Common System Capabilities – Stock and Crew System

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Synopsis

This document has been produced by the Rail Delivery Group (RDG) and passenger and freight operators, acting on behalf of the Great British rail industry, to describe a common set of systems capabilities for a Stock and Crew system based on the information contained in the RDG Concept of Operations for a Stock and Crew system.

Issue record

Issue	Date	Comments
0.1	May 2018	First draft for external review
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Executive Summary

This document defines levels of essentiality of different Stock and Crew system capabilities identified in the published RDG Concept of Operations [RD10].

The Concept of Operations provided a high-level description of a Stock and Crew system capable of interacting with other systems, such as Traffic Management. It explained how the system may be used, established how the railway may operate in the future and what the industry wants and needs could be in that environment.

This document qualifies each of the Concept of Operation's clauses with a level of essentiality only and does not introduce or remove any of the concepts previously written.

Each of the capabilities were assessed during a workshop held at the Rail Delivery Group, with representation from Passenger Train Operating Companies, Freight Operating Companies, Digital Railway, Network Rail, the Department for Transport and potential system suppliers, as nominated by the Rail Industry Association. This document defines whether a capability is a: 'short-term must have', 'long-term must have', 'nice to have' or 'long term aspiration' – see Part B.

The perceived cost of Stock and Crew systems (including Research and Development work), the lack of Traffic Management and the length of some RUs' franchises has meant that it has been difficult to generate a business case for a Stock and Crew system and hence there has been limited development.

This document, along with the Concept of Operations aims to promote and advance the development and deployment of Stock and Crew systems. This is achieved by providing an industry agreed description of the system and how it may be used, establishing how the railway may operate in the future and what the industry wants and needs are in that environment. This gives direction to prospective suppliers at an early stage, who can develop towards and innovate the system described herein. This initial development could ease procurement for RUs or encourage RUs to invest in a system. could also be used by RUs to begin tailoring potential systems towards their specific business needs.

PART A: INTRODUCTION

Rail Delivery Group

National Rail

BRITAIN RUNS ON RAIL

1 Purpose and Scope

1.1 Purpose

The Stock and Crew system proposed in the previously published Concept of Operations [RD10] aims to bring benefits to the industry by:

− improving day-to-day operations,

− improving recovery time from disruption,

− improving the customer experience,

− digitising some current practices, procedures and communications,

− providing connectivity to, and interaction with, wider industry systems including DARWIN and Traffic Management systems,

− creating greater ties between information held in various Railway Undertakings (RU) systems and a single version and source of the truth.

Train and freight operating companies today have differing control and train planning systems for stock and traincrew management. There are also many and varied systems and procedures in use, ranging from pen and paper and verbal communications to digitised systems. Where digital systems are used, they are not fully connected to others so when changes are made to planned stock and/or crew allocations, information is communicated verbally or via email or fax. This leads to additional disruption when re-planning train services.

Resources are not always together in one location and can be based across multiple sites around the country; staff can be on different roster patterns, terms and conditions etc., train vehicles can have varied fuelling and maintenance requirements. These make communications and changes challenging.

The crew systems themselves can include multiple resources, for example; drivers, train managers/guards, caterers, cleaners, on-board supervisors etc.

During times of perturbation, the fast and continually changing demands of command and control can often lead to operators being unable to maintain service expectations. Whilst in the main, this is managed well, perturbations present additional challenges to those involved in keeping track of alterations to the crew, stock and the service. The greater the perturbation the more likely that the plans will be suboptimal.

Prior to this RDG led project, there have previously been several workstreams that have proposed Stock and Crew system requirements, however these had not been collated and agreed across the industry as the required outputs of a Stock and Crew system. RDG have collated the historic wants and needs into a single document and have held workshops with industry to validate these. The outputs of these have informed: the Digital Railway Early Contractor Involvement workstream and the RDG Concept of Operations – the latter being the parent document to this one.

