Project report:

Review of Highways England's asset management of road technology
June 2019

Project Ref: ORR CT 18-78

Project Sponsor: ORR

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Contents

1 Summary of key findings

Elliott Asset Management (EAM) has been appointed by the Office of Rail and Road (ORR) to undertake this review into Highways England's asset management of road technology. The objectives of the review have been to determine whether Highways England manages its roadside technology assets:

- **safely** for road users, technology maintainers and other road workers;
- **robustly** against whole life asset management principles to meet road period targets;
- **sustainably** including performance monitoring to meet long-term requirements; and
- **efficiently** to minimise cost and add value over the long-term through asset management.

EAM has worked jointly with Highways England and its supply chain and with ORR to gather evidence to assess the above objectives. The evidence has been synthesised into a series of findings and 14 recommendations to be considered by Highways England.

1.1 Key findings

Highways England operates over 100,000 Roadside Technology (RT) assets worth £4bn across the Strategic Road Network (SRN) through national and regional control centres, a telecommunications network and regional maintenance. RT assists Highways England to operate the network safely and efficiently. However, to maximise these benefits to road users, the technology needs to be up to date and well maintained. This relies on effective whole life asset management and good governance to achieve the right level of performance at the best value for money.

The landscape of RT contracts, systems, processes and standards is complex and is subject to significant ongoing business change as part of Highways England's journey to become a network operator. The importance of RT is increasing as Highways England adapts its operations to meet future network safety and capacity demands. This will significantly alter the way RT is operated, managed, maintained and procured. In order to meet these demands Highways England has recognised the increasing importance of RT as an asset to support its network operator role. Whole life cycle processes for management of RT assets as outlined in this report will continue to help Highways England meet its Digital Roads agenda and achieve its three imperatives: safety, customer service and delivery.

More detailed findings are described in **section 4** of this report. Note that a glossary of terms is included at the end of this section.

1.2 Key recommendations

Our overarching recommendation, which links the 14 high and medium priority areas for improvement in this section, reflects the need for Highways England to continue to build on its whole life asset systems approach to manage all technology, including RT:

'Highways England recognises the increasing importance of roadside technology (RT) as an asset to support its network operator role, its Digital Roads agenda and three imperatives: safety, customer service and delivery. It should continue to develop its whole life cycle processes to manage RT assets and support these objectives.'

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We have set out the following areas for improvement for Highways England to consider based on the project findings. These are split into High and Medium priorities and ordered according to the prioritisation process and scores described in **section 4.11** and in **Figures 9 and 10**.

1.3   High priority areas for improvement

[R5] Technology maintenance standards – **It is recommended that Highways England harmonises updates to its technology maintenance standards and applies these to its various delivery contracts to create a common and flexible maintenance response framework that can meet specific network service priorities.**

[R9] Technology programme funding - **It is recommended that Highways England continues to monitor the outcomes of technology programme funding to ensure that the reliability and availability of technology continues to meet the needs of the business, including the safety and customer service imperatives.**

[R3] Technology criticality - **It is recommended that Highways England continues to review the criticality of its RT assets, including their reliability and accessibility, to manage risks to network safety and customer service.**

[R1] Technology governance - **It is recommended that Highways England should clarify the ownership of RT assets through the asset lifecycle, including how they are governed and who is accountable. Further, as part of its business change programme Highways England could consider bringing RT accountability under a single point of responsibility in order to simplify its management and future requirements.**

[R4] Technology performance - **It is recommended that Highways England consider developing an internal leading performance indicator, such as internet protocol (IP) compatibility, to support the Road Investment Strategy period 2 (RIS2) metric and inform and optimise maintenance and renewal decisions.**

[R7] Asset data - **It is recommended that Highways England uses its asset improvement programme to develop specific activities to improve RT asset information and ensure compatibility with other asset groups. It is also recommended that the improvement programme is used to understand the confidence level of RT asset data and the potential consequences to maintenance and renewal decisions as asset systems are upgraded.**

[R8] Technology maintenance - **In order to achieve its customer service imperative, it is recommended that Highways England continues to review its RT maintenance requirements, including equipment accessibility, against the performance expectations of regional control centres at priority network sites.**

[R13] Business change - **It is recommended that Highways England develops a cross-business roadmap, specifically for technology, to manage current and future technology transition.**

1.4   Medium priority areas for improvement

[R6] Asset management - **It is recommended that Highways England continues with its whole life asset management approach for RT, aligned to ISO 55001 principles, including tactical and operational asset management processes and procedures that recognise the particular needs of technology, such as managing obsolescence.**

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[R10] Technology procurement - **It is recommended that Highways England reviews its procurement process and organisation, including cross-business collaboration and knowledge sharing, to consistently control the purchase and warranty terms of all RT equipment.**

[R11] Technology procurement – **Given the increasing strategic importance of RT, it is recommended that Highways England more fully reflects whole life cost and reliability criteria in its technology tender specifications.**

[R14] Future technology requirements - **It is recommended that Highways England continues to review its provision and management of RT assets, including its asset management strategy and maintenance and renewal contract delivery, to accommodate the changes required for Digital Roads.**

[R2] Technology skills and competence – **It is recommended that Highways England continues to develop its technology skills, competencies and training programmes across the business, including in its supply chain, to match the pace of technology change.**

[R12] Collaboration and knowledge sharing – **It is recommended that Highways England should re-establish a cross-business national technology forum, aligned to its asset management improvement plan, which improves collaboration and knowledge sharing across national and regional teams. This should include the supply chain, and coordinate supplier performance management and procurement.**

1.5 Conclusions

RT is an increasingly important asset that supports Highways England's network operator role and the Digital Roads agenda. In order to sustain current performance and meet future requirements Highways England requires RT that is up to date, reliable and available. This relies on effective whole life asset management decisions that continue to achieve and sustain the right level of performance at the best value.

Highways England is undergoing a period of significant business change, including to technology systems and the way that RT maintenance and renewals are delivered. This combination of concurrent change will significantly alter the way RT is operated, managed, maintained and procured, and requires oversight to manage interdependency of outcomes and overall delivery risk.

There have been several change initiatives as part of transitioning from Highways Agency to Highways England and these have already enhanced the asset management approach to managing technology. These include the Operational Excellence programme, the development of a whole-life strategy aligned to ISO 55001 principles and the deployment of smart motorway technology to better manage strategic network sites.

The evidence from this review concludes that *Highways England's asset management of RT is developing towards a mature lifecycle approach*. The teams we have interviewed recognise the increasing importance that RT plays in delivering Highways England's business outcomes and are committed to making sure this continues. *Highways England has also shown commitment to the whole life asset management of RT to optimise maintenance resilience, renewal and replacement and to carry this out safety, robustly, sustainably and efficiently.*

As Highways England develops its approach to RIS2, its asset management strategy, plans and processes for RT require further alignment with other key asset groups such as pavements and structures, geotechnical and drainage. This will help integrate safe, robust, sustainable and efficient

management of RT and support Highways England in achieving its three imperatives: safety, customer service and delivery.

Glossary of Terms

Acronym	Description	Acronym	Description
AD	Asset Delivery contract	ADAMr	Asset Delivery Asset Maintenance Requirements
ADMM	Asset Data Management Manual	AIG	Asset Information Group
AGS	Asset Group Strategy	ALR	All lane running
AMI	Advanced motorway indicators / Asset management information	AMOR	Asset Management Operational Requirements
AMP	Asset Management Plan	APTR	All-purpose trunk road
ASC	Asset Support Contract	ASR	Asset Steward Review
CCS	Crown Commercial Services	CCTV	Closed Circuit Television
CHARM	Common Highways Agency and Rijkswaterstaat Model	COBS	Control Office Base System
COTS	Commercial off-the-shelf	DBFO Co	Design, Build, Finance and Operate Contractors
DMRB	Design Manual for Roads and Bridges	ERA	Emergency Refuge Area
ERT	Emergency roadside telephone	ETM	Emergency Traffic Management
GSM	Global System for Mobile Communications	HADECS	Highways Agency Digital Enforcement Cameras (current contract)
HEDECS	Highways England Digital Enforcement Cameras (new procurement)	HALOGEN	Highways Agency Logging Environment
HAM	Highway asset management	HAPMS	Highways Agency Pavement Management System
HATMS	Highways Agency Traffic Management System (England only)	HAWIS	Highways Agency Weather Information Service
HSM	Hard Shoulder Management	HTOC	Highway Traffic Operation Centre
IAM-IS	Integrated Asset Management – Information System	ILM	Intelligence led maintenance
IP	Internet Protocol	ITD	Information Technology Directorate
l-AMP	Lifecycle Asset Management Plan	LHA	Local Highway Authority
M&R	Maintenance and Renewals / Maintenance & Response (AD contract)	MCHW	Manual of Contract Documents for Highways Works
MIDAS	Motorway Incident Detection and Automatic Signalling	MM	Managed motorway
MP	Major Projects Directorate	MRP	Maintenance Requirements Plan
MS3/4	Message Signal Mk3 or Mk4	MTBF	Mean time between failure
NATS	National Air Traffic Services	NPT	Network Prioritisation Tool
NRTS	National Roads Telecommunications Services	NTIS	National Traffic Information Service
NTLC	National Technology Logistics Centre	NTOC	National Traffic Operations Centre
O&M	Operation and Maintenance	OD	Operations Directorate
OMM	Operational Metrics Manual	ORR	Office of Rail and Road

