: integration at the user interface level unifies different user interfaces in one common system, e.g. a portal or a plug-in-based user interface.
3. Business Logic: integration at the business logic level unifies different implementations of business logic, each using its own data sources, under a common user interface;

[19] A service provider or third party may act as intermediate to distribute the structured data to different channels.

[20] Video and audio streams are not processed directly by the ATMS but instructions from/to a router or switch that processes video and audio streams is in-scope of the ATMS.

4. Data Source: integration at the data source level provides a unified view of heterogeneous data sources.

The ATMS should support information and data integration at the highest level i.e. the Data Source level. For example, all data that are presented to the user should be referenced to time-stamp recorded when the data were measured, as opposed to when the data are received by CHARM.

4.4. Adaptability and scalability of the ATMS

volatile data

The environment of the ATMS will evolve continually. Consequently the Agencies do not know exactly with what new kind of data and situations the ATMS will need to handle after installation. It is certain that the input, output, control logic and user interface needs will change over time. The following is a list of (configuration) data items are expected to be highly volatile:

- Outgoing data feeds or information channels e.g. mapping from internal information products to external data feeds (sometimes called ETL).
- Incoming data feeds or new types of information objects e.g. mapping from external data feed to internal information product;
- Response plans e.g. conditions, actions, time intervals and constraints to guide the response to a situation or an event.
- User authorisation e.g. which role is authorised for a process or has access to information.
- Look and feel and sound in GUI, e.g. colours, icons, font, font size, language.
- Configuration updates e.g. location of sensors and actuators, (temporary and permanent) changes in road network.
- Visualisation of road network e.g. schematic view for new road network configuration.
- Localisation e.g. changes to culture specific settings like miles/kilometres, date format, driving direction.
- Configure new types objects in GUI e.g. actuators, sensors and channels.
- New data visualizations, queries e.g. charts and reporting lay-out.
- New data prediction algorithm e.g. travel time.
- New geographical domains e.g. changes to province borders.

adaptability support

The ATMS must deploy the most flexible and user-friendly methods to adapt the software to changes effectively. Examples of methods that the ATMS may deploy to deal with adaptation include:

- import of configuration file;
- data entry supported by wizard / form;
- update to parameter;
- update to decision table;
- add new or update business rules;

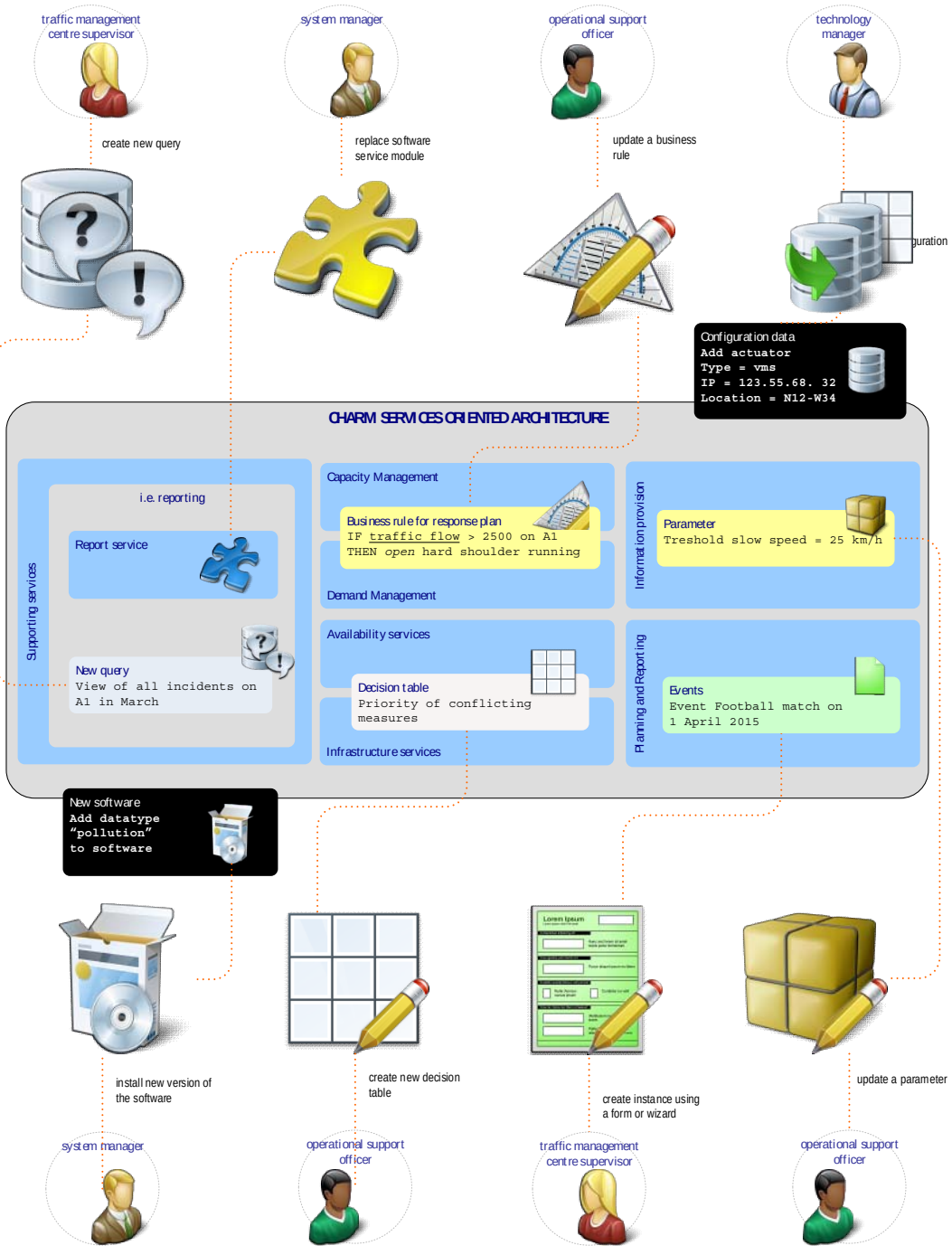
- add new, update or replace software module (eventually from other supplier)[21]; and
- new version of software (software update).

The ATMS should support adaptability in such way that the need for software updates to react to changes is minimised and the configuration, test and deploy time needed for a change is minimal.

The following diagram shows examples of expected changes to the ATMS in response to an evolving environment, including the methods and users that may be needed to accommodate these changes. The colour scheme in this diagram does not have any special meaning.

[21] For example to experiment with new algorithms to predict congestion or detect incidents motivates the need for a service oriented architecture.