This document defines levels of essentiality of different Stock and Crew system capabilities identified in the published RDG Concept of Operations [RD10]. Each of the capabilities were assessed during a workshop held at the Rail Delivery Group, with representation from Passenger Train Operating Companies, Freight Operating Companies, Digital Railway, Network Rail, the Department for Transport and potential system suppliers, as nominated by the Rail Industry Association. This document defines whether a capability is a: 'short-term must have', 'long-term must have', 'nice to have' or 'long term aspiration'.

The perceived cost of Stock and Crew systems (including Research and Development work), the lack of Traffic Management and the length of some RUs' franchises has meant that it has been difficult to generate a business case for a Stock and Crew system and hence there has been limited development. This document, along with the Concept of Operations aims to promote and advance the development and deployment of Stock and Crew systems.

The Concept of Operations provides a high-level description of a Stock and Crew system which intends to meet the aims above. It provides an industry agreed description of the system and how it may be used, establishing how the railway may operate in the future and what the industry wants and needs are in that environment. This gives direction to prospective suppliers at an early stage, who can develop towards and innovate the system described herein. This initial development could ease procurement for RUs or encourage RUs to invest in a system and could also be used by RUs to begin tailoring potential systems towards their specific business needs.

The clauses from the Concept of Operation do not attempt to provide solutions or specify system, operational or technical requirements. It has been written to follow the Digital Railway Concept of Operations Strategy [RD1], so describes a green field, utopian operating environment and is intended to be technology and supplier agnostic.

1.2   Document Scope

The Concept of Operations provided a high-level description of a Stock and Crew system capable of interacting with other systems, such as Traffic Management. It explained how the system may be used, established how the railway may operate in the future and what the industry wants and needs could be in that environment. This document qualifies each of the Concept of Operation's clauses with a level of essentiality only and does not introduce or remove any of the concepts previously written. As such, the assumptions and operating modelled defined in the Concept of Operations are repeated, for completeness.

A Stock and Crew system could extend beyond a RU Control system, encompassing other business functions such as Train Planning and Resourcing – as such the scope is expanded to include these.

Specific details and requirements are planned to be studied, formalised and agreed at later stages of development. This can include alterations that are required to systems beyond the Stock and Crew system. As such, the following is excluded from the scope of this document:

a)   The design of the working timetable,

b)   The definition of the algorithms used to determine advisory information,

c)   The design of automated setting of routes algorithms, including those algorithms used by Traffic Management systems,

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

e)   The design of the Human Machine Interface (HMI),

f)   Details of the communications links used to provide information to and from operational systems and the Stock and Crew system,

g)   Details of how stock and crew data is communicated to and used by ETCS and DAS, including C-DAS,

h)   How an Incident Management System (IMS) interacts with a Stock and Crew system,

i)   The specific method by which staff communicate to crews,

j) Commercial arrangements between dutyholders associated with the implementation and operation of Stock and Crew systems. There are commercial issues associated with the implementation of Stock and Crew systems related to the allocation of benefits and costs between the different duty holders, but these are considered to be out of scope.

It is projected that an eventual utopian state will be a Stock and Crew system feeding data to Traffic Management systems that then use this in routing and conflict decisions and automated setting of routes. This could include prioritising a train at a junction as the crew have minimal time at the terminal station to start another service, for example. To achieve this utopian state, changes to Traffic Management algorithms would be required (out of scope for this concept) and should be considered as a separate piece of work once Stock and Crew systems become established and computing power advances.

This document and the Concept of Operations were written to take into account the conceptual operation of systems in 'Migration State 9' [RD6], although assumes that the European Train Control System (ETCS), driver advisory systems (DAS) and Traffic Management do not cover all areas of the rail network and, as such, makes allowances for where these systems will not be operating.

PART B: SYSTEM CAPABILITIES

Rail Delivery Group

National Rail

BRITAIN RUNS ON RAIL

2 Assumptions

2.1 Introduction

The assumptions listed below document the context in which Stock and Crew systems operate and identifies other systems that interact with them. 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. These remain the same as in the Concept of Operations.

2.2 Working Assumptions

Information from all other systems can be accessed and are not stored in a closed, proprietary or write protected format.

Information transfer time between systems is minimal.