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Acronym	Description	Acronym	Description
PAD	Progressive Asset Delivery contract	PCF	Portfolio Control Framework
PI	Performance Indicator	R&D	Research and development
R&R	Reporting and review	RCC	Regional Control Centre
RIS1/2	Road Investment Strategy period 1 or 2	ROC	Regional Operations Centre
ROTTMS	Remotely Operated Temporary Traffic Management Signs	RT	Roadside technology
RTMC	Regional Technology Maintenance Contract	S278	Section 278 3rd party development
s-AMP	Strategic Asset Management Plan	SES	Safety, Engineering & Standards
SOFA	Statement of Funds Available	SMP	Smart motorway programme
SVD	Stopped Vehicle Detection	SRN	Strategic Road Network
TAG	Technology Assurance Group	TMMM	Technology Management and Maintenance Manual
TMT2	Traffic Management Technology framework 2	TO	Traffic Officer
TOC	Traffic/Technology Operations Centre	TTOC	Tools for the TOC
TPMS	Technology Performance Management Service	TSS	Traffic Systems and Signing (Plans Registry)
TTM	Traffic Technology Maintainer	VM	Value Management
VMS	Variable Message Sign	WLC	Whole Life Cost

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2 Introduction

2.1 Purpose of this report

2.1.1 Scope

Elliott Asset Management (EAM) has been appointed by the Office of Rail and Road (ORR) to undertake this review into Highways England's asset management of road technology (RT). The review provides a series of findings and 14 recommendations for the consideration of Highways England. The objectives of the review have been to determine whether Highways England applies an asset management approach to manages its roadside assets:

- **safely** for road users, technology maintainers and other road workers;
- **robustly** against whole life asset management principles to meet road period targets;
- **sustainably** including performance monitoring to meet long-term requirements; and
- **efficiently** to minimise cost and add value over the long-term though asset management.

The review is a snapshot of Highways England's RT asset management practice based on a sample of fourteen interviews with Highways England and its supply chain conducted over an eleven-week period.

2.1.2 Methodology

Evidence of Highways England's asset management of RT has been gathered from interviewing a number of different national and regional teams including: Information Technology Directorate (ITD), Safety, Engineering and Standards (SES), Operations Directorate (OD), Strategy and Planning, Performance, Finance and Procurement. A selection of regional maintenance contract and control centre teams were also interviewed.

As well as reviewing asset management processes for RT, the project has reviewed a sample of technology renewal schemes. A total of 11 schemes have been reviewed from 3 separate maintenance areas in 2 regions. It has considered the end to end processes and enabling information and systems used for the development and delivery of RT routine maintenance and capital renewals.

Evidence has been assessed in four areas:

- **Asset management information**:
    - How regions and contracts use the Highways England Strategic Asset Management Plan (s-AMP) or alternative asset management approaches to collect, store, monitor and report technology asset data;
    - How regions and contracts use the Technology Performance Management Service tool (TPMS) as part of its asset management system to qualify and quantify how asset data inventory, condition, criticality and performance is managed and consistently applied;
    - How technology asset information processes are applied within a risk-based approach.

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- **Maintenance and renewals planning**:
  - How regions and contracts use the Project Control Framework (PCF) phases 0 to 5 and stage gate requirements to monitor technology assets, identify technology maintenance and asset renewal need and develop project interventions;
  - How regions and contracts use the s-AMP and the Highway Asset Management (HAM) processes within the PCF phases;
  - How cost estimates for technology maintenance and renewal options are developed and validated.
- **Maintenance and renewals delivery:**
  - How regions and contracts inspect, monitor and maintain their road technology and report their findings;
  - How regions and contracts use the PCF phase 6 and 7 requirements, including governance of budgets, works quality, technology programme variations, and interaction with other asset renewal schemes.
- **Reporting and review of asset interventions delivery:**
  - How regions and contracts use the Technology Maintenance Management Manual (TMMM) requirements and s-AMP HAM processes for reporting of asset condition and performance;
  - How changes are managed for asset renewals and new assets brought into service and how this data is entered into TPMS;
  - How is technology availability measured and how the reported Performance Indicator (PI) drives behaviours;
  - Lessons learnt from technology asset maintenance, renewal and improvement and the process for recording and sharing good practice;
  - Risks to future technology maintenance and renewal planning and delivery and preparedness for future changes to the network.

2.1.3 Acknowledgements

EAM would like to thank Highways England and its supply chain for taking part in this review and providing evidence openly and collaboratively. We would also like to thank the Office of Rail and Road and Highways England Project Managers for their valuable support in facilitating this review.

2.1.4 Notice

This report has been prepared by Elliott Asset Management Ltd (EAM) on the basis of the Form of Agreement with the Office of Rail and Road (ORR) dated 30th January 2019, in relation to contract CT/18-78. This report is for the benefit and information of ORR. All surveys, observations, analysis and forecasts contained in the report have been made on the basis of the information available at the time of the study and have been prepared as at 1st June 2019. EAM cannot be liable for any subsequent changes.

In preparing the report, EAM has relied upon, and assumed the accuracy of, information obtained from a variety of sources, including but not limited to: data provided by Highways England; interviews with members of Highways England and its supply chain and representatives of industry associations; interviews with road and non-road operators; published academic and technical information. EAM accepts no responsibility and will not be liable in the event that information provided to EAM during the course of the assignment from such sources and relied upon by EAM is subsequently found to be inaccurate.

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3 Highways England's management of roadside technology

3.1 Operational technology landscape

Highways England operates over 100,000 roadside technology (RT) assets across the Strategic Road Network (SRN), including approximately 40,000 end devices, with an approximate capital value of £4bn. These are managed through a landscape of national and regional control centres, telecommunications network and maintenance and renewal contracts. **Figure 1** shows the operational technology hierarchy and information flow. Note that a glossary of terms is included at the end of **section 1**.
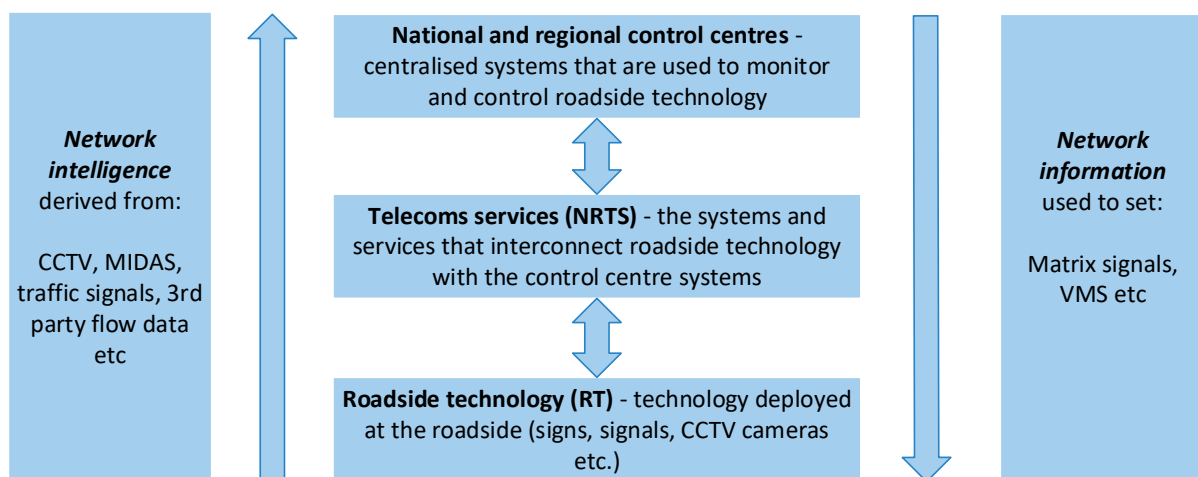

Figure 1 – Highways England's operational technology hierarchy and information flow

Highways England has inherited the legacy of austerity that Highways Agency experienced, including several spending reviews which focussed on a do-minimum risk-based approach to asset maintenance and impacted investment in technology change programmes. RT asset management has also been constrained by the uncertainty arising from regional funding allocation for asset renewals, and the current technology maintenance contract landscape.

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

- **Informing** – disseminating information through signals and Variable Message Signs (VMS);
- **Controlling** – making interventions in response to network conditions and information such as from signals, the Motorway Incident Detection and Automatic Signalling (MIDAS) system, VMS, Ramp Metering (RM) and enforcement technology; and

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- **Monitoring** – real time information monitored by control centres to manage highways effectively such as from MIDAS detectors, Closed Circuit Television (CCTV), Meteorological (MET) systems and Emergency Roadside Telephones (ERTs).