Figure 5 Example system management methods



change responsible

Changes to the ATMS configuration present a risk to operational continuity. Therefore the ATMS must have mechanisms to trace changes to a responsible user, test changes and roll-back changes. Figure 2 *context diagram operational use* on page 9 shows which roles will be involved in what type of change. The adaptation method should be chosen in accordance with the expertise level for that role.

scalability

Changes in the environment of the ATMS may also relate to the volume of data that needs be processed or disseminated. It is expected that the number of sensors and actuators will decrease while the amount of output data may increase. System performance must be maintained when data volumes increase.

workload balancing

To deal with unexpected failures or high workload on a site, the ATMS must support a workload balancing mechanism such that a Traffic Management Centre Supervisor may transfer part (or all) operations to another TMC. Examples of operations that may be transferred to another TMC include:

- reassignment of the management of individual activities;
- reassignment of the management of a particular stretch of road, such that responsibility for monitoring the road and controlling assets passes (with agreement) to a different control centre;
- all subsequent incidents (following point of handover) can be handed over to an alternative centre for management; and
- all management activities, including incidents already under management shall be transferred to another centre (i.e. a complete takeover).

responsibilities

The responsibility for a TMC may change. For example, the boundaries of traffic management regions may change over time. The reasons for these changes can be different e.g. a part of the network is added or removed from the managed area. As well as these relatively simple changes, a periodic complex restructuring of the regions can be necessary. For example, the level of automation of traffic incident handling increases significantly, so operators are able to serve larger geographical areas. Therefore it could be advantageous to combine two regions into a larger region that will be served by one traffic centre. Conversely splitting a region is also possible. The ATMS must support such changes.

4.5. Quality attributes of the ATMS

GUI performance

The RWS CHARM ATMS application must support the numbers of users, devices and services as specified in Appendix B with a high performance. Many applications in the past have not passed acceptance testing because the performance of the application was unacceptable for the operators. Operators expect the user interface to provide immediate feedback and fast response times.

data performance

Another critical performance factor is the interval between the time stamp of a measurement and the time stamp of the aggregated data becoming available in the Common Operational Picture. The operator needs to be confident that the Common Operational Picture is up to date and accurate.

graceful degradation

The ATMS is a mission critical system. Examples of system failures and their impact on the traveller include:

- Inability to remove lane closure after nightly road work, resulting in 500% more congestion in morning rush hour.

- Mistakes in travel time calculation, resulting in unreliable arrival times for travellers.
- Inability to close lane after incident, resulting in dangerous situation for travellers and on road resources.

In the event of failure of one function or component of the ATMS, other functions should continue to operate properly to minimise the impact of such a failure (also known as graceful degradation).

always operational

Traffic Management Centres are operational 24/7 and will be using the ATMS daily (24 hours, 7 days a week and 365 days a year). Therefore system maintenance must not cause any system downtime.

ergonomics

The ATMS will be used under stressful conditions when rush hour, incidents, security measures and rare weather conditions occur simultaneously. In such situations the use of the ATMS must be extremely efficient and prevent the user from making mistakes wherever possible. The Agencies expect the new ATMS to take the latest human factors research into account and test the ergonomic characteristics of the application under stressful conditions.

real time processing

The ATMS must guarantee a response to several event types within strict time constraints[22]. Examples of such events include:

- The processing of raw sensor input into meaningful information (e.g. resulting in a Common Operational Picture, updated every minute).
- The processing of sensor input into event triggers and autonomous actions (e.g. queue protection).
- The delivery of data to external partners (typically updated every minute).

This is known as real time processing[23].

security

The protection against cyber attacks, hackers, malware, viruses and other disruptive or damaging threats, is of great importance to the HA and RWS. The UK and the Netherlands governments demand certain mandatory requirements for security. It is recommended that potential providers consider these rules and regulations with care.

4.6. Interfaces of the ATMS

operational use

In Figure 1 *schematic scope overview* on page 6 shows the interfaces for operational use (labelled A - L). For each interface a short description with examples of the public standards[24] that are currently used is provided below:

A. Interface with Traffic Management Centre (TMC) of other traffic management authorities, e.g. counties (provinces) or cities. Information exchange about traffic statistics and road conditions and the control of actuators and signs of

[22] Conversely, a system without real-time facilities, cannot guarantee a response within any timeframe (regardless of actual or expected response times).

[23] The use of this word should not be confused with the two other legitimate uses of 'real-time'. In the domain of simulations, the term means that the simulation's clock runs as fast as a real clock. In the processing and enterprise systems domains, the term is used to mean 'without perceivable delay'.

[24] The ATMS also needs to support proprietary standards when no public alternative is in use by the agency.

other traffic management authorities (RWS is working with a local standard called DVMExchange for this purpose).

B. Data streams and interfaces with parties either outside the Agencies, or applications that are within the Agencies, but outside the operational traffic management domain. This category includes interfaces varying from weather information providers to parties like the NDW in the Netherlands, an organisation that relays all traffic related (real-time) data to the public. Information flows can be in either direction.
C. Interfaces with future services and applications, and also future road-side and in-car systems.
D. Control of signs, signals and traffic lights. Receiving status information and log messages. Controlling traffic lights, signs and signals in groups by using a coordinating algorithm.
E. Receiving sensor data from a large number of road-side systems that gather statistics about traffic speed and intensity, but also other devices that detect fog and wind. RWS is using the public standard Datex-2 for this information.
F. Interfaces with legacy traffic management application data. This interface may not be needed if all legacy data is to be migrated to the new ATMS.
G. Interfaces with emergency service organisations (police, fire department, ambulance), vehicle recovery companies, and parties that perform roadworks and debris removal after traffic incidents. The HA has a special secure network for communication with the Police called criminal justice exchange (CJX).
H. Business services such as e-mail, internet access and printing.
I. The ATMS data store is expected to be a database.
J. The Traffic Officer sees the same information as the operator (common operational picture) and updates the ATMS with new information from a roadside position.
K. The support officer defines response plans to planned or actual situations and makes sure the configuration of the ATMS is up-to-date.
L. The operators share a Common Operational Picture of the road conditions and response to events in the geographical area that they are responsibility for.

COP

Having a Common Operational Picture is considered to be an important benefit of an integrated ATMS. This Common Operational Picture should guarantee that all information available for one operator is also available for other operators and Traffic Officers. An effective user interface design should ensure that the user has a good overview of relevant information for the task at hand.

new configuration

Besides these operational interfaces the ATMS will need interfaces for regular configuration updates. A configuration update must not affect system performance. Location referencing for configuration updates should use a widely-used open standard, such as Open LR.

4.7. Users / affected personnel

See paragraph 2.4. for a list of role names for users / affected personnel.

changes

The roles of the personnel will not change but the way they realise their objectives will change by using the new ATMS:

- All personnel need to adjust to a new user interface.
- The Operational Support Manager will take on more responsibility for the configuration and hence the functioning of the system.
- New personnel may be needed to configure the application.
- The number of roles or combination of roles owned by one person may change.
- The location that is responsible for certain processes may change.

HRM policies

In order to safeguard the health of the operators and to reduce the risk of errors, RWS and HA have local policies and guidelines regarding usability, workload and health for systems used in control rooms, as well as a set of guidelines for making the generic requirements specific for a particular project. Adherence to these requirements and guidelines is mandatory, hence the new ATMS must be compliant with these guidelines.