Current management of both stock and crew is similar to and follows the summary workflow presented in figure 1. It is assumed that there is a linear flow from the external IM timetabling system to RU planning to RU resourcing then to RU control, with appropriate feedback loops where required.

The Stock and Crew system is utilised across the RU's entire operating area, train crews and fleet.

Only one Stock and Crew system is used across the RU's business.

All information stored within the Stock and Crew system is accurate and up to date. When changes to agreed plans are made, the system is updated immediately.

Location, schedule and running information received by the Stock and Crew system is correct to a defined level of accuracy.

Some aspects of fleet maintenance are handled within External Fleet Management systems which could be a train manufacturer's system.

The Stock and Crew system is reliable, available and maintainable during periods of RU train operation. After implementation, the Stock and Crew system becomes the default methodology in control offices for delivering the train service.

Stock and Crew and Traffic Management systems can communicate with, and pass data between, each other.

Traffic Management systems have the capability to revise (with RU approval), and accept revised, schedules and alter the routing of trains its control area.

Traffic Management systems can interrogate stock and crew data when routing changes are made – this has a minimal time impact on the operational railway.

The method of communication to RU operational staff (including on-board train crew) is organised and managed by the RU.

The European Train Control System (ETCS), Traffic Management systems, Driver Advisory Systems (DAS) and Automatic Train Operation (ATO) are not fitted or available over the entirety of the RU's operating area.

All aspects of crew Terms and Conditions can be modelled and incorporated into the system to then be used in calculation of advisory information.

3 Operating Models

3.1 Introduction and Rationale

In the Concept of Operations, three different operating models were proposed for a Stock and Crew system – these are repeated here for completeness:

a) An 'Interchange' Stock and Crew system,

b) A 'Real-time Management' Stock and Crew system,

c) An 'Integrated' Stock and Crew system.

Three operating models were conceptualised to account for disparate business needs, commitments and budgets across different RUs. This can include (non-exhaustive): lack of available funds, poor returns on investments towards the end of a franchise, recent investment in similar or partially duplicated systems, size of RU operation etc.

It is conceptualised that Stock and Crew systems are modular and RUs can build from a lower system specification to a higher one (e.g. 'Interchange' to 'Integrated') when constraints on implementation, as listed above, are eased. There may also be subtle variations to the Operating Models presented herein or modular systems.

The interactions with industry systems (such as Traffic Management) are comparable irrespective of the RU's chosen operating model.

The table below shows an applicability matrix indicating which functionalities are available from each operating model.

	Stock and Crew Operating Model		
	Interchange	**Real-time Management**	**Integrated**
Interface with industry systems	✓	✓	✓
Built-in Train Control functions	✗	✓	✓
Built-in Fleet Management functions	✗	✓	✓
Built-in Stock Allocation functions	✗	✓	✓
Built-in Crew Allocation functions	✗	✓	✓
Built-in Resourcing functions	✗	✗	✓
Built-in Planning functions	✗	✗	✓

4 System Capabilities

4.1 Introduction

This section defines levels of essentiality of different Stock and Crew system capabilities identified in the published RDG Concept of Operations [RD10]. This is achieved via a table with references to the Concept of Operations clause ID, the clause text itself and a ranking of essentiality. Each of the clauses in Sections 4 and 6 of the Concept of Operations were assessed during a workshop held at the Rail Delivery Group with participation from RUs (passenger and freight), Digital Railway, Network Rail, the Department for Transport and potential system suppliers, as nominated by the Rail Industry Association. The determinations made during the workshop have decided the ranking.

As shown in the key below, this document defines whether a capability is a: 'short-term must have', 'long-term must have', 'nice to have' or 'long term aspiration'. Short-term is considered to be within 4 years.

Key:	Must Have (Short Term)	Must Have (Long Term)	Nice to Have	Long Term Aspiration

Each of the clauses in the Concept of Operations are included in the tables below. Note that some clauses have been shorted (by removing examples or guidance) and some combined with similar clauses where the subject matter is similar. Any references to other clauses are references to the Concept of Operations document and not this document.