The range of RT assets operated by Highways England varies within each region, with newer smart motorway technology increasingly replacing outdated equipment. The principal RT asset elements as defined in Volume 9 of the Design Manual for Roads and Bridges (DMRB) and the network traffic control and communications standard TD71/16 are:

- Signals and Variable Message Signs (VMS) including Enhanced Matrix Indicators, Enhanced Message Signs, Motorway Signals (MS1 to 4), Advanced Motorway Indicators, Fixed Text Message Signs, Enforcement Devices;
- Motorway Incident Detection and Automatic Signalling (MIDAS) detector loops and radar;
- Hard Shoulder Management Subsystems;
- Closed Circuit Television equipment;
- Emergency Roadside Telephones (ERTs);
- Ramp Metering;
- Meteorological (MET) Detection Systems;
- Tidal Flow Subsystems;
- Tunnel Subsystems;
- Infrastructure including communications cables, power cables, cabinets.

Note that the DMRB, including standards such as TD71/16, are currently being refreshed and are due to be superseded in 2019.

The deployment of operational technology allows Highways England to monitor and manage the network, provide data to model current demands, predict future needs and identify areas for future investment. To maximise these benefits to road users, RT is required to be high performing and available when required. Consistently achieving a target level of performance for RT, both in today's network environment and to meet future Digital Roads requirements, relies on effective whole life asset management, including suitable governance and process alignment with other operational assets.

During this project we have spoken with and collected evidence from a cross-section of Highways England teams responsible for the specification and management of operational technology, as well as teams responsible for technology safety, engineering and standards, maintenance and renewal operations, procurement and finance. We have also visited national and regional delivery teams responsible for the planning and delivery of RT maintenance and renewals to collect scheme evidence. We have focussed on identifying evidence that documents the current asset management of RT, as well as documenting Highways England's journey towards meeting future technology requirements.

3.2 Summary findings and key challenges

What we have found is a complex landscape of contracts, systems, processes and standards for managing and maintaining RT, as well as variation within operational regions. These are summarised in **Figure 2**. We have identified significant business change, both current and future, that is happening simultaneously and that will alter the way technology is managed at a national and regional level.

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These include changes to maintenance contracts, standards, RT asset data systems and control centre systems.

Roadside technology governance (Highways England groups involved in the asset lifecycle)

- *Information Technology Directorate (ITD)* – Operational strategy + equipment standards + performance measurement

- *Safety, Engineering & Standards (SES)* – asset management, assurance, design and maintenance standards

- *Operations Directorate (OD)* – maintenance & renewal delivery

- *Major Projects (MP)* – smart motorway delivery

- *Procurement* – Traffic Management Technology (TMT) framework

- *Finance* – asset valuation

Existing roadside technology contracts

- Regional Technology Maintenance Contracts (RTMC)

- Asset Support Contracts (ASC)

- Design Build Finance Operate (DBFO)

Future roadside technology contracts

- Asset Delivery (AD)

- Progressive AD (PAD)

- DBFO

Roadside technology standards & specifications (managed by SES, ITD and OD)

- Technology Maintenance Management Manual (TMMM)

- Concept of Delivery (COD) Maintenance & Response requirements

- Traffic Systems & Signing (TSS) Plans Registry

- Asset Data Management Manual (ADMM)

Roadside technology asset management (elements specified by ITD, SES and OD)

- *Strategy:* Operational technology strategy + Strategic Asset Management plan (s-AMP)

- *Planning:* Lifecycle Asset Management plans (l-AMP)

- *Processes:* Highway Asset Management (HAM) processes + Project Control Framework (PCF) + Value Management (VM) process including Network Priority Tool (NPT)

Figure 2 – Landscape of Highways England RT governance, contracts, standards and asset management

Our evidence shows that these changes are necessary to develop the performance and resilience of RT to meet future needs, but when combined have the potential to impact RT performance and availability during their transition. This presents a risk to the successful management of RT, which is partially mitigated by the high quality of the people involved. Nevertheless, Highways England needs to continue to monitor and manage all change as part of its asset management process.

Our discussions with Highways England and supply chain staff have highlighted the high level of technical knowledge and understanding of the current and future operational needs of RT that exists within the business. We have identified examples of current and developing best practice with the provision of new technology, such as in smart motorways. While we have identified good governance in each life cycle activity, we have also identified examples where governance and communication between each activity and across the whole life asset management of RT could work better. This is a key finding which Highways England is aware of and is working to develop better coordination across the business.

The challenge of getting RT recognised alongside other asset groups is understood across the business and there is good evidence of progress with technology strategy, process, systems and data now in place to help raise awareness of the importance of technology, including RT, and better coordinate RT asset management across the business.

3.3   Operational technology asset management maturity

As required in its licence, Highways England has developed its asset management approach to be consistent with the principles of ISO 55001, the international standard for asset management. It is also required to manage its assets safely, robustly, sustainably and efficiently. Asset management maturity requires a formalised system approach, clear line of sight and embedded whole life cycle processes with appropriate governance and accountability. It also requires long-term asset investment programmes based on need with annual programme development and delivery. For Highways England to make effective investment and operational decisions for RT that maximise value for money and prevent early asset failure high quality asset data is required, as is the confidence to use it.

Evidence from this project shows that Highways England is aware of the need to further develop its asset management approach for RT in order to align it with the more mature approach adopted for other asset groups such as pavements and structures. The desire across the business to maximise RT performance and availability was evident in all interviews. Our evidence highlighted Highways England's primary commitment to operate and manage RT safely at all times, and concluded that further improvements are required to develop robust, sustainable and efficient management and operating practices. To improve its maturity of RT asset management, Highways England has recognised that more coordination is required across the asset lifecycle, and is progressing with a programme of technology and business change activities.

The importance of asset data quality to make well informed maintenance and renewal decisions is recognised within Highways England's s-AMP and asset data management processes. Highways England holds its RT inventory and fault history data in TPMS and is transitioning to a service management software called ServiceNow as part of its upgrade of control centre systems through the Common Highways Agency and Rijkswaterstaat Model (CHARM) programme. Our evidence has highlighted a varying level of regional confidence in the RT asset inventory and fault history held in TPMS as well as varying levels of data governance. The introduction of ServiceNow as part of CHARM and the move to remote asset monitoring technology should improve data governance, however it is important that the quality of the initial data set is understood and improved.

Asset condition information for RT assets is not collected and reported by Highways England in the same way as other assets such as pavements, structures and geotechnical. RT condition is reported in regional asset plans as a measure of residual life, which is determined from installation date data in TPMS and an assumed design life of 15 years. As data quality in TPMS varies, significant quantities of existing RT assets have an estimated installation date and therefore estimated residual life. Some RT

exceeds its design life and is still working reliably. Other RT either becomes faulty before its mean time between failure (MTBF) or becomes obsolete during its design life. The process for monitoring RT asset condition is also described in the Area asset plans. Under the RTMCs, planned routine condition monitoring is only undertaken during electrical inspections or during fault repairs.

3.4 Operational technology strategy

Highways England's emerging strategy for operational technology, developed by ITD, is focussed on enhancing RT capability and performance and a move towards new technology architecture based on internet and cloud-based services. This will allow Highways England to take greater control of RT through remote monitoring and a single point of first line 'find and fix' management from a national Technology Operation Centre (TOC). The TOC is aligned to the regional roll-out of Asset Delivery (AD) contracts and the future inclusion of RT maintenance in these contracts. Data security is also considered in the strategy.

The operational technology strategy sets out how Highways England will plan for whole life through delivering seven key objectives:

- **Specify with open standards** – this includes specifying future RT to use the latest open standards, services and architecture to ensure Highways England maximises its supply base and taps into wider markets that adopt approaches that cater for future uncertainty;
- **Procuring with optimum support** – this seeks to put in place support arrangements that incentivise reliable designs whilst not inhibiting Highways England's ability to use third-party maintainers to continue to restore services as quickly as possible;
- **Innovate, validate and assure** – creating a safe environment where potential suppliers can demonstrate their products and Highways England can validate their designs, test prototypes and develop working practices remote from live operating environments;
- **Remotely monitor** – this includes adopting best procurement practices from other sectors for remotely monitored RT, and which can be remotely configured and upgraded from a central location – the Technology Operations Centre (TOC);
- **Incentivise continuous improvement** – this aims to develop a performance regime that aligns technology maintainers' commercial interests with operational needs, including incentivisation for high performing technology and a continuous improvement culture;
- **Manage obsolescence** – developing processes and systems to monitor RT from cradle to grave to provide better data and knowledge to improve planning for RT obsolescence;
- **Intelligent renewals** – this aims to target renewals where they have the most benefit, sweating the asset where appropriate until it can be replaced by new innovative solutions, and programming with other works to reduce customer disruption.

In parallel with ITD's strategy, Highways England's SES team has developed a generic strategic Asset Management Plan (s-AMP). This aims to improve the maturity of all asset groups, including technology. The s-AMP includes a suite of lifecycle processes and documents. To support the s-AMP an Asset Group Strategy (AGS) for technology is being developed, aligned to the AD contract roll-out.

Evidence from this review concludes that while both the operational technology strategy and s-AMP both have clear asset management objectives, they have been developed by two directorates in parallel (ITD and SES). As a result, there are areas that could be better aligned to manage RT more effectively across the business and communicate a common approach to all teams in the asset

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lifecycle. Indeed, there may be benefits in bringing RT accountability under a single point of responsibility in order to simplify its management and future requirements.

