VOLUME 9  NETWORK – TRAFFIC CONTROL AND COMMUNICATIONS

SECTION 1  TECHNOLOGY OVERVIEW AND GENERAL REQUIREMENTS

PART 1

TD 71/16

TECHNOLOGY OVERVIEW AND GENERAL REQUIREMENTS

SUMMARY

This document provides an overview to the design and implementation of motorway communication schemes. It updates and supersedes TA 70/97 and TA 71/97.

INSTRUCTIONS FOR USE

This document is to be incorporated into the Manual.

1. This document supersedes TA 70/97 and TA 71/97, which are now withdrawn

2. Remove content pages for Volume 9 dated August 2014


4. Remove TA 70/97 from Volume 9, Section 2. Part 1 and archive as appropriate

5. Remove TA 71/97 from Volume 9, Section 3. Part 1 and archive as appropriate

6. Insert TD 71/16 into Volume 9, Section 1, Part 1

7. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.
PART 1
TD 71/16
TECHNOLOGY OVERVIEW AND GENERAL REQUIREMENTS

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1. INTRODUCTION

1.1 Background

1.1.1 The Overseeing Organisation (as specified in GD 01 Introduction to the Design Manual for Roads and Bridges (DMRB) clause 1.9) procures, operates and maintains technology devices on highways. Traffic technology devices improve safety for the travelling public and road workers, reduce delays and improve journey time reliability through better management of the road network and providing information to travellers about their journey.

1.2 Scope and Purpose

1.2.1 This document describes the typical types of traffic technology devices and systems that are permitted to be used on highways. Highways include both motorways and All Purpose Trunk Roads (APTR). This document also describes the provision of transmission networks and services that connect traffic technology devices with systems at control centres.

1.2.2 This document references other documents that provide the criteria for provision and design requirements for the traffic technology devices and systems.

1.2.3. This document provides considerations to be taken into account that may affect the design of a technology scheme.

1.2.4. Where this document contains design requirements, it must be read in conjunction with the general requirements in GD 01, GD 02 and GD 04 and with all other DMRB documents relevant to the design of the particular works to be undertaken.

1.2.5. This document provides general information about each different type of device and the general requirements and considerations for the design of technology schemes. It is intended to be read by anyone requiring an overall appreciation of the traffic technology devices; transmission networks and services; and the systems within the control centres.

1.2.6. Where this document contains technology requirements that fall within the scope of the TSS Plans Registry, it must be read in conjunction with the general requirements in TR 1000, TR 1100 and TR 2130, and with all other TSSR documents relevant to the particular works to be undertaken.

1.3 Definitions, Acronyms and Abbreviations

1.3.1. A list of abbreviations used in this document is given in Table 1.3.1.

<table>
<thead>
<tr>
<th>Table 1.3.1 Abbreviations used in this document.</th>
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1.4 Application in Devolved Administrations

1.4.1. Contract-specific additional and substitute requirements may be included for contracts where the Overseeing Organisation is not Highways England (or its successor). Where required, these will be issued by:

**Scotland:**
Transport Scotland, 8th Floor, Buchanan House, 58 Port Dundas Road, Glasgow, G4 0HF.

**Wales:**
The Welsh Government, Transport Department, Cathays Park, Cardiff, CF10 3NQ.

**Northern Ireland:**
Director of Engineering, Department for Infrastructure, Clarence Court, 10 – 18 Adelaide Street, Belfast BT2 8GB.

1.4.2. The Overseeing Organisation may also issue an initial list of alternative requirements/departures.

1.5 Implementation

1.5.1. This document is provided as an overview to the technology implemented on highways and acts as a roadmap to the rest of Volume 9. It updates and supersedes TA 70/97 and TA 71/97.

1.6 Feedback and Enquiries

1.6.1. Users of this document are encouraged to raise any queries and/or provide feedback on its content and usage to the dedicated Overseeing Organisation team. The email address for all enquiries and feedback is: DMRB_Enquiries@highwaysengland.co.uk
2. GENERAL DESIGN REQUIREMENTS

2.1 Safety Risk Assessment

2.1.1 GD 04 Standard for Safety Risk Assessment on the Strategic Road Network contains the Overseeing Organisation’s requirements for risk assessment.

2.2 Design for Maintenance

2.2.1 The designer shall liaise with current maintaining agents or maintaining contractors early in the scheme development phase to ensure maintenance issues are captured and taken into account in the design process.

