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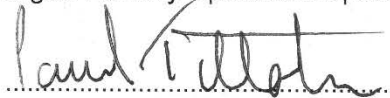
on behalf of

Digital Railway

Concept of Operations for a Connected Driver Advisory System (C-DAS)

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Acknowledgements

Contents

1 Purpose, Objectives and Strategies

1.1 Purpose

1.1.1 The purpose of this document is to provide a high-level description of the operation of a Connected Driver Advisory System (C-DAS) within the GB Mainline Railway. It provides the industry and supply chain with a view of the operational concept of a C-DAS from the perspective of its users and how they interface with it, with a view to inform further development of a system requirement specification.

1.1.2 This document is designed to:

a) identify the potential users of the system,

b) clearly identify the operational environment that it concerns,

c) describe the operational activities involved,

d) consider degraded and emergency operation as well as normal modes of operation, and,

e) support consistency between different suppliers' products.

1.1.3 As a Concept of Operation, this document does not attempt to provide solutions or specify: system, operational or technical requirements.

1.1.4 The document supports the development of the interface between the Infrastructure Manager (IM) and Railway Undertaking (RU).

1.2 Objectives

1.2.1 This document will assist stakeholders in developing an understanding of how C-DAS will affect them by providing:

a) a common vision of C-DAS operation in GB for passenger and freight operation,

b) a high level description of the system boundary and interfaces including system users and other affected roles and systems,

c) a description of the types of information presented to users of the system,

d) a system overview for developers, operators and maintainers of C-DAS,

e) an input to the development of C-DAS requirements,

f) contextual information for the potential supplier(s) of C-DAS,

g) maximum flexibility in supporting RUs' operational requirements,

h) information relevant to (but not limited to) the following:

i) The Infrastructure Manager (IM),

ii) Railway Undertakings (RU), i.e. passenger train operating companies (TOCs) and Freight Operating Companies (FOCs),

iii) Rail Safety and Standards Board (RSSB),

iv) Rail Delivery Group (RDG),

      v)   Digital Railway Programme (DRP),

      vi)   Maintenance organisations for traction and rolling stock and infrastructure,

      vii)   System/equipment suppliers and integrators,

      viii)   Department for Transport (DfT),

      ix)   Office of Rail and Road (ORR), and,

      x)   Rolling Stock leasing Companies (RoSCos) and other vehicle owners.

1.2.2   Although the content of the document is not in itself mandatory, it can be used to inform Railway Group Standards and other specifications.

1.3 Strategies

1.3.1   C-DAS development involves input from stakeholders to consider the operational environment in which it functions to thereby develop this concept document and its supporting requirements and specifications. Work streams may include support from technical, operational and commercial resources to develop the technology and requirements to support an implementation project. This work can include:

      a)   Operational Workshops,

      b)   Hazard Analysis,

      c)   Human Factors Reviews.

2 Context, Rationale and Scope

2.1 Context

2.1.1 The creation of a concept of operation document is part of the GB rail industry's plan for the implementation of a Connected Driver Advisory System (C-DAS).

2.1.2 Driver Advisory Systems (DAS) are already in use on the GB network and it is important to identify the differences between the systems and how a connected system differs from the others. Below is a list of the three major types of DAS.

Standalone DAS (S-DAS): a driver advisory system which has all data downloaded to the train at or prior to journey start.

Networked DAS (N-DAS): a driver advisory system that is capable of communicating with one or more RU control systems, enabling provision of data to the train, including updates for schedule or routing information, although these are generally not in near real time.

Connected DAS (C-DAS): a driver advisory system with a communications link to external control systems in each controlled area in which the train operates – this is most likely a traffic management system. This enables the provision of schedule, routing and speed restriction updates to trains in near real time, and also receipt of information from trains to these systems to improve regulation decisions. In an uncontrolled area, C-DAS operates with initial data (as per S-DAS), or with the most recent updates received from external systems or from RU-managed system(s) (as per N-DAS).

2.1.3 In 2009 / 2010, an initial project was led by First Group who trialled S-DAS on First Hull Trains. By May 2012, the system was fitted to the entire First Hull Trains fleet of class 180s as well as 119 HST powercars (class 43) for First Great Western (now Great Western Railway, GWR). Similar DAS systems (S-DAS and N-DAS), albeit some from different manufacturers, are also in use or have been trialled across: South West Trains (now South Western Railway), Arriva Cross Country and Chiltern Railways, for example.

2.1.4 In 2014, three 'proof of concept' trials for C-DAS were undertaken.

i. The first was a "saloon trial" involving a system from TTG in a MkIII HST carriage running between Paddington and Bristol and back. This tested communications between an operational train and a remote, off-train server.

ii. The second trial was a computer "simulation trial" developed by Cubris (the supplier for South West Trains' DAS), which demonstrated the differences between S-DAS and C-DAS performance for a number of scenarios. This was demonstrated at a cross-industry workshop in June 2014.

iii. The third trial was undertaken at Airport Junction where the spur to Heathrow Airport diverges from the Great Western Mainline. The aim was to establish if C-DAS could be applied to UK mainline passenger service trains by utilising the DAS already fitted to First Great Western's HSTs and creating a junction scheduler. This scheduler was used to detect conflicts between the HST and Heathrow Express trains before then pushing updated advice to the HST so as to prevent the HST having to stop or brake and accelerate inefficiently. From the trial, it was found that there was a 36% improvement in energy efficiency, delays were reduced to 1.6% and there was a 95 second improvement in arrival times at London Paddington.

2.1.5 During development, there have been several different versions of a C-DAS concept of operation, most recently [RD9] Technical Services: Safety, Technical and Engineering: GB Operational Concept: C-DAS v3.1 Draft C, on which this document is based, but which it is intended to supersede as v3.1 Draft C was agreed to be too prescriptive.

2.2 Rationale

2.2.1 The implementation of any DAS delivers perceived benefits in the quality, cost and efficiency of train operation whilst also improving customer experience.

2.2.2 Beyond the benefits of other Driver Advisory Systems which are documented elsewhere, C-DAS also brings the following perceived benefits:

a) Better support for regulation to optimise for network capacity or performance (based on fewer delays due to red signals),

b) Improved recovery from disruption,

c) Improved train regulation as revised schedules are available on train,

d) Improved support for conflict resolution (based on predicted running of trains),

e) More journeys benefiting from reductions in energy use, carbon emissions and wear and tear, as delayed / altered trains can take advantage of DAS advice, rather than just on-schedule trains, under standalone (S-DAS) systems; the expectation is that energy savings are comparable to, if not better than, those realised with S-DAS,

f) Improved driver guidance and incident investigations by utilising data collected by C-DAS, and,

g) Reduction in operational incidents, such as failure to call.