4.8. Support concept

requirements

The support concept for the complete traffic management solution is characterized by the need to manage, integrate and operate a multi-supplier landscape of systems, IT infrastructure and services providers to support Traffic Management Centres. The inherent complexity of these arrangements must be shielded from end users; Traffic Management Centres need to be able to rely on a single point of contact for all service related issues and their resolution

strategy

To this end, the strategy must support the following goals:

- Clear accountability for service performance by nominated providers at every level in the preferred service delivery model, providing seamless end to end delivery of CHARM and CHARM-related services.
- A point of contact, which insofar as is possible, integrates applications and IT infrastructure support activities from all providers into a single service operation with a single service desk.
- Minimising contractual interfaces between each organisation and its service providers.
- Governance to maintain integration between software and IT infrastructure components supplied by different providers as upgrades are received, for the whole life of the CHARM solution.
- A strategy designed to support variations in realisation of the overall solution or the phasing of software development between RWS or HA.

standards

HA and RWS intend to implement BiSL, ASL and ITIL v3-compliant service management processes and to achieve ISO 20000 accreditation. The processes, systems or services to deliver, operate or support the CHARM Programme must therefore be compliant with these standards.

5. Operational scenarios

The operational scenario's are not intended to be complete in terms of the processes, types of events and information needs for CHARM. The listing of screens, information and actions are indicative for the expected behaviour of the CHARM ATMS.

This operational scenario is based on a typical afternoon in a Traffic Management Centre where some planned and some unplanned events occur.

Step	Description	High level services *Capability*
start	Operator 'Elly' comes on shift at 15:00.	
A.	The first action is shift transfer briefing. Purpose is: - To be allocated a task (e.g. responsibility for part of the network) - To become aware of any particulars relevant to the upcoming shift. - Availability of staff, workload, workflow, breaks and level of qualifications During the briefing it appears that the previous shift has set this month's record for incident clearing time. The system will automatically generate this type of report.	Supporting services
B.	The operator logs on and is granted access to all functionality she needs for her task and is both qualified and authorized for (single log-on or log-over).	Supporting services
C.	The workflow inventory screen of the ATMS gives an overview of the following information and is available during the shift: - Traffic forecast including weather forecast - Planned events (e.g. road works, crowd generating events) - Hard shoulder running section under control - Available response plans - Available traffic officers	*Dynamic Traffic Management*
D.	The operator then starts to build her situation awareness. The Common Operational Picture screen gives an overview of the following and is available during the shift. - The part of the network the operator is responsible for - Indication of infrastructure that is not available (e.g. lanes closed for roadworks or incidents) - Indication of traffic flow compared to free flow (including main urban roads, monitored in NL through the NDW) - Location and status of any current events (e.g. incident location, expected duration, hazardous materials etc.) - Locations and status of traffic officers - Locations and status of emergency services - Response plans that have been activated - Technological failures that affect the operation (Ideally, the operator should not be bothered with technological failures and the system will only present response plans that can actually be executed. Dealing with technology failures is handled completely by tech support)	*Dynamic Traffic Management*

Step	Description	High level services *Capability*
E.	At 15:30 a collision occurs on the A10-West southbound. The automatic incident detection warns the operator that an accident may have occurred and automatically sets the signs and signals to warn the traffic. Also, control and image of the camera nearest to the incident location are presented. The operator sees that an incident, apparently a minor one, has occurred. Two cars have collided and are blocking the third lane.	Availability services *Incident Management*
F1.	The ATMS suggests activating the incident protocol and the operator confirms this.	*Incident Management*
G.	The system provides recommendations for the actions to fulfil each step: 1. Set tactical signs to protect incident lane 2. Notify emergency services (if no e-call) and stakeholders 3. Allocate and dispatch most appropriate traffic officer 4. Select and dispatch vehicle recovery service 5. Set strategic incident warning on VMS (could be done automatically) All required actions are selected by the operator who implements them with a single button press. All actions are logged automatically. National TMC and emergency services are notified of the incident through the Common Operational Picture of the ATMS. Other organizations are notified about the incident through outgoing data streams that are automatically shown on a public traffic information website and/or used by other systems.	Availability services Demand management services Information provision services *Incident Management* *Information Provision*
H.	At 15:40, a major corridor in the city of Amsterdam has to be closed because of a serious accident. The city of Amsterdam Traffic Management System generates a service request for increased outflow via the A10-East. The CHARM ATMS decision support generates four response plans to deal with this request, taking the accident on the A10-West into account. The operator chooses the plan that predicts the most effective mitigation for this situation. This plan entails: 1. Changes in (urban) traffic light and (highway) ramp metering cycle times and 2. Activating hard shoulder running at 15:45, earlier than usual	*Dynamic Traffic Management*
I	At 15:45 the data centre fails. The operators are notified of the situation and the failover procedure is started. As soon as the other data centre has taken over, the operators are notified and can continue working on their tasks (no additional actions needed). In the meantime an alert is send to the technology maintainer, who is already working on the situation.	Supporting services
J	At 16:00, the system warns the operator of a crowd generating event scenario. The Arena stadium will start filling shortly because of the Cup Final, which kicks off at 18:00. The response plan 'CF' has been prepared and tested in an offline state of the system by a operational support officer.	*Event Planning*

Step	Description	High level services *Capability*
K.	The protocol screen for the response plan 'CF' has the following steps: 0. Start time trigger warning 1. Activate response plan that sets appropriate texts for Arena stadium destination on 20 VMS's. 2. The system warns the operator of a conflict between the accident warning message and the diversion message 3. City of Amsterdam TC is automatically informed 4. The ATMS suggests to activate tidal flow in the direction of the Arena stadium 5. The operator monitors for a smooth traffic flow towards the Arena stadium. The system will generate triggers in the case of congestion at key points (usually junctions) 6. For each trigger, the system will suggest appropriate response plans, e.g. rerouting on both trunk roads and city roads, and setting of parking signs, the latter two through the city of Amsterdam TMC 7. The system monitors the traffic situation and suggests to de-activate measures where and when appropriate	*Dynamic Traffic Management*
L.	At 16:15 the vehicles on the A10-West have been towed away and the traffic officer sends the 'road clear' message back to the TMC. The operator logs the final incident details and marks the incident as closed. The traffic officer also logs the relevant details (e.g. pictures for evaluation purposes) in the mobile access application, which are automatically uploaded into the log system.	Information provision services *Incident Management*
M.	At 19:15 there is an incoming call from the Police informing the operator about an incident at the connection between the A2 to the A10, on the major exit route from the Arena stadium. An articulated lorry loaded with cooking oil has tipped over, requiring a full closure on a slip road. No standard response plan exists for the combination of road closure, crowd event and road works on the A10 West.	Information provision services *Contact Management*
N.	The operator starts the protocol 'lorry incident with road closure' Cleaning the road is expected to take until midnight. The ATMS generates the incident response plan which is shown on a protocol screen and has the following steps: 1. Set tactical signs to close road 2. Notify emergency services (if no e-call) and stakeholders 3. Allocate and dispatch most appropriate traffic officer 4. Assess impact 5. Inform national TMC, then sitrep every 30 minutes 6. Select and dispatch vehicle recovery service 7. Select and dispatch contractor to clean the road 8. Plan and set (pre-programmed) diversion	Availability services Capacity management services Demand management services *Incident Management*
O.	A screen pops up with a new response plan and new available actuators with a brief explanation. These new response plans and actuators have been defined "offline" by the operational support officer without affecting the operational process.	Supporting services