2.3 Code of Connection

2.3.1 Where technology subsystems connect with the Overseeing Organisation’s system, the designer shall ensure that the connection between the two systems complies with MCH 1514 Code of Connection – Application process for Agency Project Sponsors, Suppliers and Maintainers.
3. CONTROL CENTRES

3.1 Overview

3.1.1. A control centre normally has two main parts:

- The control room, where the operators answer telephone calls, set signals and monitor CCTV pictures and undertake other responsibilities to deliver the monitoring, controlling and informing objectives described in section 4.1.1;
- The equipment room, which houses the COBS, engineer’s terminal, instation equipment, communications network connections, and CCTV equipment.

3.2 The Traffic Management System

3.2.1. Each control centre provides facilities to communicate with the traffic technology devices within the relevant control centre area. These facilities are provided by the COBS and related subsystems, currently known as the Highways Agency Traffic Management System (HATMS).

3.2.2. The HATMS provides facilities for the operator to configure and operate strategic and tactical technology devices and to answer calls made on Emergency Roadside Telephones (ERTs).

3.2.3. The HATMS is a system consisting of an instation at the control centres with communications network connections allowing various instation subsystems to communicate with technology devices and for cross-boundary setting of signals where appropriate.

3.2.4. All processing of the HATMS is carried out at the instation or through intelligent roadside outstation equipment with data transmission provided by the transmission network. Performance logs of the HATMS, its associated systems and roadside devices, and the actions of the HATMS operators, are maintained locally by the HATMS and also uploaded to a central data repository for maintenance or analysis purposes.

3.3 Control Office Base System

3.3.1. The COBS is the main component of the HATMS. It is located at the control centre, together with several subsystems to provide the basic intelligence in controlling the traffic technology devices located within the control centre boundary.

3.3.2. COBS subsystems add functionality to the COBS that manage traffic technology devices via the HATMS communications network. COBS subsystems comprise, but are not limited to the following:

- Signal subsystem;
- Message Sign subsystem;
- MIDAS subsystem;
- Meteorological subsystem;
- Tidal Flow subsystem;
- Tunnel subsystem;
- Hard Shoulder Management.

3.3.3. COBS can also include an Interface subsystem to connect the control centres to a national or local authority control centre.
4. TRAFFIC TECHNOLOGY DEVICES AND EQUIPMENT

4.1 Overview

4.1.1. The purpose of traffic technology devices is to contribute to safe and reliable journeys and to assist drivers by informing them about traffic conditions ahead. The technology used on highways contributes to these objectives by:

- **Informing** – the technology devices used to allow information to be disseminated include signals and Variable Message Signs (VMS). Other forms of technology that are used to disseminate information, but are not within the scope of this document include internet, radio broadcast, apps, ‘sat nav’ and information points.

- **Controlling** – the technology allows a range of interventions to be made in response to network conditions. Interventions can be achieved through technologies such as signals, VMS, Ramp Metering (RM) and enforcement technology.

- **Monitoring** – control centres need real time information in order to effectively manage the highways. The technology used to provide this information includes (but is not limited to) Motorway Incident Detection and Automatic Signalling (MIDAS), Closed Circuit Television (CCTV), Meteorological (MET) systems and Emergency Roadside Telephones (ERTs).

4.2 Signals and Variable Message Signs (VMS)

4.2.1. Signals and VMS are devices used to communicate with drivers by giving information, advice or mandatory instructions. The primary purpose of signals and VMS is to display information to drivers about emergencies, incidents and network performance in order to improve safety and to minimise the impact of congestion.

4.2.2. VMS are technology devices, within the definition of Regulation 58 of the *Traffic Signs Regulations and General Directions (TSRGD)*, capable of displaying, at different times, two or more defined legends or messages. VMS can be in the form of light emitting or non light emitting, electrical or electro-mechanical devices.

4.2.3. A signal is a light emitting technology device, within the definition of Regulation 46 of the *TSRGD*, capable of displaying a number of defined symbols or speed limits, which can be either advisory or mandatory. Signals capable of displaying mandatory speed limits are supported by the display of a red roundel.

4.2.4. There are technology devices that are capable of both signalling and signing functions (e.g. the MS3 and MS4).

4.2.5. There are two primary types of signalling/signing functions; strategic signing and tactical signalling and signing. Guidance for the use of VMS on highways is given in the document *Policy and Procedures for the use of Variable Message Signs by the Regional Control Centres*.

4.2.6. Requirements and advice regarding the provision and design locations of signals and VMS are given in TD 46 *Motorway Signalling* and TD 33 *The Use of Variable Message Signs on All Purpose and Motorway Trunk Roads*.
4.2.7. VMS have been developed to support the provision of dynamic information using fixed roadside infrastructure. VMS allow flexibility in displaying information, with the two most common functions being the ability to:

- display a single legend during limited periods of the day;
- select from a range of messages and thereby alter the sign to cater for varying traffic conditions.

4.2.8. VMS may be used to temporarily divert traffic away from areas of congestion caused by incidents, excessive traffic, events, road-works, physical barriers, or seasonal weather hazards.