4.2 System Principles

Clause ID	Clause	Capability
4.2.1	The Stock and Crew system can understand the current and planned schedules and diagrams for all RU stock and crew.	Must Have (Short Term)
4.2.2	The Stock and Crew system can correlate elements of data to provide system users with an improved perception of current operational situations. This can include relating schedules to specific stock, crews and diagrams (or any combination of the former).	Must Have (Short Term)
4.2.3	The Stock and Crew system can monitor allocations of stock and crew during daily service and can efficiently help users make alterations to the planned diagrams and resources.	Must Have (Short Term)
4.2.4	During times of perturbation, the Stock and Crew system can alert users to potential resource conflicts. These alerts can indicate: a train or crew not being able to make a return working, a train not meeting maintenance requirements, a crew working overtime or during designated break times and whether this may affect their allocated work for the next day.	Must Have (Short Term)
4.2.5	Where resource conflicts occur, the Stock and Crew system provides the user with relevant information on available resources. The user may overrule some conflict warnings where it has been confirmed that the conflict is mitigated (e.g. agreement from a Driver to work overtime, mitigating a 'Driver over rostered hours' conflict').	Must Have (Short Term)
	Where resource conflicts occur, the Stock and Crew system provides the user with relevant information on available resources and/or advice on how the conflict could be best mitigated.	Must Have (Long Term)
4.2.6	The interface of the Stock and Crew system is intuitive and allows users to quickly make changes to train service data whilst under time pressure (see also 9.1.2, 6.2.24 and 6.2.25)	Must Have (Short Term)
4.2.7	Each piece of data and information utilised by a Stock and Crew system has a defined, single source, which can be within the system itself.	Must Have (Short Term)

4.2.8	Data from the defined source and the Stock and Crew system is in a non-proprietary, open format. See also assumption 3.2.1. Data that is not commercially sensitive or restricted is easily accessible to any systems which may benefit from the data.	Must Have (Short Term)
4.2.9	Alterations to data can only be made at the defined source from which the change can cascade outwards to systems using the data (child systems). Child systems can request modifications to the source data. The suggested modification can be automatically accepted by the source, where appropriate.	Must Have (Short Term)
4.2.10	Stock and Crew systems can communicate with railway industry systems (as defined in 2.1.12), which can include: TOPS, TRUST, DARWIN, signalling software and Traffic Management. The Stock and Crew system can also communicate with other business systems within the RU, including payroll (or finance) systems, Human Resources systems, external fleet systems and Competence Management Systems. All communications can be automated or initiated by a user request.	Must Have (Short Term)
4.2.11	Industry systems can utilise stock and crew data managed by the Stock and Crew system (see section 4.3).	Must Have (Short Term)
4.2.12	Data is presented on a unified operating environment and human machine interface (HMI), common to all applicable users within the RU (applicability is dependent on the Operating Model – see section 5).	Must Have (Short Term)
4.2.13	Data can be easily interpreted and modified by the system user via the HMI.	Must Have (Short Term)
4.2.14	The Stock and Crew system can utilise and format data in such a way that it assists users with, and reduces time spent on, menial tasks, digitising as much as possible.	Must Have (Short Term)
4.2.15	Communication to stakeholders is made using information from the Stock and Crew system.	Must Have (Long Term)
4.2.16	The Stock and Crew system is reliable and available to support the operational demands made of it.	Must Have (Short Term)
4.2.17	Users of the Stock and Crew system can find information quickly. This includes being able to access information promptly when using local terminals or workstations after initiating connection to the Stock and Crew system (i.e. from Operating System desktop and selecting the 'application' to being able to view data).	Must Have (Short Term)
4.2.18	When the Stock and Crew system loses communication with industry systems, the system user is alerted.	Must Have (Short Term)