3.5 Maintenance and renewal planning and delivery

Regional maintenance of RT is transitioning from risk-based and reactive to more proactive with minimum service levels as an integral part of the AD contract model. The maintenance standard TMMM is being enhanced to reflect increased expectations in RT availability performance and introduced to regional AD contracts in phases. The enhanced standard will also allow each region to use its in-house maintenance capability to deliver varying and tailored service levels, such as at critical network junctions. The evidence we have identified supports the future enhancement of RT maintenance service levels and Highways England's customer service imperative.

Our evidence from a sample review of technology renewal schemes and discussion with regional control centre teams has also confirmed the challenges being experienced by regions to embed the new enhanced standard within existing maintenance contracts in order to meet their technology performance expectations.

3.5.1 Technology renewal framework and process

Highways England regions follow the Portfolio Control Framework (PCF) process for the capital renewal of roadside technology. Renewal need is assessed from a variety of factors including RT inventory and fault system data in TPMS and residual design life. Areas that still operate under the Asset Support Contract (ASC) model follow the 'old' PCF process including the 'old' Value Management (VM) process which is used to assess the viability of schemes that are proposed by the Service Provider.

As Areas transition to the Asset Delivery (AD) model or Progressive Asset Delivery (PAD) they will start to follow the 'new' PCF process which includes a 2-stage VM process (i.e. using the Needs Prioritisation Tool (NPT) to prioritise schemes rather than VM workshops), with renewal need being identified by Highways England staff.

Our evidence has concluded that the PCF process is robust and well administrated, with a high quality of business case justification. The funding process, including annualised VM, can sometimes create constraints for long-term technology renewal planning. Whilst it is recognised that in a scenario of limited funding, priority should be given to pavements and structures schemes, the regions we interviewed have highlighted the difficulty in being able to achieve sufficiently high VM scores for critical RT renewal schemes to be taken forward. This increases the risk of these renewals being deferred and of being reprogrammed in-year if budgetary reductions are required.

3.5.2 Scheme development using the Needs Prioritisation Tool (NPT)

For AD contracts, the NPT will automatically determine a scheme VM score dependent on its network location, ie its locational criticality (this is the pre-determined 'Network Impact Score'), and the asset renewal scheme type (this is the pre-determined 'Operational Metrics Impact Score' although it can be overridden with justification). Both components are scored out of 50 marks and are added together to give an overall 'Business Impact Score' out of 100. **Figure 3** shows the range of impact (High, Moderate, Negligible) that Highways England has assigned for each asset type against its key objectives. The impact of technology assets has been highlighted in the figure.

Asset	Improves Safety	Network Condition	Environment Outcomes	Smooth Traffic Flow	Vulnerable Users	Achieving Efficiency	Economic Growth	User Satisfaction
Pavement	High	High	Moderate	Negligible	Negligible	Moderate	Negligible	High
Structures - Safety	High	High	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate
Structures - Non-safety	Moderate	High	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate
Structures - Non-network	Moderate	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate
Drainage	High	High	Moderate	Negligible	Negligible	Moderate	Negligible	Moderate
Geotechnical	Moderate	High	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible
Lighting	High	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	High
Technology	High	Moderate	Negligible	High	Negligible	Negligible	Negligible	Moderate
Vehicle Restraint System	High	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate
Traffic Signals	High	Moderate	Negligible	High	Moderate	Negligible	Negligible	Moderate
Tunnel Equipment	High	Moderate	Negligible	Moderate	Negligible	Negligible	Negligible	Negligible
Traffic Signs	High	Moderate	Negligible	Moderate	Moderate	Negligible	Negligible	High
Road Markings and Studs	High	Moderate	Negligible	Moderate	Negligible	Moderate	Negligible	High
Fences and Ancillary	Moderate	Moderate	Moderate	Negligible	Negligible	Negligible	Negligible	Moderate
Environmental	Moderate	Moderate	High	Negligible	Negligible	Negligible	Negligible	High

Figure 3 - NPT asset impact scores as part of the VM process

3.5.3 Technology renewal scheme sampling

A sample of technology renewals schemes from the South East and Midlands regions have been reviewed in this project. These are shown in **Figure 4**.

Location	Description of Scheme	Technical Justification
South East region: Area 3	Renew 13 life expired Emergency Roadside Telephones on the A329M, M3, M4 & M275	Life expired (based on TPMS)
	To renew 3 life expired Vehicle Activated Signs on the A3	Life expired and don't meet current standards
	Asset Support Contract Technology Scheme Canford Bottom power supply renewal	Obsolete + risk of failure
	A303 Eastbound renewal of 54 MS3 signs	Life expired, fault history + out of spares, not IP enabled
South East region: Area 4	M2 Medway Bridge CCTV Renewal	Cameras non-operational + obsolete
	A27 Traffic Signals Refurbishment at Sussex Pad	Repair defects + bring assets up to current standard
	A21 John Cross Severe Weather Information Service renewals	Life expired + update to latest standard
	A27 Southwick Tunnel approach message signs renewal	Non-operational + upgrade needed
Midlands region: Area 9	M42 J2-3a MS3 sign renewal	Assets will reach their end of life during HS2 works period and non-access
	M5 & M54 Outstation technology renewals	Life expired, fault history + out of spares, not IP enabled
	MSS sign renewals	Poorly performing signs approaching end of life

Figure 4 – Sampled technology renewal schemes and their technical justification

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The project sampling approach has included a review of scheme documentation and interviews with Area renewals teams. This has highlighted a number of conclusions:

- Technology assets encompass a wide range of equipment types including signs, cameras, telephones etc;
- Schemes can take a number of years from being first identified to being delivered on the network;
- The VM process changes over time which, given the time taken for schemes to be developed, means that schemes in the current programme may have been justified on different bases for example:
    - The VM scoring factors for some schemes are 'safety, value for money and sustainability', other schemes include 'impact' as well;
    - Some schemes include a 'Do Minimum' solution, others don't;
    - Some schemes include a value for Risk and Optimism bias, others don't for example those sampled from Area 9;
- Obsolescence is a key factor in justifying technology renewal;
- Delivery of technology renewals can be at risk due to in-year budgetary change combined with the long lead times necessary to order RT equipment;
- The new NPT uses pre-determined scores for a renewal scheme's location to reflect its network criticality and asset type. This is automated in the VM scoring process, although the asset type score can be overridden with justification;
- The new NPT shows that technology has a high influence on improving safety and smoothing traffic flows and a moderate influence on network condition and user satisfaction;
- The Operational Metrics Impact Score acknowledges that technology renewal schemes have a high influence on improving safety and smoothing traffic flows and a moderate influence on network condition and user satisfaction.

3.6 Operational technology performance

Highways England reports its technology performance for RIS1 (2015-2020), including for RT, through an availability measure. Availability data is captured in TPMS based on the number of faults in the various equipment categories. RT availability is reported as a monthly Performance Indicator (PI) in Highways England's Operational Metrics Manual (OMM) under 'Keeping the Network in Good Condition'.

The target level of technology availability is based on historic data from 2013 to 2015. Actual availability against the target is monitored and reported within Highways England monthly and externally reported annually.

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Figure 5 shows the annual performance of RT availability during RIS1. Performance has remained fairly static and in 2017/18 performance was slightly under the 98.79% annual baseline target.

Highways England Performance Monitoring Statements Year end 2017-18					
Statement PS8: Keeping the Network in good condition		For a definition of the metric and parameters for measuring and monit			
Performance specification					
	Source of baseline	**Actual**	**Annual baseline**	**KPI/PI/ Req**	**Difference**
Roadside technology					
2012-13		98.13%			
2013-14	Historic Data	98.23%			
2014-15	Historic Data, OMM	99.98%	98.23%		
2015-16	Corporate management information	98.67%	99.98%	PI	-1.31%
2016-17	Corporate management information	98.79%	98.67%	PI	0.12%
2017-18	Performance specification	98.40%	98.79%	PI	-0.39%
2018-19	Performance specification	X	[X]	PI	X
2019-20	Performance specification	X	[X]	PI	X

Figure 5 – RIS1 annual performance for RT measured as availability

Our evidence supports Highways England's view that the current headline measure does not meaningfully reflect the state of RT assets, or allow the assessment of performance against the reliability of RT expected by regional control centres. Highways England is developing a new metric for RIS2 that more accurately represents the asset management performance for RT assets across the entire organisation and associated supply chain in keeping with managing technology as a service.

We have identified examples of RT equipment that perform reliably and well beyond their expected design life, as well as RT equipment that is less reliable and performs below its intended MTBF target or becomes obsolete before the end of its design life. At a regional level, Highways England has a good understanding of RT performance, but performance issues are not always communicated to national technology teams and the Procurement team.

Our evidence has highlighted some variability in procurement of RT, with good practice evident through the governance arrangements of the Traffic Management Technology framework (TMT2). However, when RT is procured by Tier 1 contractors on smart motorway schemes, equipment warranties cannot be transferred to Highways England. Highways England's Procurement team recognises that it needs to work closer with its operational teams and is working towards the centralised governance of all RT procurement.