4.2.9. VMS providing information or warnings can also be used to divert over-height or overweight vehicles, inform drivers that they are travelling too fast or too close to the vehicle in front, advise of queuing or congestion ahead, support campaigns, provide journey time posting and apologise for delays.

Enhanced Matrix Indicators

4.2.10. On heavily-trafficked motorways, central reserve post-mounted signals (see the section for Motorway Signal Mark 1 (MS1) below) are being replaced by cantilevered structures which have a signal element and a message sign element. The signal element is a larger indicator than the MS1 known as an Enhanced Matrix Indicator (EMI). The EMI can be used in place of gantries and has similar aspects to an MS1.

4.2.11. An EMI comprises a matrix indicator panel, capable of displaying lane restrictions (using ‘wickets’) for up to four lanes. An EMI can also display alpha-numeric characters and other characters of speed restriction and lane control information. An EMI includes amber and red lanterns which provide ‘warning’ and ‘stop’ signals respectively.

Enhanced Message Signs

4.2.12. Enhanced Message Signs (EMS) are a type of VMS that typically utilise LED technology to display alpha-numeric characters to provide instructions and information to drivers. EMS are mounted on posts in the verge or on gantries, unless approved otherwise by the Overseeing Organisation.

4.2.13. Amber lanterns are used on EMS to flash in synchronous pairs from top to bottom, which draws attention to some messages set on the sign.

4.2.14. EMS can be of the following types:

- MS1 is used to inform of lane closures and speed restrictions and does not convey enforcement information.
- MS2 is used to convey traffic information and does not convey enforcement information.
- MS3 is similar to an MS2 but includes an EMI which can be used to convey enforcement information
- MS4 is a pixel array design than can convey information, symbols, pictograms and enforcement information.
4.2.15. Combined EMS / EMI are available whereby part of the display panel is made up of a continuous matrix capable of either text or EMI display depending on the particular need at any given time. These are used in MS2 and MS3.

Figure 4.2.15 EMS (2x12)+EMI

Motorway Signals MS1

4.2.16. An MS1 is a signal that comprises a matrix indicator panel with four amber lanterns. The amber lanterns flash in synchronous pairs from top to bottom to draw attention to a restriction set on the signal.

4.2.17. MS1s shall not be deployed in the central reserve. However, deployment in the central reserve has been permitted in the past and these MS1s are still in use. When the opportunity arises and with the approval of the Overseeing Organisation, existing post mounted MS1s in the central reserve which have become non-functional or reached end of life should be removed.

Figure 4.2.17 MS1 located in central reserve

4.2.18. Where MS1s in the central reserve are to be renewed as part of a scheme, these should be replaced by the Motorway Signal Mark 4 (MS4) type, which can be located in the verge.
4.2.19. Post mounted MS1s may also be found in pairs at the entry to slip roads. MS1s are provided at these locations where there may be a need to:

- close the slip road and prevent traffic joining; or
- display temporary maximum speed advice that applies to all carriageway lanes; or
- display the risk of fog ahead warnings.

4.2.20. Post mounted MS1s at entry slips include four red lanterns in addition to the amber lanterns. The red lanterns flash in synchronous pairs from side to side with an all lanes closed wicket aspect to provide a ‘stop’ signal. The red flashing lanterns accompany the wicket symbol illustrated in the TSRGD Diagram 6032.1 *Light signals conveying the requirement prescribed in regulation 38(a).* This incorporates the symbol prescribed as Diagram 6008.1 *Closure of both lanes of a two lane carriageway ahead*, 6006.2 *Closure of all lanes of a three lane carriageway ahead* or 6009.3 *Closure of all lanes of a four lane carriageway ahead*.

4.2.21. MS1s may also be mounted on gantries above each traffic lane where there is a need to display different advice or restrictions over each lane.

4.2.22. Gantry mounted MS1s include four red lanterns in addition to the amber lanterns. The red lanterns flash in synchronous pairs from side to side to indicate the closure of a lane. The red flashing lanterns are accompanied by the red ‘X’ illustrated in TSRGD Diagram 6031.1 *Gantry-mounted light signals conveying the requirement prescribed in regulation 38(3) or 38(4).*

**Motorway Signals MS2**

4.2.23. An MS2 provides instructions and information to motorists. MS2s are no longer deployed on highways, but some functional units may still be present.

4.2.24. An MS2 comprises two elements:

- EMI – capable of displaying lane restrictions (using ‘wickets’) or alpha-numeric characters and other characters of speed control and lane control information.
- EMS – displayed as two lines of twelve text characters (2x12) or two lines of sixteen characters (2x16).