4.3 Interaction with Railway Industry Systems

4.3.1 Traffic Management

Clause ID	Clause	Capability
4.3.1.1 & 4.3.1.3	Traffic Management is not essential to the functioning of a Stock and Crew system but can interact with one or more Traffic Management systems where available. So that interactions are consistent, information between the systems can be passed via the Layered Information Exchange (LINX)	Must Have (Short Term)
4.3.1.2	The Stock and Crew system is reliable and available during periods of RU train operation. Maintenance is undertaken at a time agreed to by all industry partners and should have a negligible impact on RU's operation (see also assumption 3.2.9).	Must Have (Short Term)

4.3.1.4	Changes to train schedules, diagrams, allocations or associations made within the Stock and Crew system are automatically communicated to relevant Traffic Management systems (this might be after confirmation of acceptance by the IM).	Must Have (Short Term)
	The Traffic Management system can reject any proposed alterations by the RU (via the Stock and Crew system) and provide an appropriate reason for the rejections. This may include circumstances where network capacity needs to be fairly allocated between multiple RUs.	Must Have (Long Term)
4.3.1.5	Changes to schedules made within Traffic Management are automatically communicated to relevant Stock and Crew systems.	Must Have (Short Term)
4.3.1.6	Traffic Management systems can provide the Stock and Crew system with train location information and/or train running predictions, if desired by the RU.	Must Have (Short Term)
4.3.1.7	Stock and Crew data can assist Traffic Management systems with forecasting earliest possible departure times from stations, taking into account terms and conditions for crew. This can include: walking time from each end of the train, preparation time, walking time to other platforms etc. Further details can be found in 6.2.23.	Must Have (Long Term)
4.3.1.8	Traffic Management systems can utilise stock and crew data to authenticate some routing decisions.	Must Have (Short Term)
4.3.1.9	Should a routing decision contravene a stock and crew constraint, the user of the Traffic Management system is provided with a clear explanation as to why the routing could be unsuitable.	Must Have (Short Term)
4.3.1.10	Traffic Management can provide the Stock and Crew system with information regarding a trains' delay – 'Train Delay Cause' message in LINX.	Must Have (Short Term)
4.3.1.11	When data from a Stock and Crew system is not confirmed as 'received' by Traffic Management, an appropriate member of staff is alerted.	Must Have (Short Term)
4.3.1.12	The Traffic Management system is restricted from setting a route for a service where stock and crew data shows that essential members of train crew are not currently assigned to the service.	Must Have (Long Term)

4.3.2   Signalling Software

Clause ID	Clause	Capability
4.3.2.1	Modern signalling software (Integrated Electronic Control Centre [IECC]), which may not have the full capabilities of Traffic Management, can also make use of Stock and Crew data, if reconfigured.	Long Term Aspiration
4.3.2.2	As per 4.3.1.3, Stock and Crew systems can interact with more than one signalling location.	Long Term Aspiration
4.3.2.3	Signalling systems can provide the Stock and Crew system with train location information, if desired by the RU.	Long Term Aspiration
4.3.2.4	As per 4.3.1.8, the signalling software can utilise stock and crew data to authenticate some routing decisions.	Long Term Aspiration
4.3.2.5	Should a routing decision contravene a stock and crew constraint, the signaller is provided with a clear explanation as to why the routing could be unsuitable.	Long Term Aspiration

4.3.3 C-DAS

Clause ID	Clause	Capability
4.3.3.1	Schedule and routing updates provided to C-DAS originate from Traffic Management systems. Note constraint 9.1.7, where C-DAS may be able to use stock and crew data to minimise data entry by the Driver - this may involve the Stock and Crew system being connected to the RU DAS trackside.	Must Have (Long Term)

4.3.4 TOPS/TRUST

Clause ID	Clause	Capability
4.3.4.1	The Stock and Crew system can provide planned and current (live) stock information and details of the train formation to TOPS/TRUST.	Must Have (Short Term)
4.3.4.2	The Stock and Crew system can take schedule and live running information from TRUST in areas outside the control of a Traffic Management system if preferred by the RU and supplier. (Other systems or GPS tracking of the train could also be used).	Must Have (Short Term)