Step	Description	High level services *Capability*
P.	The operator starts planning the diversion from the Arena stadium because of the lorry accident. This ATMS identifies that this diversion potentially conflicts with the road work planned for that night on the A10 West at 21:00. (The road work planning was provided by the road maintenance contractor in advance).	Demand management services *Incident Management*
Q.	She decides to delay the road works, logs this in the road maintenance planning system, and informs the contractor.	Infrastructure services *Dynamic Traffic Management*
R.	She then instructs the system to suggest a new timeslot for the roadworks based on traffic situation.	Infrastructure services *Dynamic Traffic Management*
S.	At 19:45, when working on coordinating the diversion while the match is just ending, an incident happens on the A9 with multiple vehicles and serious injury. The coordinator realises that the workload for the TMC has become too high, and that the roadworks on the A9 planned for 20:00 need to be handled by another TMC or need to be postponed as well. The coordinator contacts TMC Rhoon and asks if they are in a position to handle the roadworks from their TMC. Rhoon approves the transfer of tasks.	Supporting services
T.	The colleague on the Rhoon desk executes the transfer protocol. TMC Rhoon wil now handle communications with the contractor, the traffic officer and setting of signs and signals	Supporting services
U.	At 22:15 the system informs the operator that the road works, which had been delayed earlier, could start at 22:30.	Infrastructure services *Event Planning*
V.	The protocol screen for the road works has the following steps: 0. Start time trigger warning 1. Overview of the traffic measures associated with the road works (lane closures, speed limits, diversions) 2. Coordinate with contractor (the contractor can electronically notify the TMC of the start of the roadworks) 3. Response plan to be activated 4. Set signs and signals At 23:00 her shift ends.	Availability services Infrastructure services *Resource Management* *Dynamic traffic management*
W	The shift evaluation shows data about Elly's shift performance, like the number of incidents handled and the response time between incident detection and incident response. The evaluation is based on the key performance indicators configured by her supervisor.	Planning and reporting services
X	The ATMS generates an end of shift performance report and the operator records the issue that "No standard response plan exists for the combination of road closure, crowd event and road works on the A10 West".	Supporting services
Y.	The supervisor runs a periodic management reports on the operations of the TMC to see what response times his team has for incidents and to evaluate the issues recorded by individual operators.	Planning and reporting services

Appendix A. **Glossary**

This glossary contains our defined terminology that is used in this document. Synonymous forms are indicated between brackets in italic text, except for acronyms the first word is the preferred wording.

Term	Definition
action	used in the broadest sense possible meaning all activities that may be performed in response to an event including capacity measures, informing someone or providing instructions for someone to do something
All-Purpose Trunk Road *(All Purpose Trunk Road / APTR)*	A non-motorway road which is part of the Strategic Road Network.
Ambient Light Monitor	Road side device that measures the illumination level
application service *(service)*	A self-contained unit of functionality offered by the system
Bridge Operator	A Regional Traffic Operator managing the traffic and safety operation of a movable bridge
Business logic	definitions, rules, calculations and heuristics that are specific for the traffic domain and may also be specific to an implementation site
business service	a unit of functionality that is meaningful from the point of view of the environment and realized by one or more processes that are performed by the business roles
Call Handler	A Regional Traffic Operator receiving telephone calls, recording information and allocating events to appropriate TMCs.
Capability	A set of related functions, processes and application services that the ATMS system needs to offer to deliver the business objectives
Central Contact Centre *(CCC)*	A business unit within National Traffic Operations which acts as the central point of contact for people to notify the Agency of information including current event information, forecast event information and general queries in order to improve efficiency and consistency when communicating with customers and partners.
Closure of lanes *(Lane closure)*	a measure undertaken either by physical coning off of road lanes where an incident scene needs to be protected or by setting signs and signals to inform drivers about lane closures
Command and Control *(C&C)*	a series of computer systems operated by the Agency's Highways Agencies Regional Response Centres, to manage their operations, log and store details regarding both traffic and non traffic related information
Common Highways Agency Rijkswaterstaat Model *(CHARM)*	A Programme of cooperation between the Highways Agency and Rijkswaterstaat to define, with a view to jointly procure a new generation of traffic management systems.

Term	Definition
Common Operational Picture *(COP)*	A shared view on the road conditions, usually between different RCCs. Also used by RWS meaning coordinated incident management with police, fire department, emergency operators etc.
congestion *(queueing / traffic jam)*	a situation that occurs when a volume of traffic generates demand for space greater than the available road capacity
consortium	a group of people, companies, etc., that agree to work together, not necessarily a legal entity
control logic	the decision logic that drive the automated process that suggest the next task(s) an operator has to perform
Current Event	Anything likely to have a significant consequence on traffic movements.
decision logic	the business rules, calculation rules or other algorithms that drive the automated the process that derives or calculates new information based on incoming data
Discovery	The initial manual or automated identification of a potential incident by an organisation, one of its staff members or by technology
Dynamic Traffic Management	That activity which is undertaken to manage demand and capacity on the road network through influencing or directing the behaviour of road users and to ensure that traffic flow across the road network is as close to optimal as possible at all times and to protect people on the network.
Ecall	a European initiative intended to bring rapid assistance to motorists involved in a collision anywhere in the European Union - based on this definition Ecall must be positioned as input for CHARM ATMS (and not as an output channel of the ATMS).
Emergency operator	A Regional Traffic Operator taking the lead in co-ordinating the incident handling.
Environment Management Operator	An Operational Support Officer responsible for evaluating impact of expected weather prediction on road performance and human resource load eventually leading to recommendations on expected deployment of traffic scenarios.
Event	an occurrence located on or off the SRN with the potential to have a Material Effect on the SRN; Events include Current Events and Forecast Events
Event forecast	a list of all planned events by date, start time and end time that may influence normal traffic conditions
event information	used in the broadest sense possible referring to all information on something that has happened, is happening or will happen with an expected duration. Events may be planned or unplanned. Examples of events are: football match, incident, fire, road maintenance.
Event Planner	An Operational Support Officer responsible for receiving notifications of forecast events and producing forecast event plans
Event Planning	the co-ordination of activities to manage the response to forecast events