4.2.25. A cantilever mounted MS2 is illustrated in Figure 4.2.25.

![Figure 4.2.25 Cantilever mounted MS2](image-url)
Motorway Signals MS3

4.2.26. Cantilever mounted MS3s comprise both EMS and EMI elements. Cantilever mounted MS3s have two variants:

- MS3 (2x16) capable of displaying either two lines of sixteen (2x16) 400mm high text characters in EMS only mode as shown in Figure 4.2.26a, or two lines of twelve (2x12) 400mm high text characters plus EMI in combined mode; or
- MS3 (3x18) capable of displaying three lines of eighteen (3x18) 400mm high text characters in EMS only mode (strategic signing) as shown in Figure 4.2.26b.

Figure 4.2.26a MS3 (2x16)

Figure 4.2.26b MS3 (3x18)

4.2.27. The EMI is equipped with amber and red lanterns, which provide ‘warning’ and ‘stop’ signals respectively. However, EMS only incorporate amber lanterns.

Motorway Signals MS4

4.2.28. An MS4 display comprises an array of LED pixels. The lantern display is a configurable feature depending on whether text and/or pictograms are to be displayed.

4.2.29. The EMI aspect has greater priority over the text component. It is more important that a road user sees the EMI than the supporting text message, as it is quicker to understand the pictogram messages on the EMI than reading text.
4.2.30. The key characteristic of the MS4 is that it is capable of displaying bitmaps, which can be designed to include approved messages and pictograms, including mandatory and warning pictograms and different sizes and cases of text.

4.2.31. Cantilever mounted MS4s supersede central reserve MS1s and cantilever mounted MS3s (2x16) for use on schemes with verge located signalling. Figure 4.2.31 illustrates a cantilever mounted MS4.

![Figure 4.2.31 Cantilever mounted MS4](image)

4.2.32. MS4s may also be used as a VMS when mounted on portal gantries. Figure 4.2.32 illustrates a portal gantry mounted MS4.

![Figure 4.2.32 MS4 mounted on portal gantry](image)
Advanced Motorway Indicators

4.2.33. Advanced Motorway Indicators (AMI) are signals used to display speed limits and lane control aspects. AMI are mounted on portal gantries over each live lane or are post mounted in pairs at the start of entry slip roads. An AMI display comprises a LED matrix and a red roundel to display enforceable speed limits, lane closures and lane diverts. Four LED lanterns (red/amber) are incorporated in the corners of the AMI. The lanterns flash as synchronous pairs from top to bottom (amber) to draw attention to a restriction set on the indicator, other than when enforceable speed limits are set, or left to right (red) for lane closures set on the indicator.

4.2.34. Figure 4.2.34 illustrates AMI mounted on gantries over each running lane in a Smart Motorway scheme.

![AMI mounted on gantries over each running lane](image)

4.2.35. A variant of the AMI, the AMI(EE), is used in conjunction with Highways Agency Digital Enforcement Camera System (HADECS) v2 and HADECS v2.5 speed enforcement equipment (see section 4.2.42). This AMI variant incorporates a physical interface with the HADECS equipment by which means the enforcement equipment determines the displayed speed limit to be enforced.

4.2.36. HADECS v2 and HADECS v2.5 have both been superseded by HADECS v3 equipment for new installations. HADECS v3 utilises visual character recognition to determine the displayed speed limit, requiring no physical interface with the AMI. This allows the use of standard AMI at enforcement sites so the AMI(EE) variant is no longer manufactured.

Fixed Text Message Signs

4.2.37. Fixed Text Message Signs (FTMS) are a type of VMS that display two or more fixed legends (or a blank display and one or more legends). FTMS are mounted on posts in the verge or on gantries. Advice should be sought from the Overseeing Organisation for alternative mounting arrangement proposals.

4.2.38. There are a number of technologies used in such signs, the more common being electro mechanical flexible roller blind and rotating plank or prism. Of these types, the rotating plank or prism is most suitable for strategic use, but alternative types can be proposed to the Overseeing Organisation for consideration.

4.2.39. A FTMS that can display a sign face identical to a fixed sign should be used whenever possible. A FTMS comprises a rigid plate display, flexible roller blind or trans-illuminated display face. This is particularly important for signs displaying warning or regulatory messages where the familiarity to drivers of a normal sign face will aid recognition.
Enforcement Devices

4.2.40. Enforcement devices are deployed to encourage compliance with traffic regulations.

4.2.41. Enforcement devices are commonly used with Smart Motorways or at roadworks, and can include speed cameras, average speed cameras, and devices for the enforcement of High Occupancy Vehicle (HOV) or Heavy Goods Vehicle (HGV) lane usage.

4.2.42. Highways Agency Digital Enforcement Camera System (HADECS) v2 and HADECS v2.5 may still be in use, but have been superseded by HADECS v3 equipment for all new installations. HADECS v3 utilises visual character recognition to determine the displayed speed limit.