2.2.3 Qualification and quantification of the benefits of C-DAS forms part of the construction of business cases.

2.2.4 There are commercial issues associated with the implementation of C-DAS related to the allocation of benefits and costs between the different duty holders, but these are considered to be out of scope of this document.

2.3 Document Scope

2.3.1 The scope of this document is the operation of C-DAS within the context of the GB mainline railway on: fixed and variable formation trains and ETCS fitted and unfitted trains. The document describes how users interact with the system and the anticipated system behaviour, in certain circumstances. The principles on which the system is conceptualised are laid out along with the responsibilities of certain roles within the industry with regard to C-DAS operation.

2.3.2 The following is excluded from the scope of this document:

a) The design of the working timetable,

b) The definition of the on-board algorithms for the determination of the advisory information,

c) The format of data and the means of exchange between involved parties,

d) Details of the communications carriers used to provide live information from operational systems to C-DAS,

e) The design of the Driver Machine Interface (DMI),

f) Commercial arrangements between dutyholders associated with the implementation and operation of C-DAS, and,

g) The interoperable Automatic Train Operation (ATO) over ETCS system which functions as C-DAS (generating driver advisory information on the ETCS DMI) when the train is not driven automatically [RD11] [RD12]

2.3.3 This document reflects the outcome of trials undertaken to demonstrate the feasibility of the concepts presented in this document.

2.3.4 This document has been written so as to follow the Digital Railway Concept of Operations Strategy [RD10] so describes a green field, utopian operating environment and is technology and supplier agnostic.

3 Assumptions

3.1 Introduction

3.1.1 The purpose of the assumptions listed below is to document the context in which C-DAS operates and in certain cases, identifies other systems that interact with C-DAS.

3.1.2 These points can cover processes that are assumed to be carried out by other systems or describe how other systems / the real world have / has been idealised to aid the construction of the concept.

3.2 Working Assumptions

3.2.1 C-DAS comprises of on-train (on-board) and off-train elements, with the off-train elements providing an interface with a traffic management system.

3.2.2 C-DAS operates with a traffic management system which has the capability to revise the schedules and/or routing of trains in the area it controls.

3.2.3 In a controlled area, updates to schedule, routing or speed restrictions are provided by a traffic management system and supplied in sufficient time to allow C-DAS to support effective regulation.

3.2.4 Current train performance characteristics are available to the on-board C-DAS without the involvement of a traffic management system.

3.2.5 Calculation of advisory information is based on factors such as current schedule, infrastructure geography, permissible speeds / static speed profiles (SSPs) qualified by applicable speed restrictions, and train capability characteristics. The applicable timetable forms the default schedule data unless further schedule updates (Very Short Term Plan / Short Term Plan) are provided. A schedule for a C-DAS fitted train is accessible at the time of setup on the train.

3.2.6 All external data required by C-DAS is made available by infrastructure-based systems at an appropriate level of accuracy and quality.

3.2.7 The introduction of C-DAS is not accompanied by any significant changes to operational rules and practices in respect of informing drivers of changes to speed restrictions or stopping patterns. Drivers continue to receive Emergency Speed Restriction (ESR) notifications, special stop orders, not-to-stop orders etc. in the manner appropriate to the method of signalling.

3.2.8 C-DAS is capable of persistently storing and utilising information regarding route availability and exceptional loads. The system understands the route availability of vehicles and locomotives within the train and also the route of the train concerned. The system understands the requirements of special conditions of travel (RT3973).

3.2.9 Operators and systems in the controlling location are able to distinguish between trains unfitted/fitted with any form of DAS and identify which form is fitted.

3.2.10 The infrastructure geography data and permissible speed / SSP data (including Permanent Speed Restrictions) for the scheduled route and any likely alternative re-routing on which C-DAS is required to operate, are downloaded to C-DAS before journey start and stored persistently.

3.2.11 C-DAS on fixed formation trains is primed with the train consist and capability characteristics ('presets') for each expected formation; these are stored persistently, i.e. such that they are retained after a power-down. They are accessible to C-DAS for calculating recommended speed profiles.

3.2.12 The core driver advice is a speed profile calculated by the C-DAS. This assumption is based on operational experience which demonstrates that speed-based advice is preferred by drivers over time-based advice.

3.2.13 Driver training instructs drivers to never prioritise C-DAS advice over safety or professional judgment. Drivers are trained to recognise and ignore an advice speed if it exceeds a lower speed value associated with, for example, a Temporary Speed Restriction (TSR), Emergency Speed Restriction (ESR), blanket speed restriction or special condition for travel (RT3973).

3.2.14 Telecommunication needs to support C-DAS implementation are managed by the IM.

4   Concept

4.1   Introduction

4.1.1   In this section, a high level, outline of the concept is first presented which summarises the aims of the concept and behaviour of the system at a basic level.

4.1.2   The succeeding section, operational principles, describes the philosophies on which C-DAS functions (as opposed to the previous section, assumptions, which describe how other systems / real world are anticipated to work / interact).

4.2   High Level Concept

4.2.1   C-DAS is capable of communicating with traffic management systems that can facilitate accurate prediction of future movements of C-DAS fitted trains.

4.2.2   C-DAS has the capability to provide driver advisory information in both controlled and uncontrolled areas that, if followed, enables the driver of a C-DAS fitted train to manage train speed so as to minimise deviations from the current schedule and, where possible, reduce energy consumption.

4.2.3   C-DAS fitted trains about to enter or operating in a controlled area are capable of receiving updates to application data at any time. These updates can include: revised arrival, passing or departure times at timing points, rerouting onto a different line or to a different destination, or any new, changed, temporary or emergency speed restrictions, with differentiation between different types of trains where applicable e.g. traction type, ETCS fitted or unfitted.

4.2.4   In controlled areas, C-DAS uses the information updates listed in 4.2.3 to inform the driver of, and help in the delivery of, the current plan / schedule.

4.3   Operational Principles

4.3.1   General Operation

4.3.1.1   Information provided to drivers by C-DAS is wholly advisory. The advisory nature of the information displayed by the on-board C -DAS is clearly defined and communicated to drivers.

4.3.1.2   The hierarchy of displayed messages and information that the driver is expected to apply and follow is:

   a)   Safety related information (out of scope of C-DAS),

   b)   Optimising performance, and,

   c)   Optimising environmental savings.