Term	Definition
forecast	estimation, prognosis
Forecast Event	A forecast event is defined as anything likely to have a significant consequence on expected Traffic Data about which there is reasonably accessible prior knowledge.
Future Operating Model *(FOM)*	A view of the processes, organisation, technology and information required to deliver an organisations core and supporting capabilities in the future.
Highways Agency *(Agency / HA)*	The organisation responsible for building, maintaining and operating the Strategic Road Network in England
implementation of diversions	Setting of signs and signals to divert traffic away from problem areas of the road network. Diversions are either strategic (from one part of the organisation road network to another) or tactical (diversion across “local” roads);
implementation site	a traffic control centre that uses the CHARM ATMS
Incident Management	That activity which is undertaken where an event occurs on a live carriageway that causes traffic flow to deviate from normality or occurs off-network with an impact on the network. Incident management requires an on-road response to restore the network to normality (a Current Event).
Incident Support Unit *(ISU)*	ISU crews perform a variety of roles working from strategically placed depots to help keep drivers moving. After an accident they may be deployed to sweep up broken glass, mop up fuel spills or effect repairs on a damaged safety fence. They also assist traffic officers get drivers away from major accident scenes - for example setting up diversion routes around an incident scene. The ISU is the Agency's primary response team in all areas where the Traffic Officer Service is not operational.
Information Provision	That activity which provides information about the state of the road network to any of the Highways Agency’s internal or external information consumers.
infrastructure *(traffic infrastructure)*	the interconnected structural elements that support a society, in our context typically referring to roads, tunnels, bridges and equipment for traffic management, should not be confused with IT infrastructure
installation site	the site where software is installed, very often the same site as implementation site is intended
IT infrastructure *(technical infrastructure)*	the composite hardware, software, network resources and services required for the existence, operation and management of an enterprise IT environment
Key Performance Indicator *(KPI)*	a Performance Measure for which performance below the Target Service Level leads to the accrual of Service Points by the Service Provider
log	an official record of events, usually including a time stamp, the events may relate to system events (system log) or traffic events, i.e. incidents (action log)

Term	Definition
log-over	Log-over allows a new user to log on without having to re-start applications
Maintenance Contractor	Organisation that is able to build and/or maintain the road network and/or can carry out maintenance on equipment that is required to operate the road network.
modular software package	a software package that is built according to a design that allows for parts of the software package to be removed, added or exchanged by other parts, even by different vendors.
multi-tiered technical support process	The process that distributes support activities over multiple organizational units with different levels of knowledge and expertise
National Liaison Officer	A National Traffic Operator maintaining an overview of current events on the road network and co-ordinating response;
National Rostering team *(National Resource Management Team / National Rostering team member)*	A National Traffic Operator providing information about the individuals who are assigned to each Traffic Management Centre shift.
National Traffic Control Centre *(National Traffic Management Centre / NTCC)*	The Agency's National Traffic Control Centre, which delivers information about network conditions to customers (both road users and within the Agency) through identified delivery channels
National Traffic Operations Centre *(NTOC)*	The location at which centralised operational activity is undertaken in England
National Traffic Operator	A person (operating from a National Traffic Centre) that is responsible for Accessing updated incident information to assess strategic response required, setting strategic signs and signals
Network demand forecast	a list of all expected netwwork demand by date, start time and end time in terms of the expected traffic volume
Normality	The situation when the road network is operating within expected profiles of traffic flow (including routine congestion).
Officer of Duty	A Traffic Officer responsible for day to day management of a team of On-Road Traffic Officers.
on road resource	traffic officer or other resources that are involved in inspecting and maintaining safety on the roads
OpenLR *(Open location referencing)*	open standard for location referencing
Operational Support	An Agency organisational unit responsible for undertaking operational support activities such as resource management and delivery of business changes to the operational service.
Operational Support Officer	A person responsible for evaluating, reporting and improving procedures for the traffic operator having one or more of the following roles: Transport Planner, Road Network Operator, Traffic Predictions Operator, Event Planner, Environment Management Operator

Term	Definition
Operator	general classification for the internal user of the ATMS, responsible for one or more regions, roads and/or processes and a person who works in traffic control centre and is responsible for accessing updated information related to traffic to assess strategic response required, setting strategic signs and signals e.g. National Traffic Operator, Regional Traffic Operator,
package supplier	party that is responsible to deliver a package, the licenses for the software and updates to the software
Police	Organisations that provide services which ensure public safety and health by addressing different emergencies, in particular Safety and crime prevention
process *(business process)*	groups behaviour based on an ordering of activities (workflow) specific, the ordering may be specific for an implementation site
Ramp Metering	A system located at the roadside that are used to relay a message to the travelling public about road conditions ahead or strategically on other parts of the network. There are a variety of versions in which all can display text and some can also display pictures as well as text. Some VMS is also being used to display signals
real time processing	a process that can guarantee a response within a given timeframe
Recovery	The recovery of vehicles, loads, obstacles and debris from the carriageway and the carrying out of essential repairs to the infrastructure
Regional Control Centre *(RCC / Regional Traffic Management Centre)*	Regionally based traffic operations control rooms responsible for managing incidents and ensuring the smooth operation of the motorway network and trunk roads.
Regional Traffic Operator	A person (operating from a Regional Traffic Centre) responsible for all incoming and outgoing information for a regional traffic centre (incidents, radio, signs, signals, on road crews, calls from the public) potentially having a special focus expressed by one of the following roles: Emergency Operator, Tunnel Operator, Bridge Operator, Call Handler
required functionality	the functionality required by the agencies to deliver the services that support the agencies' traffic management business processes.
resource	reference only personnel & staff
Resource Management	the management of people and physical resources to ensure sufficient coverage of the priority areas of the road network based on road network intelligence
response plan *(scenario)*	a set of instructions that will be used by the ATMS (fully- or semi-automated) or operator (manual process) to response to an event
Rijkswaterstaat *(RWS)*	The organisation responsible for building, maintaining and operating the Strategic Road and canal network in the Netherlands
road condition	collection of information about the traffic situation
Road emergency contractor *(contractor)*	A contractor (person working for an external supplier of the agency) that is involved in dealing with roadside emergencies.

Term	Definition
Road Network Operator	An Operational Support Officer responsible for evaluating, reporting and improving the performance of the road network and identifying the cause of an identified problem
road side equipment	used in the broadest sense possible referring to all equipment along a road such as cameras, variable message signs, traffic lights etc.
Roll-Out Contractor	party that is responsible for taking the overall solution and implementing it in the TMCs in each country, following the successful roll-out implementation in the first two TMCs by the ATMS System Provider
Scene Management	The management of those activities that need to be completed at the scene before the incident location can be cleared, such as the protection of the scene by implementation of diversions or other traffic management measures when required, the relief of trapped traffic, further treatment and evacuation of casualties, the removal of hazardous chemicals, the investigation of the incident and the collection of evidence
Service Manager	A System Manager that ensures that performance of technology service providers complies with agreed service levels. It manages technology related incidents, problems, configurations, etc.
Service Provider	external organisation that resolves Sensor and Actuator technology related incidents
Service Provider User	An System Manager from an external organisation that resolves Sensor and Actuator technology related incidents
sign	an instruction for dynamic travellers having a conventional meaning and used in place of words
Signal	the command send to a traffic signal
situation report *(sitrep)*	report about a situation
software localization	the process of adapting software to the linguistic, cultural and technical requirements of a target market
status information	structured information about the functioning (behaviour) of road side equipment and sensors
Strategic Road Network *(SRN)*	All roads maintained and operated by the agencies
Strategic Traffic Operator	A National Traffic Operator ensuring that the impact of events on the road network is limited for regular traffic flow
System Management Support	all activities related to manage, maintain and install the system
System Manager	A person that has direct access to CHARM ATMS in order to manage and maintain the CHARM ATMS with one of the following roles: Technology Manager, Technology Maintainer, Service Manager, Service Provider User
System *(software system)*	A logical entity that could be comprised of extant applications as-is, enhancements to existing applications, new applications, shared components/common services between multiple systems or any combination thereof.