4.2.43. For requirements regarding HADECS v3 equipment see TR 2482 Specification for Highways Agency Digital Enforcement and Compliance systems (HADECS).

4.2.44. For requirements regarding the Legacy HADECS v2 and HADECS v2.5 speed enforcement equipment, see MCE 0104 HADECS Digital Speed Enforcement Equipment Requirements.

4.3 Motorway Incident Detection and Automatic Signalling (MIDAS)

4.3.1. MIDAS is a type of vehicle detection system that was developed to make the signalling system more responsive to traffic conditions.

4.3.2. The primary objective of MIDAS is to protect the back of traffic queues, which have formed or are about to form, by automatically setting suitable signals to warn approaching traffic. When traffic flow returns to free flowing conditions, the signal settings are cancelled.

4.3.3. Secondary functions of MIDAS include provision of traffic management data such as:

- Vehicle presence (moving and stationary);
- Count;
- Speed;
- Gap/headway;
- Lane occupancy;
- Vehicle classification.

4.3.4. MIDAS systems comprise traffic sensors (detectors) to detect traffic in each lane along the respective sections of highways and detection equipment/outstations connected via the transmission network to an instation which can either directly or indirectly operate roadside signalling systems.

4.3.5. MIDAS outstations process traffic information using the HIOCC (High Occupancy) algorithm to inform the MIDAS subsystem of the formation of traffic queues and other unusual disturbance in traffic flow. By combining information from related MIDAS outstations, the MIDAS subsystem requests the setting of signals and message signs to warn drivers.

4.3.6. For requirements and advice regarding the provision and design of MIDAS see TD 45 Motorway Incident Detection and Automatic Signalling (MIDAS).
4.4 **Hard Shoulder Management Subsystem**

4.4.1. The Hard Shoulder Management (HSM) subsystem does not have its own devices or communications links to roadside equipment, so uses existing systems to operate and monitor roadside equipment.

4.4.2. The MIDAS subsystem manages the MIDAS detectors and reports information to the HSM subsystem server on Emergency Refuge Area (ERA) monitoring.

4.4.3. The HSM subsystem sets signals by sending requests to the Signal subsystem.

4.4.4. The HSM subsystem sets VMS by sending requests to the Message Sign subsystem.

4.4.5. The HSM subsystem controls the display of CCTV images and switches the imagery displayed to control centre operators using one or more of the following interfaces:

- by sending requests to the CCTV system;
- by sending requests directly to a Telecommunications Services Provider’s Service Control Interface;
- by sending commands to a local CCTV matrix.

4.4.6. The HSM reports link and section states as device status to subsystems that register an interest. MIDAS uses the link and section states to manage the queue protection and vehicle detection algorithms.

4.4.7. Further information on the requirements of the HSM Subsystem is available in MCE 2574 *Hard Shoulder Management Subsystem Server Technical Requirements*.

4.5. **Closed Circuit Television**

4.5.1. CCTV cameras provide operators with the ability to monitor traffic and weather conditions, view surveillance of incidents and the ability to record information for studies. They are primarily operated from control centres and support operators to make a timely and appropriate response to incidents and congestion.

4.5.2. Functions of CCTV include, but are not limited to, the following:

- monitoring smart motorways;
- monitoring network usage;
- identifying and managing incidents;
- ensuring the safety of vulnerable motorists and monitoring callers on ERT;
- providing images to the public via the internet to influence journey decisions;
- protection of the Overseeing Organisation assets;
- detection and prevention of crime directed against the network.

4.5.3. For further information regarding the provision of CCTV see TD 17 *Criteria for the Provision of Closed Circuit Television on the Strategic Road Network*.

**CCTV System**

4.5.4. The architecture of the Overseeing Organisation CCTV system centres on an instation called the Television Base Station (TVBS), which encompasses all of the user facilities, external interfaces and control of cameras. TVBS functions include:

- the generation of instructions to set up links between CCTV cameras and monitors;
- the conversion of operator actions (for example for Pan, Tilt and Zoom (PTZ)) into data messages, and the performance of a number of other control and system monitoring functions.
4.5.5. Camera outstations are called Television Outstations (TVOS). The TVOS comprises the Television Base Unit (TVBU), the interfaces to the telecommunications services provider’s infrastructure, the physical interfaces to cabinets and masts, and the camera equipment.

4.6. **Emergency Roadside Telephones (ERTs)**

4.6.1. ERTs are deployed along highways to allow customers to contact the control centre in the event of an emergency, breakdown or to obtain assistance.

4.6.2. ERTs deployed on highways are versatile, highly visible instruments that provide dedicated voice communication to a control centre operator.