3.7 Operational technology valuation

A brief review of how Highways England values RT for its annual accounts was undertaken in order to understand the assumptions for RT equipment age and depreciation and how these compare with the asset age assumptions used by the regions to identify RT renewal need.

Highways England carries out a valuation of its main asset groups (pavements, structures, technology etc) in accordance with international and UK Government accounting practice on a rolling 5-yearly cycle. The technology assets listed in **section 3.1** of this report were last valued in 2014 and are currently being revalued. The current value of technology including RT is £4bn. The valuation uses a nominal 15-year design life for RT, 30-years for cabling and 50-years for structures such as gantries.

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The valuation is reported in Highways England's annual accounts and is reported in the whole of government accounts under the Department for Transport (DfT).

In conclusion, the current method of valuing RT uses a nominal 15-year design life: this is the same assumption for nominal renewal life that is adopted by the regions to identify renewal need. The valuation assumes that all RT is recorded accurately in TPMS and uses this data as an inventory base. This contrasts to the evidence collected from Highways England's regions which points to varying quality of TPMS data.

3.8 Sector comparison

As part of the project a comparison has been made between how railside (trackside), airside and roadside technology is operated in the Railway/Aviation/Highway sectors. The comparison recognises the increasingly important role that RT plays in making safety-based decisions on highways. It has also identified areas of synergy between RT and technology in other sectors where safety-critical equipment is operated. There are significant parallels, for example with the whole life management of assets, as well as significant differences, particularly with the 'safety critical' environment within which railways and airside operations are carried out.

3.8.1 Sector similarities

- All three sectors attach importance to technology design and specification including equipment obsolescence, software management and guarding against cyberattack;
- All sectors rely on experienced specialists and skills to manage technology including control centre and first line technical support;
- All sectors recognise whole life asset management principles. In the aviation sector NATS is certified to ISO 55001 and both Network Rail and Highways England have adopted asset management approaches consistent with ISO 55001 standards;

3.8.2 Sector differences

- Railway and aviation sectors operate with 'safety critical' systems to control the safe separation between traffic. RT enables safety-based decisions to instruct and inform drivers, adding to the minimum standard of competence (driving test), to enable safe operation of their vehicle under due care and attention;
- Train drivers and airplane pilots are rigorously (professionally) trained and the network itself is closed;
- When rail and aviation technology systems develop faults, the system either sets to 'fail safe' or provides automatic warnings which trigger predetermined traffic avoidance scenarios. RT faults register a system warning for further analysis and response by the local maintainer and do not close the highway;
- Telecommunications principles and operational practices including language protocols vary across the sectors. Highways England currently operates with Airwave radio for internal communication and with other emergency services to manage incidents. This is due to be replaced by the Emergency Service Network (ESN) which will transform emergency services' mobile working, especially in remote areas and at times of network congestion, and create a single platform for sharing data and imagery;

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- Rail and highway technology systems are operated from similar regional control centres. Air space is operated nationally and integrated with ground-based air traffic control at airports;

- All sectors report on passenger/vehicle delays, inherent in which is the performance of technology. Highways England measures journey reliability through average speed and average delay and reports on roadside technology availability while air and rail run to timetables which is easier to measure;

- The rail sector uses asset condition monitoring including sensor technology to identify equipment close to failure and has successfully reduced the rates of faults through proactive intervention. RT is not routinely monitored for condition and is maintained through a 'fault-find-fix' approach;

- Rail technology renewal investment is prioritised based on its 'safety critical' priority. Roadside technology competes with other asset groups and does not always score highly on safety in the value management process;

- Rail and aviation technology standards are harmonised with European standards, and for aviation with international standards. RT standards are specific to the UK.

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4 Findings and Recommendations

4.1 Presentation of the findings

The following findings have been derived from interviews and evidence reviews with Highways England and their supply chain partners. These have been grouped and are set out in the following sections:

- Technology overview, organisation and governance
- Service performance and availability
- Technology standards
- Asset strategy, planning and process
- Management systems and asset information
- Maintenance, renewal and third-party schemes
- Technology procurement
- Collaboration and knowledge sharing
- Business change and future requirements.

Recommendations have been developed from the project findings and are described under each section. **Figure 6** shows the alignment between findings and recommendations. Prioritisation of the recommendations is described later in this section.

Area of interest	Findings (report Section 4)	Recommendations (report Sections 1 and 4)
Technology overview, organisation and governance	F1, F2, F3	R1, R2, R3
Service performance and availability	F4, F5, F6, F7	R4
Technology standards	F8, F9	R5
Asset strategy, planning and process	F10, F11, F12, F13	R6
Management systems and asset information	F14, F15, F16	R7
Maintenance, renewal and third party schemes	F17, F18, F19, F20, F21	R8, R9
Technology procurement	F22, F23, F24	R10, R11
Collaboration and knowledge sharing	F25	R12
Business change and future requirements	F26, F27, F28, F29	R13, R14

Figure 6 – Synthesis of review findings and recommendations

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4.2 Technology overview, organisation and governance

4.2.1 Findings

[F1] General technology overview - Highways England manages over 100,000 technology assets including approximately 40,000 active devices across Roadside Technology (RT), control centres and National Roads Telecommunications Services (NRTS). The importance of overseeing the functionality for technology assets, which has increased as a result of smart motorways, has recently been recognised by combining the Traffic Technology Division (TTD) with the Information Technology Directorate (ITD). Note that ITD is one of several directorates responsible for aspects of RT whole life asset management (see F3 below). The importance of RT is likely to increase further as Highways England develops its 'Digital Roads' agenda.

RT is not categorised as safety-critical which means it can be allowed to develop faults without closing the highway. However, RT is relied on by Highways England's national and regional control centres to make intelligence-led decisions and provide safety-based information.

There is a complex landscape of contracts, systems, processes and standards for managing and maintaining RT as well as variation within operational regions. There is also significant business change, both current and future, to the way technology is managed, principally with systems and maintenance. This change will significantly impact RT governance, performance and procurement. The following findings expand on these points.

[F2] Future technology direction – Highways England is developing its Digital Roads programme which includes Digital Customers, Digital Design & Construction and Digital Operations. This will lead to the wider use of smarter technology assets on the network with different service requirements. Digital roads will potentially use less physical infrastructure than smart motorways currently have. To support the Digital Roads programme Highways England is developing a road map to introduce technology to support connected autonomous vehicles in RIS2. This builds on its proof of concept technology communication and transport models and live vehicle to infrastructure communication trials.

[F3] Organisational and contract landscape - There is a split responsibility for aspects of technology governance, management and maintenance within Highways England. This includes ITD (Technology Control Centre, NRTS, RT standards and specifications), SES (asset management standards and RT design and maintenance standards), OD (Regional Control Centres, ASC/AD/PAD technology renewal delivery, and RTMC maintenance contracts), Major Projects (MP) (smart motorways) and Procurement. This split responsibility also extends to individual elements of RT equipment including civils, technology and IT components. There are examples of good collaboration between directorates, such as for smart motorways where the SES standards for RT have been well developed and specified by ITD and implemented by MP.

4.2.2 Recommendations

[R1] Technology governance - **It is recommended that Highways England should clarify the ownership of RT assets through the asset lifecycle, including how they are governed and who is accountable. Further, as part of its business change programme Highways England could consider bringing RT accountability under a single point of responsibility in order to simplify its management and future requirements.**

[R2] Technology skills and competence - **It is recommended that Highways England should continue to review the requirement for future technology skills and competency requirements across the**

business, including in the supply chain, in order to mitigate the risks of skills and competency gaps resulting from the pace of technology change and to provide specialist business resilience.

[R3] Technology criticality - **It is recommended that Highways England continues to monitor the criticality of its RT assets, including their reliability and accessibility, to manage risks to network safety and customer service.**

4.3 Service performance and availability

4.3.1 Findings

[F4] Current technology performance measurement - Highways England currently reports technology availability performance based on largely historic contractual measures, a legacy from Highways Agency. The Performance Indicator (PI) reports the overall availability of assets as a non-weighted calculation based on asset numbers. There is no reported measure of technology asset condition or residual life, as with other asset groups, and the current technology availability PI does not therefore meaningfully reflect the state of RT assets. The proportion of MIDAS assets comprises approximately 71% of the total assets and therefore dominates the overall reported availability measure. The current RIS1 PI is a contractual measure of faults which the relevant technology contractors are responsible for repairing.

[F5] Roadside equipment reliability - Certain types of RT equipment, specifically Advanced Motorway Indicators (AMIs), are less reliable than expected and do not meet their Mean Time Between Failure (MTBF) targets. This can be mitigated by the process for procurement and storage of critical spares but otherwise can require long lead in times to replace faulty equipment. Some RT equipment installed on SMART motorways comprises used parts where the age and residual life of individual components is unclear. These reliability risks impact on technology availability and there is some evidence of regions carrying out analysis to identify and improve the instances of poor performing equipment with the support of ITD and Procurement.