4.3.1.3   The overall impact of activities associated with on-board C-DAS start up and setup on railway timing and driver workload, is minimised.

4.3.1.4   The advisory information displayed does not lead to unacceptable workload demands on drivers or cause unacceptable distraction from other driving activities. C-DAS does not impact negatively on safety.

4.3.1.5   C-DAS only displays information that is useful to the driver and has the potential to enhance their driving technique.

4.3.1.6   C-DAS receives information from the required systems regarding route availability of vehicles, locomotive and infrastructure, advising on potential limitations of train and route.

4.3.1.7 C-DAS receives information from the required systems regarding special conditions of travel (RT3973) and adjusts its calculations and advice to take account of it.

4.3.1.8 C-DAS does not advise drivers on when to brake.

4.3.1.9 C-DAS provides advice that the driver can achieve and is akin to actual driving styles, rather than expecting maximum application of either the traction or brake.

4.3.1.10 Speed and distance information displayed by the C-DAS is in the same units employed by the in-cab speed display. Switching between units of speed and distance is performed automatically.

4.3.1.11 The C-DAS driver interface does not duplicate display information which is already provided to the driver where there is the potential for confusion or distraction, for example, current train speed. Situations where the C-DAS does not display duplicate information include any of the following:

a) Where the information is already displayed by an equipment of higher integrity,

b) Where the information displayed by the other equipment is derived from a different source,

c) Where the information displayed by other equipment does not require manual intervention by the driver to enable the display.

4.3.1.12 The current time is displayed on the C-DAS driver interface and is aligned with a traffic management system. The format of current time display is configurable by the RU. The time information on the display allows the driver to view the C-DAS system time against journey segment information received from a traffic management system.

4.3.1.13 The C-DAS system utilises data from other on-train systems so as to minimise data re-entry by the driver.

4.3.1.14 Driver operation with C-DAS is, as far as possible, the same in controlled and uncontrolled areas and on ETCS fitted trains regardless of operating level.

4.3.1.15 Drivers do not have to acknowledge receipt of data updates or changes to advisory information.

4.3.1.16 Absence of a working or fully functioning C-DAS is not a reason to take a train out of service, or to delay it whilst repairs are carried out. Trains can enter service from a depot without a working or fully functioning C-DAS.

4.3.2 Input Data

4.3.2.1 The on-board C-DAS can be customised to allow the information described in section 4.3.3 of this document to be calculated for a particular journey segment and displayed to the driver. The customisation data may not all be available prior to or at journey start; it may become available during the journey.

4.3.2.2 To enable customisation of the C-DAS on-board, data is divided into four components:

a) Application data, which can include:

      i) Infrastructure geography data – track geography (centre line, curvature, altitude), track features (station / junction locations, etc.), timing point locations, and network models. To support ETCS fitted trains this can include additional information such as national values and their applicable areas, ETCS operating level areas, and applicable speed display units by area,

      ii) Route availability (RA) for lines of route,

      iii) Planned schedule (routing, departure and arrival times at station stops and timing points),

      iv) Schedule updates i.e. changes to the planned schedule,

      v) Routing updates,

      vi) Permissible speeds including Permanent Speed Restrictions (PSRs),

      vii) Temporary speed restrictions (TSRs),

      viii) Emergency speed restrictions (ESRs),

      ix) Blanket speed restrictions (for environmental conditions etc.).

b) Train specific data, which can include:

      i) Current train acceleration and braking characteristics (taking into account any reduced performance capabilities, for example due to train defects),

      ii) Power consumption characteristics (e.g. traction and hotel power consumption, efficiency etc.),

      iii) Current maximum train speed (taking into account any limitations due to, for example, train defects),

      iv) Route availability of locomotives and vehicles,

      v) Train weight profile,

      vi) Train length,

      vii) Special conditions of travel (RT3973),

      viii) Current power mode (applicable only to a train that is capable of operating in different power modes: electric / diesel traction or electric overhead/ third rail),

      ix) Current ETCS operating level and mode (if C-DAS is capable of detecting this information),

      x) Train types and/or applicable ETCS train category information.

c) Start of Journey Information (See section 5.1.1 of this document).

d) User data, containing user definable characteristics of a particular on-board C-DAS, which can include:

     i)   Display brightness configurations (maximum, minimum and default night and day display brightness levels; automatic brightness switching constraints etc.),

     ii)   Which information is displayed and when, for example journey segment / route look-ahead information, departure countdown timers etc. (see section 4.3.7 of this document),

     iii)   Specific display formats (colour, font, on-screen location etc.) for the various information types displayed,

     iv)   The content, format and display conditions for the Selected Customisation data (see sections 4.3.3, 4.3.4, 4.3.5 and 4.3.6 of this document),

     v)   Information related to the definition of suppression areas (see section 4.3.7 of this document),

     vi)   Approaching advisory information look-ahead parameters (see section 4.3.4 of this document).

4.3.3 Information Displayed

4.3.3.1   C-DAS can display two classes of information:

     a)   Advisory information - providing information or recommendations to the driver,

     b)   Selected Customisation data - indicating to the driver the data which the C-DAS is currently using as the basis of its calculations, such as train consist and timetable information.

4.3.3.2   The C-DAS user interface can display current and approaching advisory information to the driver at the same time.

4.3.3.3   Current advisory information displayed to the driver for the operational situation consists of relevant information, as deemed by the RU, for instance, a currently advised speed value or other advisory information.

4.3.3.4   Approaching advisory information displayed to the driver for the operational situation consists of relevant information, as deemed by the RU, for instance, a new advice speed value that is approaching or other approaching advisory information.

4.3.3.5   Other advisory, or approaching advisory, information can include:

     a)   Notification that the train is within a coasting area or has been advised to coast. Such advice can be given on the approach to a lower advice speed value or to a station stop, for example. The RU may determine it appropriate for the driver to be informed why coasting is being advised.

     b)   No specific advice offered, which might include details of why no specific advice is offered. Situations where no specific advice may be available might include, for example:

          i)   The calculated advice speed value is greater than or equal to the lower of the linespeed and the maximum train speed,

          ii)   Application data is not available for the journey segment.

4.3.3.6   C-DAS displays advisory speed values (current or approaching) that are calculated as no higher than the lower of the linespeed and the maximum train speed. The RU can also define a minimum advice speed value, if desired.

4.3.3.7   In ETCS areas, C-DAS can confirm the ETCS operating level that the train is operating in. Until this is determined or the train is using Level NTC, C-DAS uses NTC static speed profiles when calculating linespeeds and advisory information.