Term	Definition
Technology Maintainer	A System Manager or an organisation (service desk), possibly external, that responds and rectifies technology related incidents.
Technology Manager	A System Manager that support business with appropriate technology services by identifying opportunities for technology service improvements, coordination of technology service issue and improvement activities at regional level. This person is Regional service point of contact related to technology services
traffic control centre *(TCC / TMC / Traffic Management Centre)*	the buildings from which the agencies deliver their traffic management services
traffic light	A traffic signal with red, amber and green light.
Traffic Management Centre Supervisor *(supervisor)*	A person responsible for (non-limiting listing): 1. Allocation of roles to Regional Control Centre Operators at the start of each shift; 2. Management of day to day operations of a team of Traffic Operators in a Regional Traffic Management Centre; 3. Coordinating execution of Fail-over and Load sharing actions; 4. Brief and debrief of Regional Traffic Management Centre Operators; 5. Management and decision making for escalated incidents.
Traffic Management Directorate *(TMD)*	(from Feb 2010) An Agency directorate, comprising of the 7 traffic officer service regions, plus a national group incorporating the NTCC plus HAIL, NILO and support to traffic officer operations, with responsibility for delivering a world class Traffic Management service to all customers
Traffic Management *(TM)*	The combination of semi-automated control of traffic signs and signals, application of demand management techniques (including traffic cones), and traffic Information and advisories to achieve an optimal traffic flow throughout a defined management area.
traffic measure *(control measure)*	an intervention as part of a traffic management strategy to inform, guide or control the traffic using one or more roadside devises or traffic officers
Traffic Monitoring Equipment	A system located at roadside or within the road infrastructure, traffic monitoring equipment is used to provide information to the operator regarding the traffic conditions on the network, in some cases they are also used to automatically set signs and signals for queue protection.
Traffic Officer Supervisor	A person that allocates roles and tasks to individuals on shift and provides information about on-road Traffic Officers booked on and off shifts
Traffic officer *(road inspector)*	A person (operating from a roadside locations) that liaise with the police commander at scene to establish the details of when any closed carriageways or lanes will reopen and when other specialist resources are required to be deployed.
Traffic Operator	a regional traffic operator or a national traffic operator

Term	Definition
Traffic Predictions Operator	An Operational Support Officer responsible for initiating traffic predictions and evaluating effect of traffic predictions with respect to expected network load and human resource deployment
traffic signal	A system located at the roadside, typically located at the end of a motorway slip road, that are used to platoon traffic as it enters the motorway during peak periods. Traffic light is mostly used as the traffic signal with red, amber and green light.
Transport Planner	An Operational Support Officer responsible for evaluating the effect of a scenario and making recommendations for areas of improvements
Traveller	A commercial or private person being a static traveller or dynamic traveller.
Tunnel operator	A Regional Traffic Operator managing the traffic and safety operation of a tunnel
Variable Message Sign *(VMS)*	Variable Message Signs, being electronic roadside signs that convey messages
VCNL *(Verkeers centrale Nederland)*	The location at which centralised operational activity is undertaken in the Netherlands

This acronym list contains acronyms that are used in this document.

Acronym	Description
APTR	All Purpose Trunk Road
ASL	application services library
AID	Automatic Incident Detection
CCC	Central Contact Centre
C&C	Command and Control
CHARM	Common Highways Agency Rijkswaterstaat Model
COP	Common Operational Picture
FOM	Future Operating Model
GUI	graphical user interface
HA	Highways Agency
ISU	Incident Support Unit
IT	information technology
ITIL	integrated technology infrastructure library
ISO	internatial standards organiation

Acronym	Description
KPI	Key Performance Indicator
MIDAS	Motorway Incident Detection & Automatic Signalling
NDW	Nationaal databastand wegen
NRTS	National Roadside Telecommunications Services
NTCC	National Traffic Control Centre
NTOC	National Traffic Operations Centre
OpenLR	Open location referencing
RCC	Regional Control Centre
RWS	Rijkswaterstaat
SLA	service level agreement
SRN	Strategic Road Network
TCC	traffic control centre
TMC	Traffic Management Centre
TM	Traffic Management
TMD	Traffic Management Directorate
VMS	Variable Message Sign
VCNL	Verkeers centrale Nederland

List of Actor names and responsibility.

Actor name	Responsibility
Bridge Operator	A Regional Traffic Operator managing the traffic and safety operation of a movable bridge
Call Handler	A Regional Traffic Operator receiving telephone calls, recording information and allocating events to appropriate TMCs.
chief traffic operator	
Dynamic Traveller	A traveller who is using a variety of modes of transport like a driver, car pooler or a public transport passenger
Emergency operator	A Regional Traffic Operator taking the lead in co-ordinating the incident handling.
Environment Management Operator	An Operational Support Officer responsible for evaluating impact of expected weather prediction on road performance and human resource load eventually leading to recommendations on expected deployment of traffic scenarios.
Event Planner	An Operational Support Officer responsible for receiving notifications of forecast events and producing forecast event plans

Actor name	Responsibility
National Incident Liaison Officer *(NILO)*	National Incident Liaison Officer, being operatives who are based at the Agency's NTOC and receive and disseminate information about critical and major incidents to senior managers
National Liaison Officer	A National Traffic Operator maintaining an overview of current events on the road network and co-ordinating response;
National Rostering team *(National Resource Management Team / National Rostering team member)*	A National Traffic Operator providing information about the individuals who are assigned to each Traffic Management Centre shift.
National Traffic Operator	A person (operating from a National Traffic Centre) that is responsible for Accessing updated incident information to assess strategic response required, setting strategic signs and signals
Officer of Duty	A Traffic Officer responsible for day to day management of a team of On-Road Traffic Officers.
On Road Traffic Officer	A Traffic Officer responsible for collects and provides relevant information for Dynamic Traffic Management and Incident Management and performance activities to guarantee safety for all travellers along an event scene
Operational Support Officer	A person responsible for evaluating, reporting and improving procedures for the traffic operator having one or more of the following roles: Transport Planner, Road Network Operator, Traffic Predictions Operator, Event Planner, Environment Management Operator
Operator	general classification for the internal user of the ATMS, responsible for one or more regions, roads and/or processes and a person who works in traffic control centre and is responsible for accessing updated information related to traffic to assess strategic response required, setting strategic signs and signals e.g. National Traffic Operator, Regional Traffic Operator,
Regional Traffic Management	A person (operating from a Regional Traffic Centre) that is responsible Coordinating the human resource deployment of • Managing on-road traffic measures – managing the on-road response to an event, informing of progress; • Debriefing on road resource – identifying compliance with procedures, possible performance improvements when responding to similar events and to monitor the welfare of on road staff involved, informing of the output; • Verifying Current Event Information – providing required additional information to relating to Current Events; • Protecting the current event scene – securing the current event scene by placing their vehicle in fend-off positions, coning-off the incident or implementing rolling road clocks, providing updates to along with estimated clearance times. • Clearing up carriageways – managing the clearance of debris and other network incursions from the current event scene, informing of progress; • Verifying the road is clear – Following a current event, informing when the road is clear:

Actor name	Responsibility
Regional Traffic Operator	A person (operating from a Regional Traffic Centre) responsible for all incoming and outgoing information for a regional traffic centre (incidents, radio, signs, signals, on road crews, calls from the public) potentially having a special focus expressed by one of the following roles: Emergency Operator, Tunnel Operator, Bridge Operator, Call Handler
Road emergency contractor *(contractor)*	A contractor (person working for an external supplier of the agency) that is involved in dealing with roadside emergencies.
Road Network Operator	An Operational Support Officer responsible for evaluating, reporting and improving the performance of the road network and identifying the cause of an identified problem
Service Manager	A System Manager that ensures that performance of technology service providers complies with agreed service levels. It manages technology related incidents, problems, configurations, etc.
Static Traveller	A traveller intending to travel but hasn't yet embarked on their journey. Instead they are in the process of planning their journey supported by CHARM
Strategic Traffic Operator	A National Traffic Operator ensuring that the impact of events on the road network is limited for regular traffic flow
System Manager	A person that has direct access to CHARM ATMS in order to manage and maintain the CHARM ATMS with one of the following roles: Technology Manager, Technology Maintainer, Service Manager, Service Provider User
Technology Maintainer	A System Manager or an organisation (service desk), possibly external, that responds and rectifies technology related incidents.
Technology Manager	A System Manager that support business with appropriate technology services by identifying opportunities for technology service improvements, coordination of technology service issue and improvement activities at regional level. This person is Regional service point of contact related to technology services
Traffic Management Centre Supervisor *(supervisor)*	A person responsible for (non-limiting listing): 1. Allocation of roles to Regional Control Centre Operators at the start of each shift; 2. Management of day to day operations of a team of Traffic Operators in a Regional Traffic Management Centre; 3. Coordinating execution of Fail-over and Load sharing actions; 4. Brief and debrief of Regional Traffic Management Centre Operators; 5. Management and decision making for escalated incidents.
Traffic officer *(road inspector)*	A person (operating from a roadside locations) that liaise with the police commander at scene to establish the details of when any closed carriageways or lanes will reopen and when other specialist resources are required to be deployed.
Traffic Officer Supervisor	A person that allocates roles and tasks to individuals on shift and provides information about on-road Traffic Officers booked on and off shifts

Actor name	Responsibility
Traffic Predictions Operator	An Operational Support Officer responsible for initiating traffic predictions and evaluating effect of traffic predictions with respect to expected network load and human resource deployment
Transport Planner	An Operational Support Officer responsible for evaluating the effect of a scenario and making recommendations for areas of improvements
Traveller	A commercial or private person being a static traveller or dynamic traveller.
Tunnel operator	A Regional Traffic Operator managing the traffic and safety operation of a tunnel

Appendix B. **Statistics**

The appendix contains information on expected size of the system in terms of Strategic Network that has to be managed, the number of internal end-users that will be actively concurrently using the systems (on duty), the numbers of external and roadside systems that will be connected to the CHARM ATMS and the volume of the data (transactions).
How to read the following table:

- The table combines information for HA and RWS, empty cells indicate that the information is note relevant or not available for the authority.
- Figures are approximates.
- The 2015 column provides information on system *prior to implementation of first CHARM ATMS* (Base line)
- The 2018 column specifies what we expect will be the situation when all traffic centres use CHARM ATMS (Introduction phase of product lifecycle)
- The 2022 column describes the expected situation when CHARM ATMS has been 5 years in usage, thus the organisation gained sufficient experience in using the system (Maturity phase of product lifecycle).

		HA			RWS		
		2015	**2018**	**2023**	**2015**[25]	**2018**	**2023**
Network	Length of Road Network in km.[26]	7,000	7,000	7,000	3,000	3,200	3,400
	Of which motorway in km.	3,500	3,500	3,500			
	Total length of lanes[27]				7,500	8,000	8,500

[25] Data from the official system with statistical data from RWS named NIS.
[26] For HA this is the length of the Strategic Road Network (SRN) which include all of the roads managed by the HA ranging from single carriageway roads through towns to dual carriageways and motorways. Motorways have a legal definition in the ENGLAND and their own regulations. The HA often refer to the SRN that isn't motorways as All-Purpose Trunk Roads (APTR).

		HA			RWS		
		2015	2018	2023	2015[25]	2018	2023
	Hard shoulder lanes[28]				39		
Network usage	Network performance[29]	130 billion			64 billion		
	Incidents per year	320,000	330,000	340,000	100,000		
	Accidents per year	15,000	14,500	14,000	17,000		
Internal users on duty per shift	Traffic Operators on duty	50	50	50	36	40	40
	Supporting officers on duty	100	100	100	50	50	50
	Traffic officers on duty	200	200	200	50	45	40
Information providers and partners in operation	Other Transport Authorities				tens	tens	tens
	Forecast Event Information Provider	100	200	300	several	several	several
	Weather Information Service Provider	1	1	1	several	several	several
	Traffic and Road Data Providers	1	1	1	several	several	several
On-Road Resources in operation	Emergency Service Organisation	150	150	150	several	several	several
	Technology Maintenance Contractor	15	15	15	several	several	several
	Road Maintenance Contractor	25	25	25	several	several	several

[27] A motorway may consist of multiple lanes. In the Netherlands traffic management conditions and measures are managed per lane.

[28] Hard shoulder lanes are opened or closed as part of a response plan to increased or decreased traffic demand based on traffic flow and velocity.

[29] Same as **vehicle-kilometer**: a measure of traffic flow, determined by multiplying the number of vehicles on a given road or traffic network by the average length of their trips measured in kilometers, see also: http://en.wikipedia.org/wiki/Units_of_transportation_measurement#Units_of_Transportation_Density

		HA			RWS		
		2015	2018	2023	2015[25]	2018	2023
	Vehicle Recovery Contractor	1	1	1	several	several	several
	On-Road Emergency Contractor (ISUs)	400	400	400	several	several	several
Sensors and Actuators in operation	Traffic Monitoring Equipment	10,000	12,000	15,000	5,500	5,600	4,000
	Weather Monitoring Equipment	700	700	700	tens	-	-
	Closed Circuit Television Cameras	3,500	4,000	5,000	2,900	3,000	2,500
	Signals and Variable Message Signs	2,500	3,000	5,000	400	350	200
	ALMs	450	500	600			
	Ramp Metering (sites)	200	300	500	100	90	75
	Lighting (controllable zones)	50	100	200	1	1	1
	Barriers				tens	tens	Tens
	Tunnel Management System	4			22	24	26
	Bridge Management System				several	several	several
	Inductive loop detectors	18,000	24,000	32,000	17,000		
	Radar detectors	None	None	None	2,000		
	Matrix Traffic Signal	5,000	6,000	8,000	16.000		
	Multisigns				500		

Appendix C. **Description of level 3 services**

The table below shows an overview of the expected level 3 services that will be needed to support business service (limited to those related to daily operations) to illustrate expectations of the ATMS.