[F6] Regional customer service expectations - There is an apparent misalignment between the high technology performance service levels expected from Regional Control Centres (RCCs) in order to manage traffic and incidents on critical parts of the network and the current Regional technology Maintenance Contract (RTMC) performance requirements. This is a legacy issue from Highways Agency when RTMC contracts were introduced. The misalignment can be compounded by network constraints to access roadside technology, in particular through All Lane Running (ALR) sections. Moving to the later version of the Technology Management and Maintenance Manual (TMMM) and integrating technology maintenance into Asset Delivery (AD) contracts, with single responsibility for network occupancy planning, should better align these expectations.

[F7] Future technology performance measurement - Highways England is developing a new headline metric which better reflects the requirements of good customer service and more accurately represents the performance of the entire organisation and associated supply chain. The proposed RIS2 metric will measure what Roadside Technology is available to positively influence road user journeys. The new metric is being run in parallel with the existing RIS1 metric, to ensure Highways England understands the impact of its proposed implementation in March 2020. Highways England has also been in discussions with DfT and ORR to introduce a leading indicator based on technology asset condition.

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4.3.2 Recommendations

[R4] Technology performance - **It is recommended that Highways England consider a leading performance indicator, such as IP compatibility, to support the RIS2 metric and inform and optimise maintenance and renewal decisions and to identify future RT deployment, including at high-priority and other priority network sites. This will provide Highways England with greater line of sight between local need and RIS2/SOFA investment.**

4.4 Technology standards

4.4.1 Findings

[F8] Current standards and specifications – Highways England use the risk-based Technology Management and Maintenance Manual (TMMM) to set the service response levels for RT equipment maintenance implemented by the RTMCs. Depending on the fault category, fault restore times vary between 2 hours and 56 days. All RTMCs use TMMM version 1. ITD manage over 1000 detailed standards and specifications for RT and other technology in the TSS (Traffic Systems and Signing) Plans Registry, which is shared with equipment suppliers and is also used by local authorities. Keeping the TSS Plans Registry up to date with emerging RT is a significant task and is a pressure on ITD resources.

[F9] Future maintenance standards - Highways England reviews its asset management and maintenance standards periodically to make sure it embeds continuous improvement into its business. The latest version of TMMM released in 2017 (version 2) reflects the increasing importance of RT in managing the different operating regimes across the strategic road network, such as the introduction of ALR and smart motorways. TMMM version 2 allows the Traffic Technology Maintainer (TTM) to balance the impact of a service-affecting fault against the exposure of risk to the workforce in undertaking the repair. It also allows maintenance contractors to optimise fault restore planning and network occupancy based on As Low As Reasonably Practical (ALARP) principles. TMMM version 2 is being progressively implemented into AD contracts and negotiated into those RTMC contracts that have been extended until 2021. There is concern by TTMs that network constraints, in particular at strategic interchanges, will not allow response and repair performance targets to be met.

4.4.2 Recommendations

[R5] Technology maintenance standards - **It is recommended that Highways England harmonises updates to its technology maintenance standards and applies these to its various delivery contracts to create a common and flexible maintenance response framework to meet specific network service priorities.**

4.5 Asset strategy, planning and process

4.5.1 Findings

[F10] Technology functional strategy – ITD has developed an operational National Technology Strategy (2015) based on a customer service led approach supported by technology, rather than a technology driven approach. This aligns with Highways England's customer service imperative. The strategy outlines the transition to an enterprise IT environment based on commercial off the shelf software (COTS), and with more centralised asset data and knowledge. The strategy outlines a seven-step approach to maximise benefits to customers and minimise technology whole life cost. This is shown in **Figure 7.** The whole life planning approach relies on effective and informed, consistent and continuous governance.
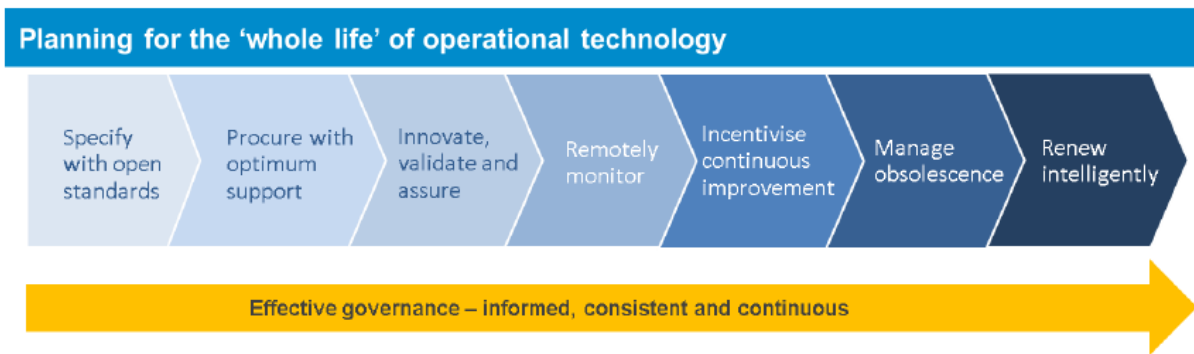
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Figure 7 – ITD National Technology Strategy steps

[F11] Technology asset strategy - In parallel with ITD's strategy, the Asset Information Group (AIG) within SES has developed a strategic asset management framework and plan (s-AMP) which provides Highways England's central reference point for defining the asset management system for all asset groups, including technology. The asset management framework is shown in **Figure 8**. The s-AMP details how the requirements for ISO 55001:2014 have been met through specific asset management processes and activities. The s-AMP is being rolled out to regions with AD contracts and to cover all asset groups. Non-AD contracts such as ASCs will continue to use the Asset Management Operational Requirements (AMOR) and contract Annexes, which include the requirement to become PAS55 accredited. Some suppliers have invested in ISO 55001 certification. DBFOs have their own contract asset management requirements but are also investing in ISO 55001.
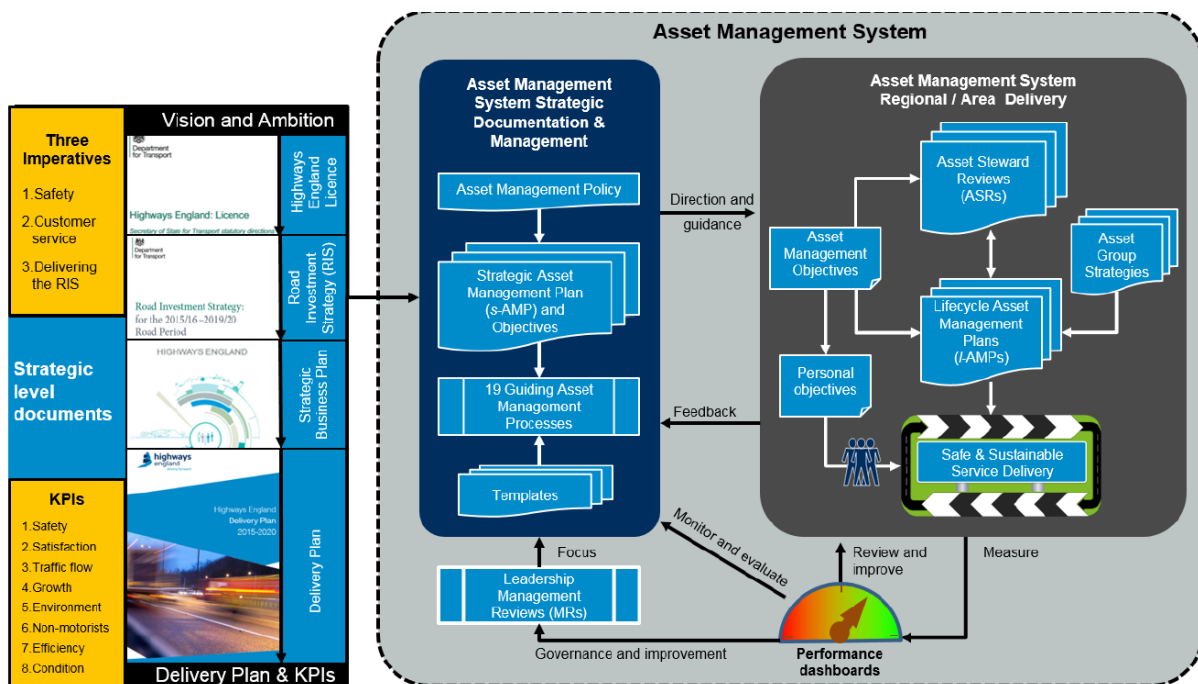

Figure 8 – s-AMP Asset Management Framework / System developed by Highways England's AIG team

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[F12] Tactical planning –The s-AMP requires each Highways England operational region to prepare a lifecycle plan (l-AMP). The l-AMP details the specific maintenance and renewal interventions required to maintain the technology and other asset portfolios to the required levels taking into account whole life costs. To ensure that each l-AMP aligns with ITD's technology strategy, AIG is developing an Asset Group Strategy (AGS) for technology which will be based on customer needs for RIS2.

[F13] Asset management process – Lifecycle asset management is delivered through Highways England's regional project control framework (PCF) operated by OD. The PCF includes the value management process for technology renewals, and a suite of generic strategy and planning documents developed by the Asset Information Group (AIG) within SES. Regional asset management responsibilities including the role of Asset Stewards are defined in the s-AMP Highways Asset Processes (HAPs). These include the interfaces with technology scheme delivery partners and maintainers.