4.3.3.8   C-DAS displays approaching information if a change in advisory information occurs within a distance or time defined by a configurable 'look-ahead' parameter.

4.3.3.9   An indication supports the driver in determining where or when current advice will change (i.e. where or when approach advice will become current).

4.3.3.10   C-DAS indicates to the driver when the receipt of new data results in a change to advisory information (current and / or approach advice) which takes effect within less than a pre-defined time or distance threshold.

4.3.3.11   The conditions under which displayed advisory information is refreshed, are controlled and configurable.

4.3.4   Journey Segment and Route Look-Ahead Information

4.3.4.1   C-DAS supports the display of journey segment information.

4.3.4.2   The provision, format and content of the journey segment information display is configurable by the RU and can include:

   a)   The name of the next station stop or timing point,

   b)   The scheduled arrival time at the next station stop or timing point,

   c)   The scheduled departure time, and a countdown indication to the scheduled departure time when a train is at a stand in a departure station,

   d)   The planned next station platform number or letter,

   e)   The current estimated train location,

   f)   The line to which the current advisory information is applicable where this is important for speed control.

4.3.4.3   C-DAS supports the display of route look-ahead information.

4.3.4.4   The provision, format and content of the route look-ahead information display is configurable by the RU and can include:

   a)   A distance scale,

   b)   Stations and / or other timing points,

   c)   Speed limits and start and end locations for Permissible Speed and TSR data being used by the C-DAS,

   d)   Start and end locations for ESR data being used by the C-DAS,

   e)   Route availability notifications or advice,

   f)   Special conditions of travel (RT3973).

4.3.5 Train Consist Information

4.3.5.1 C-DAS supports the display of train consist information that is considered useful to the driver. The provision, format and content of the train consist display is configurable by the RU and can include:

a) On passenger trains, C-DAS displaying the current train formation, e.g. 4 cars or 12 cars, to assist the driver in identifying a platform stop location,

b) On freight trains, C-DAS displaying train length and train mass,

c) C-DAS displaying maximum train speed, or details of defective equipment affecting train operations entered by the driver during setup (See section 5.1.1 of this document),

d) C-DAS displaying details of route availability for vehicles and locomotives overlain onto the infrastructure route availability,

e) C-DAS displaying details of special conditions of travel, if required.

4.3.6 System Information

4.3.6.1 Indications to the driver can show when the on-board C-DAS is in communication with traffic management systems, where applicable.

4.3.6.2 Means are provided for the driver to determine whether the user interface display has 'frozen'. Notification is noticeable, but avoids potential driver distraction.

4.3.7 Information Display Conditions

4.3.7.1 C-DAS displays advisory and journey segment / route look-ahead information (if configured) if the customisation data for that journey segment is available to the on-board C-DAS.

4.3.7.2 If C-DAS cannot detect the train's position or detects that the train's position is not consistent with the current journey, advisory and journey segment / route look-ahead information (if configured) is automatically suppressed.

4.3.7.3 C-DAS advice is not automatically suppressed within the known area of positional uncertainty around the train, inherent to the means by which C-DAS determines train position.

4.3.7.4 If the system detects that the driving is not consistent with the current advisory profile, the RU can configure automatic suppression of advisory information.

4.3.7.5 On ETCS fitted trains where C-DAS is capable of detecting that the train is operating, the display of advisory information is automatically suppressed if the train is in an ETCS mode where the provision of advisory and other information is not appropriate, such as: Standby (SB), On Sight (OS), Staff Responsible (SR), Reversing (RV), Shunting (SH), Non Leading (NL). When in Isolated (IS) or Unfitted (UN) mode, advisory information is not automatically suppressed if under the control of another train protection system.

4.3.7.6 Where C-DAS is not capable of detecting the ETCS operating mode, the driver manually suppresses the display of advisory information in situations where it could distract from mode-related driving tasks, and is part of operator procedures on entry to Staff Responsible (SR), Shunting (SH) and Non Leading (NL) modes, for example.

4.3.7.7　C-DAS suppresses the display of advisory information if it detects that an on-train protection or warning system is providing a brake intervention to bring the train to a stop.

4.3.7.8　The display of advisory, journey segment / route look-ahead and train consist information (if configured), can be automatically suppressed when C-DAS detects that ATO has been engaged.

4.3.7.9　The display of advisory information is automatically unsuppressed following automatic suppression, if the system detects (in the absence of any other suppression condition):

a)　that the train's actual position is consistent with the current journey (see clause 4.3.7.2) – possibly as a result of being routed back to a route for which application data is available,

b)　that driving is within a predefined tolerance of the current advisory profile (see clause 4.3.7.4). This can, for example, be due to the train speed changing such that it falls within the specified tolerance of the current advisory profile, or the on-board C-DAS recalculating advisory information following receipt of a schedule update,

c)　that ATO is disengaged, should it already be suppressed,

d)　entry to an ETCS mode where the provision of advisory / other information is appropriate (if C-DAS is capable of detecting ETCS mode).

4.3.7.10　When configuring the detection of these situations, the display cannot flip between suppressed and unsuppressed states too frequently for risk of driver distraction.

4.3.7.11　C-DAS includes pre-defined suppression areas in order to avoid advisory information distracting the driver in complex areas where there is likely to be high workload, or where, for other reasons, there is little benefit in providing advisory information. Suppression areas can include:

a)　the approach to, within or departing from stations or other complex areas,

b)　permissive platforms or permissive freight areas,

c)　immediately before and after transitions between ETCS operating levels,

d)　ETCS overlay areas with different linespeed profiles for Level 2 and Level NTC.

4.3.7.12　The RU can determine areas where advisory information is suppressed using a suitable risk based approach.

4.3.7.13　Approaching advisory information can be retained so that the driver is aware of what the advisory information will be when the train leaves the suppression area.

4.3.7.14　On leaving a pre-defined suppression area, C-DAS automatically unsuppresses the display of advisory information.

4.3.7.15　The C-DAS driver interface does not display advisory information if C-DAS has been manually suppressed.

4.3.7.16　The C-DAS driver interface does not display advisory information, journey segment / route look-ahead or train consist information (where configured), if C-DAS has been disabled.

5 Operational Processes

5.1 Conceptual operation of C-DAS from the perspective of a Driver

5.1.1 Start of Journey:

5.1.1.1 Before the start of a particular journey, the on-board C-DAS is primed by off train systems, with setup information relevant to the train and the journey being undertaken (including infrastructure geography data and permissible speeds).

5.1.1.2 If the on-board C-DAS cannot obtain the schedule from the off-train C-DAS system, it obtains it from another source at or prior to journey start.