Level 1 / Level 3 business service	Description of level 3 business service
Infrastructure services	
01.02.01: Roadworks planning	Roadworks planning involves co-ordination between those responsible for infrastructure maintenance and traffic management, since roadworks are a major source of disruption.
01.02.02: Roadworks support	Co-ordination of roadworks execution with the Traffic Officer and/or contractor and implementation of road safety measures from the control room.
Availability services	
02.01.01: Queue protection	Warning road users against slow moving vehicles downstream Autonomous service, (AID, MIDAS) without operator action; it can also be interpreted as a signal that an incident may have happened.
02.01.02: Lane closure	Safely closing a lane or lanes for traffic if use of that lane would be dangerous, for example because of an accident or roadworks.
02.01.03: Speed limit	Increasing road safety by setting a maximum speed for a specific lane or road segment HA has advisory (flashing amber) and mandatory (red circle) speed limits, RWS has only mandatory ones.
02.01.05: Weather-related road conditions	Warning the road user for unsafe road conditions caused by weather: wind, fog, ice etc.
02.01.08: Winter maintenance support	Signing for winter maintenance vehicles and informing the road users.
02.01.09: Extreme weather warning	Warning road users against dangerous road conditions because of extreme weather.
02.01.12: Differential lane speed limit	Special case of speed limit co-ordinated over cross section, used for safety for roadworks or incidents.

Level 1 / Level 3 business service	Description of level 3 business service
02.04.02: Height detection	Detecting vehicles that are too high for a tunnel.
02.04.03: Critical infrastructure protection	Protect critical infrastructure by monitoring for undesirable activities.
02.05.01: Speed limit	Setting a maximum speed for a specific road segment.
02.05.02: Variable street lighting	Decreasing the intensity of street lighting in situations where road safety is not compromised to save energy and/or protect wildlife.
Capacity management services	
03.01.01: Ramp metering	Controlling the access rate of vehicles to the motorway. The ramp metering service is delivered by autonomous systems. Cycle times are set off-line by a Traffic Engineer.
03.01.02: Exit slip traffic lights	Using traffic lights on the exit slip to accommodate the traffic exiting the motorway.
03.01.03: Non-motorway traffic lights	Preventing collisions on intersections (not on motorways) using traffic lights.
03.01.04: Slip road signalling	Setting signs on the exit ramp to close an exit.
03.01.05: Carriageway flow control	Dynamic closure of a carriageway to avoid congestion on connecting roads or upstream on the same road. Typically used to avoid congestion in tunnels.
03.01.06: Coordinated on-ramp flow control	Coordinates the cycle times of various ramp metering systems on the same road segment to optimize throughput of traffic.
03.02.01: Hard shoulder running control	Opening the hard shoulder in a safe way, monitoring it while it is open, and closing it again when the increased capacity is no longer needed.
03.02.02:Tidal flow control	Opening the tidal flow lane in a safe way, monitoring it while it is open, and closing it again when the increased capacity is no longer needed. Tidal flow lanes can be used in two directions, the direction used depends on for which traffic flow most capacity is needed.
03.02.03: Special purpose lanes	Special purpose lanes: HOV, bus, crawler, etc.
03.02.04: Bonus lane	Opening and closing a bonus lane. A bonus lane is an additional lane to the carriage way (next to the highest-speed lane) and is normally not used, unless additional capacity is needed.

Level 1 / Level 3 business service	Description of level 3 business service
03.02.05: Variable speed limit	Setting a speed limit over the carriage way in order to stimulate traffic to drive at the same speed, so that a homogenous traffic flow occurs, in this way optimizing the most efficient way of using the road capacity.
03.02.06: Dynamic HGV overtaking restriction	Setting signs to forbid overtaking by HGVs, so that the traffic flow is less disturbed decreasing the chance of congestion.
03.02.08: Coordinated urban traffic light/ramp metering control	Coordinates the cycle times of various ramp metering systems and or traffic lights on the same road segment to optimize throughput of traffic.
03.03.01: Incident detection	Detecting incidents (in many cases by third parties).
03.03.02: Incident scene protection	Protecting the incident scene to prevent further collisions and to enable a safe working environment for emergency services.
03.03.03: Incident scene management	Coordination/assistance of third parties involved in solving the incident.
Demand management services	
04.01.01: Diversion route	The communication to the road user of a diversion route that has been set up. Currently this is done by displaying texts on one or more VMSs.
04.01: Diversions	Information about and implementation of diversions from the normal route.
04.02.01: Travel time	Distribution of information on the travel time that can be expected on a certain route to the road user (usually via a VMS). Usually this is done close to a junction, so that the road user has a choice to reach his destination via route A or route B.
04.02.02: Delay	Distribution of information on the delay that can be expected on a certain route to the road user (usually via a VMS). Usually this is done close to a junction, so that the road user has a choice to reach his destination via route A or route B.
04.02.03: Tailback length	Distribution of information on tailback length currently present on a certain route to the road user (usually via a VMS).
04.02.04: Crowd generating event direction	Suggestion of a route to road users to follow e.g. in case of a crowd generating event, without giving any details on expected delays or travel times. The route can dynamically be changed in case of changing circumstances.

Level 1 / Level 3 business service	Description of level 3 business service
04.02.05: Bridge opening	Announcement of the (expected) opening of bridge that lies ahead. May give the road user the opportunity to choose an alternative route.
Information provision services	
05.01.01: Congestion information	Producing congestion information from several sources, including traffic data.
05.01.02: Cause of congestion	Adding known causes of congestion (usually limited to incidents and roadworks) to the congestion information.
05.01.03: Travel time/delay time for link	Producing travel time and/or delay time from traffic data.
05.01.04: Incident completion	Estimating the time when an incident will have been cleared.
05.01.05: Hard shoulder status	Producing the status of hard shoulder running links.
05.01.06: Roadworks in progress	Producing status information of ongoing roadworks.
05.01.07: Bridge open	Producing the status (open/closed) of bridges .
05.01.08: Information distribution	
05.02.02: Traffic situation	A comprehensive overview of the traffic situation, including actual speed compared to free flow speed, locations of incidents and roadworks.
05.02.03: Provide major impact traffic management information	Provide information about serious disruptions of the network (festivals, floods). This information will reach the public through internal and/or external service providers.
05.05.01: Fog and wind data	Delivering fog and wind data to third parties.
Planning	
06.03.01: Response plan development	The development of response plans. A response plan describes for a specific location on the network which traffic control measures should be applied under which circumstances (typically high traffic intensity, low average speed of traffic).
06.03.02: Traffic forecast	The production of a traffic forecast for the short term. The forecast is used in TMCs for planning traffic measures and Traffic Officers to be deployed. The forecast is also communicated to the outside world.
06.03.03: Extreme weather situation plan	Production of a plan describing traffic measures to be taken in case of expected extreme

Level 1 / Level 3 business service	Description of level 3 business service
	weather, including any escalations that may be deemed necessary
06.03.04: Roadworks plan	Production of a plan describing traffic measures to be taken in case of planned roadworks.
06.03.05: Crowd generating events plan	Production of a plan describing traffic measures to be taken in case of a crowd generating event.

Appendix D. **Index**