4.6.3. The Centralised Maintenance Depot Terminal Equipment (CMDTE) provides centralised monitoring of the ERT network. The CMDTE reports diagnostic and fault information from ERTs and provides information to the Overseeing Organisation’s logging system.

4.6.4. For advice regarding the provision and design locations of ERTs see TD 73 *Emergency Roadside Telephones*.

4.7. **Ramp Metering**

4.7.1. Ramp Metering (RM) is a system that manages traffic joining a motorway, using traffic signals on an entry slip road, to reduce congestion caused by traffic merging with the main carriageway. RM reduces congestion by maintaining a maximum main carriageway traffic flow in the vicinity of the motorway junction.

4.7.2. The aim of RM is to prevent or delay the onset of flow breakdown on the main carriageway by a combination of:

- managing the flow of traffic onto the motorway that, if unrestricted, would trigger flow breakdown;
- managing the flow from the entry slip road to avoid large platoons of vehicles entering the main carriageway and causing flow breakdown;
- stimulating mainline recovery towards the end of the peak period.

4.7.3. The RM traffic signals operate when detectors on the main carriageway indicate that traffic is becoming congested. Traffic flow data from the main carriageway and the entry slip road are used to determine the required restriction to traffic flow from the entry slip.

4.7.4. Traffic information on the main carriageway is collected using sensors. Data from the sensors is processed and delivered to the RM traffic signal controller.

4.8 **Meteorological (MET) Detection Systems**

4.8.1. MET Detection Systems are used to detect physical conditions such as (but not limited to) fog, wind and ice in areas where particular risks are identified.

4.8.2. The MET subsystem shows these devices on the Windows Operator Interface (WOIF) maps, and allows the operator to be informed when conditions are outside of specified limits. Visibility sensors report a status that is related to visibility distance, known as the Measured Visibility Range (MVR), anemometers measure the wind speed in miles per hour (mph) and the ice detectors measure the depth of ice in millimetres.
4.8.3. The MET subsystem allows plans to be created in site data that link the statuses of meteorological devices with settings on signals and message signs. Automatic plans allow fog and wind warnings to appear as settings on signals and message signs without operator intervention.

4.8.4. The Highways Agency Weather Information System (HAWIS) provides a single source of weather information that will gather, store and make available a suite of weather related services. HAWIS comprises of four principal elements:

- A network of Environmental Sensor Stations (ESS) – commonly known as weather stations
- A central data bureau service (HAWCS)
- Provision of weather forecasting to HAWCS
- Connectivity requirements from ESS to HAWCS

4.9 Tidal Flow Subsystem

4.9.1. Tidal Flow operation is used at sites where the predominant flow of traffic changes from one direction to the other over the course of a day. Under the Tidal Flow system, additional lanes are opened in the direction of the higher flow, at the expense of the other (less trafficked) direction, reversing the configuration as necessary to accommodate changes in the balance of flows.

4.9.2. The Tidal Flow subsystem is used to provide this by appropriate setting of motorway indicators located in the Tidal Flow Area, using a series of protection functions to ensure safe setting of indicators.

4.9.3. The Tidal Flow subsystem has been used on the A38(M) Aston Expressway in Birmingham. On this stretch of road, a buffer lane (i.e. a lane closed in both directions) separates the opposing carriageways (there is no central reserve). The Tidal Flow subsystem is used at this site to change the number of lanes on each carriageway to favour the direction of the highest flow. The stretch of motorway under Tidal Flow control has seven lanes, normally configured as two 3 lane carriageways, with a buffer lane between. During busy periods, the Tidal Flow subsystem allows the setting of up to one 4-lane and one 2 lane carriageways, separated by a buffer lane. This enables traffic to flow more smoothly either to or from the city.

4.10 Tunnel Subsystem

4.10.1. The tunnel subsystem is attached to the Control Office Base System (COBS) for controlling traffic in motorway tunnels. The Tunnel Subsystem interfaces to the COBS and subsystems to set signals and VMS, and interface to the Operator Interface to display tunnel related information and allow the operator to respond to tunnel alarms.

4.10.2. The tunnel subsystem’s safety functions are summarised below and are performed with Safety Integrity Level (SIL) 2 dependability:

- to alert the control centre operators to the occurrence and clearance of various tunnel hazards in its area of control;
- to control signals and VMS in its area of control to present information to customers relating to various tunnel events;
- to control and monitor the tunnel equipment (plant) in each tunnel.

4.11 Infrastructure

4.11.1. The communications infrastructure is made up of items comprising ducts, chambers, hard-standings, transmission station bases, cabinet bases, access infrastructure and protection infrastructure. The infrastructure facilitates the provision of communications services obtained from the Overseeing
Organisation’s Telecommunications Services Provider. The provision of cabinets and items in the cabinets is then split between the Overseeing Organisation and the Telecommunications Services Provider.