5.1.1.3 Where multiple on-board systems require input of the same, or a part of the same setup information, the driver only enters this data once.

5.1.1.4 The driver can input the following at journey start, should the information not be obtainable from other systems:

a) a unique Driver ID, where requested by the RU,

b) the TRN (GB alphanumeric, eight digit or any other future format) to allow journey identification,

c) train consist information (see section 4.3.5),

d) power mode,

e) reduced maximum speed or changes to other performance parameters associated with train defects, if applicable,

f) Route restrictions for vehicle and locomotive, if applicable,

g) Special conditions of travel (RT3973), if applicable.

5.1.1.5 Manual entry or selection of C-DAS setup data by the driver, is performed in a leading cab and when the train is at a stand. When changing ends within the same locomotive, the option to retain train data is available.

5.1.1.6 The driver is able to confirm that the system has identified the correct details from the information provided.

5.1.1.7 Where the system has identified the incorrect information, the driver is able to correct the error. Where information is downloaded from an external system, the driver can also notify the source of that information of any errors and request a correction.

5.1.1.8 The on-board C-DAS allows the driver to check and confirm that the current train consist information has been entered / selected / determined / downloaded correctly.

5.1.1.9 C-DAS operation is enabled if the following conditions are all met:

a) The driver has entered and/or confirmed setup information,

b) The driver has selected and/or confirmed train schedule,

c) Current and correct train specific data is available,

d) All the data required to be available to the C-DAS on-board at or prior to journey start has been transferred and confirmed current.

5.1.1.10 The driver is provided with an indication if the setup process is unsuccessful.

5.1.1.11 The driver can customise areas of their display with configurable information (see section 4.3.4).

5.1.2   Driving with C-DAS:

5.1.2.1   The driver treats the information provided by the C-DAS as advisory only and continues to drive in accordance with current rules, policies, route knowledge and operational notices.

5.1.2.2   C-DAS provides advisory information that supports drivers in meeting the following driving goals identified by Research Project T724 [RD2]:

   a)   Maintain the schedule of the service ("as far possible, [ensure that] the trains runs to time and any avoidable delay is prevented"; p.9, [RD4]),

   b)   Apply additional driving guidance in best practice (such as professional driving) and RU specific initiatives (section 5.3.1 of [RD2] "Eco-driving": Improving energy efficiency of service delivery).

5.1.2.3   The driver's ability to achieve the (highest priority) goal of maintaining safety (identified by Research Project T724 [RD2], "safety duties take priority over all other duties"; p.9, [RD4]), is not diminished by the implementation of C-DAS.

5.1.2.4   The driver operates/interacts with C-DAS when it is safe to do so, such that it does not detract from their normal operating duties.

5.1.2.5   The driver's use of C-DAS does not affect existing on-board safety systems (Driver's Reminder Appliance (DRA), Driver's Safety Device (DSD), Driver's Vigilance Device (DSD), Automatic Warning System (AWS), ERTMS etc.) in accordance with existing rules and procedures.

5.1.2.6   Failure of the C-DAS system does not compromise the operation of safety critical systems.

5.1.2.7   When re-routed and C-DAS has not updated its route information, the driver can update the system with the train's new route.

5.1.2.8   The driver can manually suppress and unsuppress, disable and re-enable the display of C-DAS information.

5.1.2.9   The driver can amend train consist information or TRN without having to re-enter all the setup information.

5.1.2.10 The driver can determine (via the user interface) whether the display of C-DAS information is being suppressed (following manual or automatic suppression) or disabled.

5.1.2.11 The driver cannot unsuppress the display of C-DAS information if the display is automatically suppressed.

5.1.2.12 When C-DAS has been disabled, all setup information is reset and needs re-entry after C-DAS is re-enabled.

5.1.2.13 The C-DAS display can adjust between different brightness settings manually or automatically.

5.1.2.14 If the RU utilises C-DAS journey records as part of network performance monitoring processes, then:

a) The driver can manually select or input explanatory information that describes why the C-DAS advisory information was not followed during a journey,

b) The driver can manually select delay attribution codes in the event that the service is delayed,

c) The explanatory information and delay attribution code is recorded in the journey records and be available to both the RU and IM.

5.1.2.15 C-DAS has a holdover capability to allow driver change without requiring full setup.

5.1.2.16 Where the identification of the driver using a unique Driver ID is required, drivers can enter a new Driver ID at driver changeover, without having to re-enter all other setup information.

5.1.3 Abnormal and Emergency Operations:

(Note that abnormal and emergency operations are not separate as possible actions are similar between each situation.)

5.1.3.1 When the train has been re-routed, and the on-board C-DAS continues to display advisory or journey information associated with the original route, and the driver is not able to manually select the new route, the driver can manually suppress the display of advisory and journey information.

5.1.3.2 For moves into, within and out of possessions and worksites or when its operation becomes degraded, the driver can manually disable the on-board C-DAS.

5.1.3.3 If the driver is informed of the need to operate over degraded infrastructure, the on-board C-DAS can either be manually disabled or the display suppressed. This can include examination of the line, temporary block working, single line working, and wrong direction movements.

5.1.3.4 In the event of operational incidents, the on-board C-DAS can either be manually disabled or the display suppressed. This can include: moving the train following a train failure, or the reduction of infrastructure availability due to a bridge strike or broken rail.

5.1.4 End of Journey:

5.1.4.1 Other than train consist / formation, setup information from a completed journey is not retained by the C-DAS on-board.

5.1.4.2 The RU can decide if they want drivers to re-enter train consist / formation at the start of each journey, or whether this data is retained by the C-DAS system from the previous journey and presented to the driver for confirmation.

5.1.5 Journey Records:

5.1.5.1 C-DAS records the details of each C-DAS journey so that the impact of C-DAS on network performance can be evaluated.

5.1.5.2 C-DAS continues to record journey data when the information display is suppressed.

5.1.5.3 The RU can download or transfer journey records from the train.

5.1.5.4 The RU can configure the on-board C-DAS to provide feedback on economic driving technique after a journey, if desired.

5.1.6   Training:

5.1.6.1   The RU reviews its driving policy as part of the introduction of C-DAS.

5.1.6.2   Drivers' competency and skills on the usage of C-DAS are adequately developed through the provision of suitable training and the definition of driving guidance.

5.2   Conceptual operation of C-DAS from the perspective of traffic management systems

5.2.1   Systems provide the train's current schedule to C-DAS and can deliver schedule updates and / or changes to routing to C-DAS when they are altered. These updates can come from multiple sources, including traffic management systems.