4.5.2 Recommendations

[R6] Asset management - **It is recommended that Highways England continues with its whole life asset management approach for RT, aligned to ISO 55001 principles, including tactical and operational asset management processes and procedures that recognise the particular needs of technology, such as managing obsolescence**.

4.6 Management systems and asset information

4.6.1 Findings

[F14] Technology management systems – Highways England uses a combination of national and regional control systems to manage technology. NRTS provides the Strategic Road Network (SRN) communication trunking and operates a bespoke technology management system. Control centres use multiple systems including Control Office Base System (COBS) to manage traffic and incident management technology. RT equipment is managed regionally by the RTMCs using the Technology Performance Management Service tool (TPMS). TPMS holds RT inventory and is used to manage faults which are recorded in Highways England's traffic database Highways Agency Logging Environment (HALOGEN). TPMS is life expired and has a varying level of asset data quality: confidence in the reliability of TPMS data varies across regions.

[F15] Technology asset data – RTMCs are responsible for TPMS data accuracy, although are not the single point of data entry and cannot control the accuracy of data loaded by other users such as technology renewal and smart motorway providers. Current asset data quality is considered variable and although is updated when RT is renewed or added is unlikely to be improved when migrated to ServiceNow (see Business Change). There is a reliance on experienced technology staff in the supply chain to make up for the varying quality of information about the age and condition of RT assets which presents a future risk as Highways England transitions this intelligence in-house.

[F16] Asset management data, information and knowledge development - AIG manage a national facing Informed Asset Management Plan (IAMP) across all assets which defines the business actions to achieve products and outputs that improve asset management data, information and knowledge. The IAMP includes targets to improve asset data quality by the end of RIS1, including a technology Asset Group Strategy (AGS) and technology data requirements in the Asset Data Management Manual (ADMM) by the end of 2019.

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4.6.2   Recommendations

[R7] Asset data - **It is recommended that Highways England uses its asset improvement programme to develop specific activities to improve RT asset information and to ensure compatibility with other asset groups. It is also recommended that the improvement programme is used to understand the confidence level of RT asset data and the potential consequences to maintenance and renewal decisions as asset systems are upgraded.**

4.7   Maintenance, renewals and third-party schemes

4.7.1   Findings

[F17] Current maintenance approach – Since 2012, Highways England has operated with RTMCs delivering a minimum risk-based response and repair regime and limited asset condition inspections. Maintenance is reactive and based on minimum service levels and there has not been a 100% coverage of RT equipment inspection or maintenance since the contracts commenced. This has led to varying confidence in RT asset condition knowledge and data quality in TPMS, which presents a risk to regional asset management decision making and the development of regional l-AMPs.

[F18] Technology renewals – Technology renewal need comes from an assessment of network priority and asset age, such as assets with less than 2-years design life remaining, based on reports from TPMS. This is used as the basis to develop a 5-year rolling RT renewals programme. When developing schemes, TPMS data is supplemented by feedback from the RTMC and information on obsolescence, availability of parts, and fault history in HALOGEN. Highways England operates a needs-prioritisation VM process for capital renewal investment schemes as part of the Portfolio Control Framework (PCF) process. Regions do not feel that the current VM process fully reflects the requirements of RT and it is difficult for technology renewals to score sufficiently highly to get through the current VM process. The new Network Prioritisation Tool (NPT) looks at the importance of network section and type of scheme to come up with an objective priority score. VM workshops then consider the technical solution for schemes that are approved to proceed to design.

[F19] Technology renewal delivery risks – Once renewal schemes are approved, RT equipment is procured centrally. Due to long lead times to procure equipment, schemes may commence towards the end of the financial year, putting pressure on delivery if there are changes to the annual renewal budget. Technology renewals also compete for regional funding with other assets. In addition to funding risks, RT equipment manufacturers use specific fixing details which are sometimes not compatible with other suppliers. The choice of renewal scheme equipment manufacturer is not confirmed until they are procured which then means site surveys and potential programme delay and cost increase. This can put further pressure on in-year delivery. Highways England is proposing to mitigate these risks in RIS2 with a funded technology programme which should allow for longer lead-times to be accommodated.

[F20] Design for maintenance - Highways England provides design for maintenance advice in the DMRB and there is an expectation that technology RT and infrastructure designs: reduce exposure to risk by road workers and users; reduce the level of site accident rates and ill-health arising from maintenance activities; provide more efficient and cost-effective maintenance and; reduce congestion and delay. There are examples of technology infrastructure design where access to equipment for repair or removal is difficult within a live network environment and leads to increased roadworker risk. There are also examples where specifications have recently changed and now provide easier

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accessibility to RT, such as for gantry access. RTMC teams would like to be more involved in the initial design for maintenance process for new RT, led by ITD.

[F21] Commissioning of 3rd party equipment - Section 278 schemes (3rd party development) typically include new or upgraded RT equipment and require specific liaison and acceptance processes. These can include sterilised network sections which are maintained by the developer through a s278 agreement. There are several challenges with s278 schemes which the technology team feel could be improved. These include better engagement with the scheme designer and implementer to use acceptable and compliant RT which meets Highways England specifications. Non-adopted RT, which is not maintained by the RTMC, carries a residual risk to road users and roadworkers.

4.7.2   Recommendations

[R8] Technology maintenance - **In order to achieve its customer service imperative, it is recommended that Highways England continues to review its RT maintenance requirements, including equipment accessibility, against the performance expectations of regional control centres at priority network sites.**

[R9] Technology programme funding - **It is recommended that Highways England continues to monitor the outcomes of technology programme funding against the recognised importance that technology reliability and availability provide to the business, including the safety and customer service imperatives**.

4.8   Technology procurement

4.8.1   Findings

[F22] Procurement overview – Highways England's Procurement team are responsible for the procurement and supply of RT equipment and tendering of technology maintenance contracts. Procurement oversee the centralised category management framework for supply of all Highways England's assets, including the Traffic Management Technology framework (TTM2) managed by Crown Commercial Services (CCS). RT procurement practice varies depending on the type of scheme and operation. Smart motorway programme procurement also varies, with Tier 1 contractors running their own procurement competitions, using TMT2, or using Highways England's centralised bulk purchasing system. This can lead to varying procurement outcomes including cases where specifications are not followed and where RT equipment warranties cannot be passed onto Highways England. For RT renewals, the AD/ASC contracts procure equipment through the Construction Works Framework lots or through bulk purchasing. RTMCs use the TMT2 framework to procure spares. Managing RT equipment supply is acknowledged as particularly challenging due to procurement lead in times impacted by in-year budget changes and a highly litigious supplier marketplace.

[F23] Roadside equipment stores and spares - There is consensus across regional technology maintainers that the process for ordering and supply of RT spares, in particular for ERTs and AMIs, where Highways England has moved to 'just in time' logistics planning, requires improvement. The provision of technology support and spares that Highways England's stores provide to the regions largely works well but the prioritisation process could be improved. There is evidence of some RT provided in smart motorway schemes which has been procured outside the Highways England stock management system, such as hard shoulder monitoring cameras and Remotely Operated Temporary Traffic Management Signs (ROTTMS). This creates potential warranty and obsolescence risk to Highways England.

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[F24] Whole life considerations in technology procurement – Highways England currently procures its RT based on initial cost within a quality/price formula and manufacturer's reported performance quality, rather than whole-life cost. This includes RT assets procured under the smart motorway programme. This creates several risks to regional RT maintainers including uncertainty of maintenance costs, and future equipment reliability including RT not meeting its intended MTBF targets.

4.8.2 Recommendations

[R10] Technology procurement - **It is recommended that Highways England reviews its procurement process and organisation, including cross-business collaboration and knowledge sharing, to consistently control the purchase and warranty terms of all RT equipment**.

[R11] Technology procurement - **Given the increasing strategic importance of RT, it is recommended that Highways England more fully reflects whole life cost and reliability criteria in its technology tender specifications**.

4.9 Collaboration and knowledge sharing

4.9.1 Findings

[F25] Technology forums – Sharing knowledge on current and future technology requirements, equipment intelligence and performance is important to effective supply chain collaboration. There is evidence of formal and informal RT knowledge sharing practice but this is ad-hoc. Internal discussions are held informally between ITD, OD, Procurement and Logistics. ITD hold quarterly meetings with the supply chain including RTMCs to discuss equipment issues. Feedback from the regions and ITD to Procurement on RT equipment performance varies and is not formalised. Previously a national technology forum was run by Highways England for regions and their suppliers to discuss equipment issues and future technology direction. Some regions have initiated technology management boards which include ITD representation.