4.11.2. TD 72 Transmission Infrastructure provides further information regarding communications.

Communications Cables

4.11.3. The cable network comprises a cable (or cables) laid along the length of all motorways and selected APTR, this cable is termed “longitudinal cable”. Longitudinal cables are installed in standard lengths that are jointed together to form a cable network. Local cables connect to longitudinal cables to provide communications services to roadside equipment.

4.11.4. Where a third party provides the transmission network, these cables are provided and installed by the Telecommunications Services Provider who may also be instructed by the Overseeing Organisation to provide or extend the communications infrastructure.

Power Cables

4.11.5. There are two types of power cable that are used to transfer power to equipment on highways; non-armoured and armoured power cables. Armoured power cables provide mechanical protection using a steel wire armour sheath.

4.11.6. Cable sizes are calculated based on the equipment loads, the distance between the equipment and the Distribution Network Operator (DNO) supply and the DNO earthing supply type and parameters. The design load will be based on data obtained from the Overseeing Organisation’s equipment manufacturer.

4.11.7. The provision of power is the responsibility of the Overseeing Organisation.

Cabinets

4.11.8. There are several types of cabinets. These include, but are not limited to, the following:

- Type 600 – for housing electronic equipment;
- Type 609 – for housing above-ground cable joints, DNO interfaces, power isolation and distribution equipment and private telecommunications interfaces;
- Type 620 – for housing equipment to interface to a public telecommunications network;
- Type TC – for housing the Telecommunications Services Provider’s transmission equipment.
5. TRANSMISSION NETWORK

5.1 Overview

5.1.1. The Transmission Network, telecommunications services and the associated infrastructure, including the ducted network, chambers, cabinets and associated cabling are used to support the use of technology on highways by providing a means to transmit data between control centres, systems and traffic technology devices. Additional advice relating to ‘transmission’ can be found within TD 72 Transmission Infrastructure.

5.2 The Core Network

5.2.1. The term Core Network is used to describe the underlying network provided by the Telecommunications Services Provider that links control offices with Transmission Stations and Transmission Cabinets. It consists of the Internet Protocol (IP) capable network, power and network management. The Core Transmission Network comprises an optical network overlaid with open standard IP. Where the optical network is not available, the IP network is overlaid on a copper cable network.

5.2.2. Transmission Stations and Transmission Cabinets are provided at regular intervals along the road network and at other major node points, such as motorway to motorway intersections. Transmission Stations and Cabinets house electronic transmission equipment that aggregates all the roadside devices onto the high bandwidth Core Network.

5.2.3. The IP capable architecture provides many advantages in terms of a more resilient and flexible solution and is based on commercial off the shelf equipment, rather than one which is bespoke to the Overseeing Organisation.

5.3 Telecommunications Services Provider (TSP)

5.3.1. The Overseeing Organisation procures telecommunications services for highways under the National Roads Transmission Services (NRTS) project from a TSP. The telecommunications services support signals, ERTs, cameras, detection systems, enforcement systems (HADeCS) and other devices that in turn support safe and reliable journeys and ensure drivers are informed of traffic conditions ahead.

5.3.2. The TSP operates and maintains the Core Network and all transmission network equipment that provides connections between roadside equipment, control centres and other locations. Although the TSP has end-to-end responsibility for provision of telecommunications services, the roadside and control centre equipment and associated applications remain the responsibility of the Overseeing Organisation.

5.3.3. The TSP is responsible for the design, provision, and performance monitoring of the telecommunications services; providing a resilient and reliable service; and for providing additional local connections to support roadside devices as required by the Overseeing Organisation.

5.3.4. The TSP offers a range of telecommunications services based upon a particular geographic location or, where longitudinal communications cables exist, the type (copper or fibre) and capacity of these cables.

5.3.5. The TSP’s services connect via a Service Delivery Point (SDP) where the Overseeing Organisation’s equipment interfaces with the TSP’s network. An SDP may be located at the roadside, control office or other location.

5.3.6. The TSP should be consulted at the outset and throughout the life of any scheme.
5.4 Legacy Transmission System Protocols

5.4.1. The term National Motorway Communications System Mark 2 (NMCS2) is used to describe the current generation of control centre instation equipment (although it is now known as HATMS – see section 3.2) and the bespoke transmission protocols it uses to communicate with NMCS2 compatible roadside devices over the TSP’s transmission network.

Under the telecommunications services provided by the TSP, NMCS2 protocols are now transported between the instation and roadside devices over the TSP’s IP network. To support this change to IP transmission, elements of the NMCS2 instation have necessarily been updated, but its underlying method of operation remains unchanged.