5.2.2   Traffic management systems provide C-DAS with information on speed and route restrictions, including TSRs, ESRs and RT3973 information.

5.2.3   Traffic management systems receive acknowledgement from C-DAS fitted trains in the managed area when schedule updates are accepted by C-DAS.

5.2.4   If a C-DAS fitted train in a managed area cannot meet the expected timing of a point on its current schedule, traffic management systems receive notification and a predicted earliest possible timing for this point from C-DAS.

5.2.5   Traffic management systems can subscribe to the location and speed information from C-DAS fitted trains in the managed area. This information can be passed to other systems where deemed useful.

5.2.6   Traffic management systems and / or controlling location staff receive information about the operational state of C-DAS on-board and trackside systems.

6 Roles and Responsibilities

6.1 RU Roles and Responsibilities

6.1.1 General

6.1.1.1 The roles and responsibilities specified in this section are based on the use case interactions outlined in Figure 1 below.
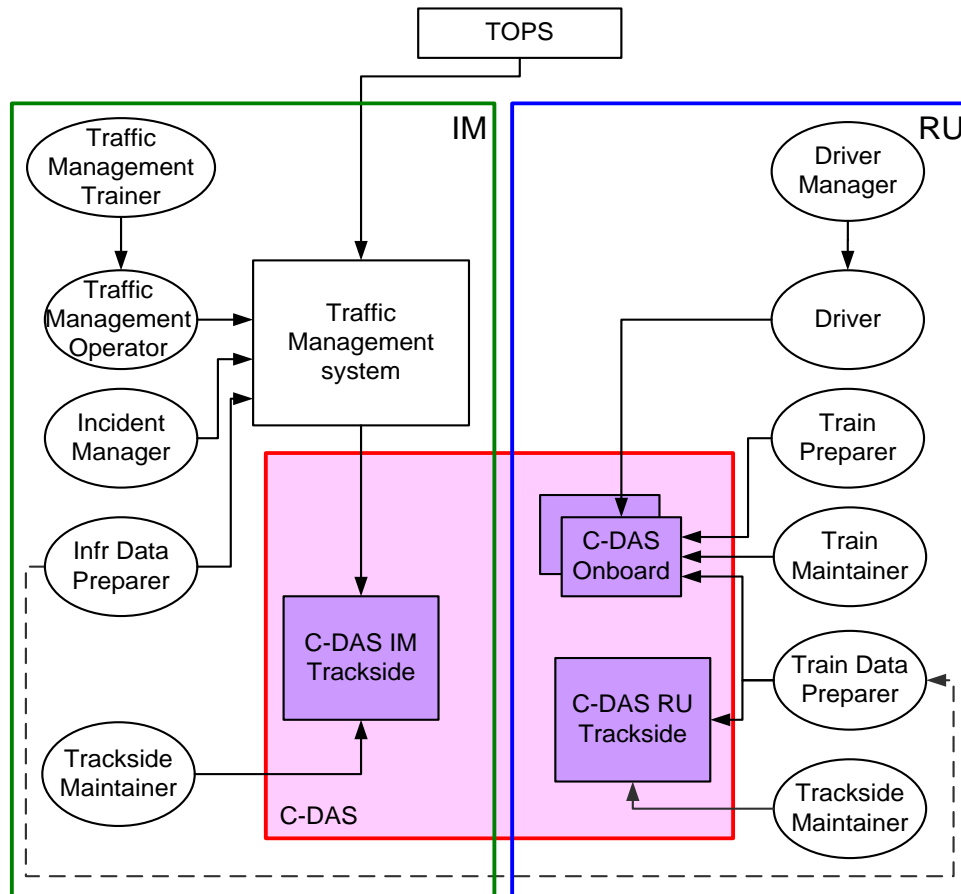

Figure 1 System Boundary and Use Case Interactions.

*Dispatcher could be IM and/or RU.

Note: C-DAS Trackside Maintainer for IM/RU could be a supplier. All roles mentioned require training / briefing. The Trainer could be IM and/or RU or joint trainer / briefer.

6.1.1.2 The responsibilities listed below are in addition to / clarification of those already placed by the Railways and Other Guided Transportation System (safety) Regulations 2006 (ROGS).

6.1.2 Customisation Data Responsibilities

6.1.2.1 The RU prepares and maintains all user and train specific data required for C-DAS, ensuring that all data is current.

6.1.2.2 The RU provides IM Operations Planning with train-specific customisation data, in accordance with data requirements (such as precision and granularity) agreed with the IM, to allow the performance of C-DAS fitted trains to be modelled for the identification of network performance improvements.

6.1.2.3   The RU ensures that all data preparation and formatting processes employ a level of checking appropriate for the data.

6.1.2.4   The RU ensures the security of stored data and of the transfer of that data for which it is responsible.

6.1.2.5   The RU manages the transfer of the required datasets to ensure that they are available to C-DAS in sufficient time.

6.1.2.6   The RU provides the IM with requirements for application datasets, including data partitioning requirements where relevant.

6.1.2.7   The RU manages any (RU maintained) local copies of application datasets.

6.1.2.8   The RU validates that all the IM supplied application data required for C-DAS operation is correctly prepared and formatted.

6.1.2.9   The RU ensures that any system requirements for validating on-board copies of datasets are allocated to the appropriate RU operation and technical systems.

6.1.2.10   The RU ensures that correct versions of the application datasets are available to C-DAS.

6.1.2.11   The RU ensures that the processes for correctly preparing, formatting and transferring application data to C-DAS limits the amount of manual data entry. Where data is manually entered, a checking process appropriate to the required integrity of the data is employed to ensure the data is entered correctly.

6.1.2.12   The RU has contingency arrangements in place should any C-DAS software, application data and train specific data not be current.

6.1.2.13   The RU develops the processes and procedures necessary for the retrieval, analysis and distribution of C-DAS journey records.

6.1.2.14   The RU develops processes and procedures necessary for the receipt of system anomaly reports from drivers and/or maintenance staff. Managing and addressing these reports may require co-operation with the IM.

6.1.2.15   The RU develops and manages processes and procedures for the maintenance and upkeep of the on-board C-DAS equipment and interfaces. Any RU managed trackside equipment supporting C-DAS operations, meets system-wide availability targets.

6.1.3   Driver

6.1.3.1   The driver is the only direct user of the on-board C-DAS, and:

    a)   completes system setup prior to journey start and system shut down at the end of a journey,

    b)   monitors C-DAS during the journey and follows advisory or additional information (text messages) in accordance with company driving policies,

    c)   amends or updates setup information as required during the journey.