4.9.2 Recommendations

[R12] Collaboration and knowledge sharing - **It is recommended that Highways England should re-establish a cross-business national technology forum, aligned to its asset management improvement plan, which improves collaboration and knowledge sharing across national and regional teams. This should include the supply chain, and coordinate supplier performance management and procurement.**

4.10 Business change and future technology

4.10.1 Findings

[F26] Regional technology management - There is significant change underway with how technology will be managed in the regions. This includes key system and contract changes (described below). Highways England's transition to a network operator will include centralising technology decision making, initial fault detection and response through remote monitoring, with second line maintenance and response capability delivered through regional AD contracts. The timescale for transitioning from current to future state will vary in each region depending on the mix between the ASC/RTMC and AD/M&R contract models. This is likely to add to the complexity of RT management and which will potentially impact the degree of control over this asset until 2021. As part of the single operating model, OD and SES are enhancing the AD maintenance requirements for technology and other assets through a new Intelligence Led Maintenance (ILM) approach from 2020. Regions will set out their

Asset Delivery Asset Maintenance Requirements (ADAMr) and bespoke technology maintenance requirements in a Maintenance Requirements Plan (MRP) based on network knowledge, asset information and customer insight. The TMMM will be updated to reflect this change.

[F27] Technology system upgrades – Highways England is implementing a major upgrade of national and regional control centre systems under the Common Highways Agency and Rijkswaterstaat Model (CHARM) programme. CHARM will provide the functionality to better manage and operate the network, including RT, and enhance technology performance levels to enable RCCs to make better intelligence-led decisions. RT equipment systems will also require a step change to support future operational need. In parallel with the CHARM roll-out a new technology service software ServiceNow, which will replace TPMS and the current HALOGEN event management system, are being upgraded through the Tools for the TOC (TTOC) programme. The introduction of TTOC will also improve data management: this won't address existing data quality but this should improve organically over time. ServiceNow will allow the remote monitoring of RT equipment and an initial fault management capability through national technology specialist teams. It will also manage RT assets and data as a service and reduce data duplication.

[F28] CHARM programme and implications for RT - When the switch to CHARM occurs, a lot of RT will no longer report to HALOGEN and TPMS. It is therefore important that the switch from TPMS to ServiceNow occurs simultaneously with the CHARM switchover. This is currently programmed in six-monthly regional phases commencing in July 2019. In addition, because some RT assets such as CCTV and MIDAS do not go through the existing control centre COBS system, when CHARM is implemented RCCs will have 2 systems to manage in the interim before these are fully integrated under the TTOC programme. In order to minimise this period of duplication, ITD is proposing to accelerate the introduction of ServiceNow ahead of the CHARM roll out.

[F29] Technology innovation - SES manage technology innovation and use the TAG (technology assurance group) and Technology Concurrence process to develop and implement new technology. Technology innovation is largely funded through Innovation Designated Funding (IDF) which is approved by Highways England's Investment Decision Committee. New technology applications need to consider technical, safety and legal requirements.

4.10.2 Recommendations

[R13] Business change - **It is recommended that Highways England develops a cross-business roadmap, specifically for technology, to manage current and future technology transition**.

 [R14] Future technology requirements - **It is recommended that Highways England continues to review its provision and management of RT assets, including its asset management strategy and maintenance and renewal contract delivery, to accommodate the changes required for Digital Roads.**

4.11 Prioritisation of recommendations

Recommendations R1 to R14 have been prioritised against the following four project review objectives, where these could lead to improvements to:

- **safety** to road users, technology maintainers and other road workers;
- **robustness** against whole life asset management principles to meet road period targets;
- **sustainability** including performance monitoring to meet long-term requirements; and
- **efficiency** to minimise cost and add value over the long-term though asset management.

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A ranking system has been used to score the contribution of each recommendations to the four project review objectives. This provides an initial priority view: High, Medium, Low.

The definition of High Medium and Low has been arbitrarily set, but is intended to highlight the contribution that each recommendation could potentially make to Highways England's asset management of RT. For example, a High priority recommendation would have a significant contribution to 3 out of the 4 objectives (safety, robustness, sustainability, efficiency).

Figures 9 and 10 set out on the following pages presents the recommendations in priority order and grouped by High and Medium priority. It is recommended that Highways England considers the specific actions, timescales and resources to deliver each recommendation.

Ref No	Recommendation / 0 No direct contribution / 1 Minimal contribution / 2 Moderate contribution / 3 Significant contribution	Safety	Robustness	Sustainability	Efficiently	Total score (S+R+S+E)	Priority: 0-4 Low 5-8 Medium 9-12 High
R5	Harmonise updates to technology maintenance standards and apply these to its various delivery contracts to create a common and flexible maintenance response framework that can meet specific network service priorities.	2	3	3	3	11	High
R9	Continue to monitor the outcomes of technology programme funding to ensure that the reliability and availability of technology continues to meet the needs of the business, including the safety and customer service imperatives.	2	3	3	3	11	High
R3	Continue to review the criticality of RT assets, including its reliability and accessibility, to manage risks to network safety and customer service.	3	2	2	3	10	High
R1	Clarify the ownership of RT assets through the asset lifecycle, including how they are governed and who is accountable. As part of a business change programme, consider bringing RT accountability under a single point of responsibility in order to simplify its management and future requirements.	1	3	3	2	9	High
R4	Consider developing an internal leading performance indicator, such as IP compatibility, to support the RIS2 metric and inform and optimise maintenance and renewal decisions.	1	3	2	3	9	High
R7	Use the asset improvement programme to develop specific activities to improve RT asset information and to ensure compatibility with other asset groups. Use the improvement programme to understand the confidence level of RT asset data and the potential consequences to maintenance and renewal decisions as asset systems are upgraded.	1	3	3	2	9	High
R8	Review RT maintenance requirements, including equipment accessibility, against the performance expectations of regional control centres at priority network sites.	1	2	3	3	9	High
R13	Develop a cross-business roadmap, specifically for technology, to manage current and future technology transition.	1	3	3	2	9	High

Figure 9 – High priority project recommendations

Ref No	Recommendation 0 No direct contribution 1 Minimal contribution 2 Moderate contribution 3 Significant contribution	Safety	Robustness	Sustainability	Efficiently	Total score (S+R+S+E)	Priority: 0-4 Low 5-8 Medium 9-12 High
R6	Continue with whole life asset management approach for RT, aligned to ISO55001 principles, including tactical and operational asset management processes and procedures that recognise the particular needs of technology, such as managing obsolescence.	1	3	2	2	8	Medium
R10	Review the procurement process and organisation, including cross-business collaboration and knowledge sharing, to consistently control the purchase and warranty terms of all RT equipment.	1	3	2	2	8	Medium
R11	More fully reflect whole life cost and reliability criteria in technology tender specifications.	1	2	2	3	8	Medium
R14	Continue to review the provision and management of RT assets, including its asset management strategy and maintenance and renewal contract delivery, to accommodate the changes required for Digital Roads.	1	2	3	2	8	Medium
R2	Continue to develop technology skills, competencies and training programmes across the business, including in the supply chain, to match the pace of technology change.	1	2	2	2	7	Medium
R12	Re-establish a cross-business national technology forum, aligned to the asset management improvement plan, which improves collaboration and knowledge sharing across national and regional teams, including the supply chain, and coordinates input to supplier performance management and procurement.	1	2	2	2	7	Medium

Figure 10 – Medium priority project recommendations

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5 Conclusions

This project review is a snapshot of Highways England's asset management Roadside Technology (RT) practice. It is based on a sample of fourteen interviews with Highways England and its supply chain conducted over an eleven-week period.

The review has recognised that RT is an increasingly important asset that supports Highways England's network operator role and the Digital Roads agenda. Due to this importance, in order to sustain current performance and meet future requirements Highways England requires RT that is up to date, reliable and available. This relies on effective whole life asset management strategy, plans and processes in order to achieve and sustain the right level of performance at the best value.

There have been several change initiatives as part of transitioning from Highways Agency to Highways England and these have already enhanced the asset management approach to managing technology. These include the Operational Excellence programme, the development of a whole-life strategy aligned to ISO 55001 principles and the deployment of smart motorway technology to better manage strategic network sites.

This review has also recognised that Highways England is undergoing a period of significant business change, including to technology systems and the way that RT maintenance and renewals are delivered. This combination of concurrent change will significantly alter the way RT is operated, managed, maintained and procured. It therefore requires oversight and alignment with Highways England's other key asset groups, to manage interdependency of outcomes and overall delivery risk.

Highways England's asset management of RT is developing and there is a coherent strategy to plan for whole life management of operational technology and to deploy effective governance. This needs to be communicated and embedded across the business and aligned to Highways England's asset management approach for other key asset groups such as pavements and structures, geotechnical and drainage. This alignment will better integrate safe, robust, sustainable and efficient management of RT and help Highways England achieve its three imperatives: safety, customer service and delivery.

The evidence from this review concludes that *Highways England's asset management of RT is developing towards a mature lifecycle approach*. The teams we have interviewed recognise the increasing importance that RT plays in delivering Highways England's business outcomes and the improvement steps that are necessary to maximise these outcomes. *Highways England has shown to be committed to the whole life asset management of RT to optimise maintenance resilience, renewal and replacement and to carry this out safety, robustly, sustainably and efficiently.*

As Highways England develops its approach to RIS2, its asset management strategy, plans and processes for RT require further alignment with other key asset groups such as pavements and structures, geotechnical and drainage. This journey will help support Highways England in achieving its three imperatives: safety, customer service and delivery.

To improve its maturity of RT asset management, this report recommends that Highways England should consider implementing the 14 prioritised recommendations developed from this review and monitor the effectiveness of these actions during the remainder of RIS1 and within RIS2.