Whilst all existing roadside devices retain their legacy NMCS2 interfaces and are supported by variants of the TSP’s telecommunications services, all new roadside devices shall use IP interfaces allowing them to interface directly with the TSP’s IP transmission network.

5.4.2. A considerable investment has been made in NMCS2 devices since they started to be deployed in the late 1980’s and many of these will remain deployed on highways for a number of years. To allow these legacy devices to remain in service but to benefit from the improved resilience and performance of the TSP IP network, the Overseeing Organisation has replaced all NMCS2 transponders with a TSP device known as an IP Translator (IPT). The IPT is an integral part of the TSP’s network providing an upstream IP connection to the HATMS instation, whilst retaining the downstream legacy RS485 serial interface to the end device.

5.4.3. The use of the IPT is restricted to the support of existing legacy roadside devices and is not deployed in the support of new roadside devices. All new roadside devices installed by schemes shall use interfaces with which they connect directly to the TSP’s SDP.
6. DOCUMENTATION

6.1 Design Documentation

6.1.1. Details of handover documentation to be produced are given in MCH 1349 Technology Maintenance Instruction Operational and Maintenance Requirements for Technology Systems and Equipment.

6.1.2. Following construction, a set of as-installed drawings will be produced (accurately recording details of the infrastructure and traffic technology devices that have been provided) in accordance with MCH 1652 Communications Records Drawings Computer Aided Drawings Standard.
7. **MAINTENANCE**

7.1 **System and Equipment Requirements**

7.1.1. It is important that all systems and equipment installed can be operated and maintained to the required standards of operation detailed in MCH 1349. MCH 1349 gives further information on installation standards, spares, documentation, routine maintenance schedules, specialist test equipment, handover into maintenance and warranty.

7.1.2. MCH 1349 includes technology systems maintenance handover certificate pro formas, which should be used to evidence that the systems and equipment provided by the scheme are suitable for operation and handover into maintenance.

7.1.3. MCH 1349 includes information for the handover of communications infrastructure and specific cabinets where these are to be maintained by the TSP.

7.2 **Changes to Equipment Quantities**

7.2.1. The maintenance contractor should ensure that the inventory list of equipment to be maintained is provided by the Overseeing Organisation at the time the contract is established; and ensure it is correct and complete.

7.2.2. The Overseeing Organisation should be notified of all changes to the technology network using MCH 1399 *NMCS Maintenance Instruction Notification of a Change in Equipment Quantities for Maintenance*. The TSP should also be advised of changes to equipment quantities where they relate to changes in the number or type of telecommunications services provided or required by the TSP.

7.3 **Changes to Site Data**

7.3.1. Changes to site data shall be carried out in accordance with the requirements in *TD 72 Transmission Infrastructure*.

7.4 **Changes to Systems in Service**

7.4.1. Changes to systems whilst in service are subject to operational change controls operated by the Overseeing Organisation and the impact is assessed through an appropriate operational change board.

7.5 **Maintenance of DBFO Roads**

7.5.1. The maintenance of technology operated by Design, Build, Finance and Operate Contractors (DBFO Co) is as described in the contract.
8. REFERENCES

8.1 Normative References

8.1.1. The following normative references are included in this document:

1. MCH 1514  Code of Connection – Application Process for Agency Project Sponsors, Suppliers and Maintainers
2. TD 72    Transmission Infrastructure
3. GD 01    Introduction to the Design Manual for Roads and Bridges (DMRB)

8.2 Informative References

8.2.1. The following informative references are included in this document:

4. GD 04    Standard for Safety Risk Assessment on the Strategic Road Network
5. TSRGD    Traffic Signs Regulations and General Directions
6. TA 83    Guide to the Use Of Variable Message Signs for Strategic Traffic Management on Trunk Roads and Trunk Road Motorways
7. TD 46    Motorway Signalling
8. TD 33    The Use of Variable Message Signs on All Purpose and Motorway Trunk Roads
9. TD 73    Emergency Roadside Telephones
10. TD 45    Motorway Incident Detection and Automatic Signalling (MIDAS)
11. TD 17    CCTV (Criteria for the Provision of Closed Circuit Television for the Strategic Road Network)

TSS Plans Registry:

- MCE 0104 HADECS Digital Speed Enforcement Equipment Requirements
- MCE 2574 Hard Shoulder Management Subsystem Server Technical Requirements
- MCH 1349 Technology Maintenance Instruction Operational and Maintenance Requirements for Technology Systems and Equipment
- MCH 1399 NMCS Maintenance Instruction Notification of a Change in Equipment Quantities for Maintenance
- MCH 1652 Communications Records Drawings Computer Aided Drawings Standard
- TR 2482 Specification for Highways Agency Digital Enforcement and Compliance systems (HADECS)
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