6.1.3.2   Where possible, drivers also report any journey or system anomalies that are noticed in the operation of the system, for example advised speeds higher than a PSR.

6.1.4 Driver Manager

6.1.4.1 The Driver Manager manages C-DAS driver competency and arranges for drivers to be trained and/or briefed in the use of C-DAS.

6.1.4.2 The Driver Manager analyses journey information where/when appropriate.

6.1.5 Train Maintainer

6.1.5.1 The train maintainer maintains the on-board C-DAS equipment as required by maintenance processes.

6.1.6 Train Preparer

6.1.6.1 The train preparer completes any train preparation activities associated with the on-board C-DAS, as required by the RU.

6.1.7 Operations Controller

6.1.7.1 The RU informs the IM when there are deviations from the plan (whether DAS is fitted or unfitted (see Assumption 3.2.9).

6.1.7.2 The RU informs the IM when drivers have been instructed not to use C-DAS because of a software fault or because application data or train specific data is not current.

6.1.7.3 The RU advises drivers if application data or train specific data is not current or if software is faulty, so that the appropriate contingency arrangements can be implemented.

6.1.8 Other RU Responsibilities

6.1.8.1 The RU informs staff of when fleets are DAS fitted (S-DAS or C-DAS – see Assumption 3.2.9).

6.1.8.2 The RU informs the IM of when fleets are DAS fitted (S-DAS or C-DAS – see Assumption 3.2.9).

6.1.8.3 The RU ensures that the software installed on C-DAS is current.

6.1.8.4 Where practicable, the RU provides the IM, on request, with selected journey records as input to capacity planning and timetable improvement.

6.1.8.5 The RU analyses journey information and can provide feedback on economic driving style post journey.

6.2 IM Responsibilities

6.2.1 General

6.2.1.1 The roles and responsibilities specified in this section are based on the interactions outlined in Figure 1 above.

6.2.1.2 The responsibilities listed below are in addition to / clarification of those already placed on the IM by ROGS.

6.2.2 Customisation Data Responsibilities

6.2.2.1 The IM prepares and maintains all application data.

6.2.2.2 The IM defines (and agrees with RUs) options for specifying data partitioning for application data.

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6.2.2.3   The IM defines (and agrees with RUs) configuration management and operational protocols to be used by remote systems to ensure that versions of datasets held locally or copied from local copies match the current master version.

6.2.2.4   The IM ensures that any system requirements relating to the use of these protocols for validating datasets are allocated to the appropriate IM operational and technical systems.

6.2.2.5   The IM provides application datasets in line with the data partitioning requirements specified by the RU.

6.2.2.6   The IM disseminates complete, correct and accurate data in sufficient time to make it available to IM and RU systems before operations: over changed infrastructure, over areas with changed speed data, or with a changed timetable.

6.2.2.7   The IM documents and provides data access services to RUs.

6.2.2.8   The IM ensures the security of stored data and of the transfer of that data for which it is responsible.

6.2.2.9   The IM ensures that any data preparation processes required for the provision of application data or data updates employ a level of checking appropriate to the required integrity of the data.

6.2.2.10 The IM ensures that all the application data required for C-DAS operation is correctly prepared and formatted in accordance, where relevant, with data requirements (such as precision and granularity) agreed with the RU.

6.2.3   IM Data Preparer

6.2.3.1   The role of the IM data preparer is responsible for collating, checking, and maintaining C-DAS application data and delivering it to the RU. This role is not necessarily fulfilled by one person and could be a team of independent preparers and checkers.

6.2.4   Signaller or Automatic Setting of Routes

6.2.4.1   The IM determines, in conjunction with the RU, the policy for train signalling and regulation control in areas where C-DAS trains operate.

6.2.5   Other IM responsibilities

6.2.5.1   The IM manages the telecommunication needs to support C-DAS.

6.2.5.2   The IM trains those interacting with C-DAS on how it impacts their role.

6.3   System Maintenance

6.3.1.1   C-DAS system components are easily accessible for maintenance activities.

6.3.1.2   The C-DAS system is testable in the maintenance environment.

6.3.1.3   The RU considers the impact of C-DAS implementation on existing Vehicle Maintenance Instructions (VMIs) and Vehicle Maintenance Overhaul Instructions (VMOIs) and revises them as necessary.

6.3.1.4   The IM considers the impact of C-DAS on existing maintenance specifications and revises them as necessary.

6.3.1.5   Although not a CCS-type system, consideration is given to including C-DAS in existing Data Recording, Analysis and Corrective Action System (DRACAS) applications.

7 Definitions and Abbreviations

7.1 Definitions

Abnormal Working

A mode of railway operation to handle unforeseen or unplanned events which do not have life threatening or extreme loss implications. Abnormal events include faults and failures external to C-DAS equipment, user failures, e.g. the failure of a train due to traction problems, or the reduction of infrastructure availability due to a bridge strike or broken rail. Abnormal mode also includes any planned maintenance activity not affecting the functionality on the lines remaining open to traffic.

Advisory

Recommended but not compulsory.

Advisory information

The C-DAS recommendation to the driver.

Applicable Timetable

The Working Timetable as amended at 22.00 on the day prior to the day of operation.

Application data

Part of Customisation data.

Coasting (or the advisory information COAST)

The driver does not need to apply traction to meet the requirements of the schedule, but can still apply traction if necessary. The driver still brakes to follow any restrictive aspects.

Connected DAS

A system which provides train drivers with advisory information that is informed by the real-time, measured progress of the individual train against (static) Infrastructure Geography with (dynamic) linespeed and schedule data.

Controlled area

An area controlled by a traffic management system. Such areas will be capable of supporting full C-DAS operation, i.e. systematic data exchange in near-real time-between C-DAS-fitted trains in the area and the traffic management system.

Current Schedule

The current planned sequence of named locations, corresponding times and path for a single train service. The times specified will be arrival and departure for scheduled stops, and passing times for non-stopping locations. The current schedule may contain the same data as the planned schedule, or include any number of schedule updates.

Customisation Data

The data which determines the detailed operation of the C-DAS. It comprises of four parts:

a) Application data – infrastructure geography, permissible speeds, TSRs and ESRs, schedule,

b) Train specific data – train characteristics, power consumption characteristics, maximum speed, route availability, train weight, train length, special conditions of

travel, power mode, ETCS level and mode, train types, ETCS train category information

c) Start of Journey Information – Driver ID, Train Running Number (TRN), communications addresses,

d) User data – selection and parameterisation of operator defined features.

Data Partitioning

Infrastructure geography and permissible speed datasets change relatively rarely, and the aim is to partition these datasets so as to provide RUs with the application data required for their routes, without requiring updates when there are changes to parts of the national data which are not relevant to their operations.

Degraded Working

Method of signalling trains when the normal controls are unavailable.

Disable

Action by which the on-board DAS is closed down, either by the driver or automatically, in the event of a system failure, frozen display or as instructed.

ETCS Fitted Trains

A vehicle which is equipped with commissioned and fully functioning on-board ETCS equipment.

ETCS Operating Level

The level of ETCS functionality within ERTMS.

ETCS Unfitted Train

A train not equipped with a commissioned ETCS on-board, or a train equipped with an ETCS on-board that is not functional.

European Train Control System (ETCS)

The train control subset of the ERTMS providing a level of protection against overspeed and overrun, depending upon the capability of the lineside infrastructure.

GB Mainline Railway

GB Mainline Railway refers has the meaning given to it in the Railways and Other Guided Transport Systems (Safety) Regulations 2006.

Infrastructure Geography

The data which describes the topography and topology of the network infrastructure. It comprises three parts:

a) Track Geography – track centre line, altitude and curvature.

b) Rail Network Model(s) – connectivity and navigability, including operational line names.

c) Track Features – asset data, including location of points, stations, location markers, e.g. mileposts, tunnels etc., together with other parameters, e.g. C-DAS speed display units and ETCS National Values.

It should also include:

d) Linkages (mapping) between (b) and (a).

e) Linkages (mapping) between timing point locations and track geography / track features.

f)   Means (based on sequence of track link ID) to support mapping between routing data and track geography.

Journey

The scheduled movement of a train between two named points, for example, the journey between London Euston and Glasgow Central.

Journey Segment

That part of the operational route which lies between adjacent timing points.

Linespeed

The Permissible Speed modified by any applicable Temporary and Emergency Speed Restrictions for a particular train type in the direction of travel.

Linespeed Profile

The Permissible Speed Profile modified by applicable temporary and emergency speed restrictions to be observed by a particular train.

Network Model

A description of the track layout which specifies both its connectivity and how it may be traversed, i.e. permissible sequences of track links.

Networked DAS

Networked DAS (N-DAS) is a driver advisory system that is capable of communicating with one or more RU control systems, thus enabling provision of data to the train, including updates for schedule or routing information, though generally not in near real time.

Permissible Speed

The maximum speed at which any train is allowed to travel on the line at that particular geographic location, normally identified in the sectional appendix.

Plan

The collective schedule for multiple trains.

Planned schedule

The part of the Applicable Timetable that applies to a single train service. It is analogous to the contents of the Common Interface File (CIF) [RD6].

Route

The sequence of track links which make up the train journey or journey segment.

RT3973 Restriction

Condition of travel (including speed related, or restriction on route or line) which has to be applied to a particular movement and is stated on form RT3973, Advice to Train Crew of Exceptional Load.

Schedule update

Any change made to the applicable timetable in respect of a particular service so as to accommodate VSTPs, regulate trains and/or recover from perturbation.

Setup data

Part of Customisation data.

Standalone DAS

Standalone DAS (S-DAS) is a driver advisory system which has all data downloaded to the train at or prior to journey start.

Static Speed Profile

This is the speed profile at which the train may operate over a particular stretch of infrastructure, and reflects infrastructure constraints, direction and the ETCS train categories. Static Speed Profiles are the ETCS equivalent of Permissible Speeds.

Suppress

Action by which the on-board C-DAS display is disabled in whole or in part. This is either performed by the driver manually or automatically in circumstances defined by the RU / IM.

Timing Point

A timing point location in a train's schedule, with an associated time qualified as arrival, departure or passing time.

Timing Point Location

A location for which a time is specified on the train's schedule. Timing point locations will include all locations in the train's published schedule, and may include further locations which contribute to improving train regulation.

Track Link

The individual track between any two locations on a journey, subject to the limitation that it cannot include any points, cross-overs or loops, other than as an end point.

Train Performance Data

Part of Customisation data.

Train Running Number

The operational train identifier used by staff to identify a given train service, and unique to a service within a 24-hour period.

Train specific data

Parameters which determine the behaviour of a particular train, including train length, mass, maximum speed, braking parameters, traction parameters and resistance coefficients including Train Consist together with Train Performance Data.

Uncontrolled area

An area which is not controlled by a traffic management system. Such areas may support N-DAS operation, i.e. limited data exchange between C-DAS fitted trains in the area and an RU's facility.

User data

Part of Customisation data.

Working Timetable

The Working Timetable shows all train movements, their timings and other relevant information. The WTT is revised on two occasions each year: the 'Principal Change Date' in December and the 'Subsidiary Change Date' in May.

7.2 Abbreviations

ATO	Automatic Train Operation
AWS	Automatic Warning System
C-DAS	Connected Driver Advisory System
CIF	Common Interface File (see [RD6])
DAS	Driver Advisory System
DfT	Department for Transport
DMI	Driver Machine Interface
DRA	Driver's Reminder Appliance
DRACAS	Data Recording, Analysis and Corrective Action System
DRP	Digital Railway Programme
DSD	Driver's Safety Device
DVD	Driver's Vigilance Device
ESR	Emergency Speed Restriction
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FOC	Freight Operating Company/Companies
GB	Great Britain
GN	Guidance Note
IM	Infrastructure Manager
km/h	Kilometres per hour
mph	Miles per hour
N-DAS	Networked Driver Advisory System
ORR	Office of Rail and Road
PSR	Permanent Speed Restriction
RDG	Rail Delivery Group
RSSB	Rail Safety and Standards Board
ROC	Railway Operations Centre
ROGS	Railways and Other Guided Transportation System (Safety) Regulations 2006
ROSCO	Rolling Stock leasing Company
RU	Railway Undertaking
S-DAS	Standalone Driver Advisory System
SSP	Static Speed Profile
STP	Short Term Planning
TOC	Train Operating Company
TRN	Train Running Number
TSR	Temporary Speed Restriction
VSTP	Very Short Term Planning
WTT	Working Timetable

8　　Related Documents

8.1　　References

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[RD5]　S-DAS Operational Concept, Issue 1.0 (12th March 2012) Ref NS-FUTRO OC (9001).

[RD6]　Network Rail Common Interface File: User Guidance Notes, Version 28.

[RD7]　Guide to the Train Driving Licences and Certificates Regulations 2010, Second edition, published by the ORR, November 2012

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