4.3.5 DARWIN

Clause ID	Clause	Capability
4.3.5.1	Stock and crew data that is of use to customers is available to be utilised by DARWIN.	Must Have (Short Term)
4.3.5.2	Stock and Crew systems that can take into account the timing impact of non-train running activities (as listed in 6.1.8), can assist train running predictions provided to customers via DARWIN. This is further explored in 6.2.23.	Long Term Aspiration

4.3.6 Train Data via Internet (TD.net)

Clause ID	Clause	Capability
4.3.6.1	The Stock and Crew system can take train location information from TD.net if preferred by the RU. This could be for outside of Traffic Management areas.	Must Have (Short Term)

4.4 Data for use by the system

Clause ID	Clause	Capability
6.1.2-6.1.13	The following data listed is known to, and can be used by, the Stock and Crew system: - Longstanding stock and crew details (6.1.2, 6.1.3), - Crew competency details (6.1.4), - Route details (6.1.5), - Stock and crew diagrams details (6.1.6, 6.1.7, 6.1.8), - Stock diagram details after stock is allocated (6.1.9), - Crew diagram details after crew is allocated (6.1.10), - 'On the day of operation' stock and crew details (6.1.12, 6.1.13).	Must Have (Short Term)
6.1.11	Stock and crew diagrams and allocations to those diagrams can be created and modified within the system.	Must Have (Short Term)

4.5 System Processes

Clause ID	Clause	Capability
6.2.3 - 6.2.6	The Stock and Crew system has sectional running times available to use for: a) planning b) planning modifications c) auto-calculating appropriate timings between specified locations When a service schedule has been altered, it can be compared back to the original schedule.	Must Have (Short Term)
6.2.7- 6.2.8	The Stock and Crew system, where possible, has Timetable Planning Rules codified within the system for use when creating train schedules and for alerting users when a schedule may infringe on a Timetable Planning Rule and/or is below the minimum headway for a stretch of line.	Must Have (Short Term)
6.2.9	The Stock and Crew system automatically checks 'stock balances'.	Must Have (Short Term)
6.2.10	Planning users of the Stock and Crew system can customise their planning screen to display different information ['Integrated' only].	Must Have (Long Term)
6.2.11	Plans to be validated by the IM can still be easily exported in a format useable by the IM's validation systems. Plans received back from the IM can be easily imported into the Stock and Crew system.	Must Have (Short Term)
6.2.12 & 6.2.17	The Stock and Crew system can advise and provide options for users on how to assign stock to diagrams for maximum productivity. See also 6.2.18, 6.2.21 and 6.2.22. The Stock and Crew system has granular detail about activities undertaken by both stock and crew and is aware of which activities can be altered, done in parallel or are fixed (by time or location).	Nice to Have
6.2.13 - 6.2.16	Links, as defined in 2.1.9, can be created, managed and modified in the Stock and Crew system. Crew assigned to each link can be viewed by system users. The routes that specific links cover can be displayed as a list of routes and graphically over geographic areas. The Stock and Crew system highlights when a link member does not have the full link competency (e.g. a new crew on a link that does not sign all routes yet). The Stock and Crew system can assess whether there are sufficient qualified spare cover for each link – including if cover can be found from other links.	Must Have (Short Term)
6.2.19	For each train service, the Stock and Crew system is aware of which members of the train crew are essential (primary) and non-essential (secondary). A train is able to depart without a secondary member of the crew, if acceptable to the RU.	Must Have (Short Term)
6.2.20	The Stock and Crew system can assist users in easily managing crew sick leave. When a member of crew is booked off sick, the Stock and Crew system updates any allocated diagrams to be 'uncovered'. Longstanding data for that crew member is updated to show that they are booked off sick – this is visible to both Resource and Control staff.	Must Have (Short Term)
6.2.23	When plans are amended, the Stock and Crew system can calculate and list non-train running activities (see also 6.1.8). These timings can be critical, non-critical, parallel or spare time within the diagram. The list can be used to predict the minimum turnaround time between services of either stock or crew.	Must Have (Long Term)

6.2.25	The Stock and Crew system allows the user to model possible changes to services and is provided with feedback to help evaluate changes before activation and publication to wider systems ('sandbox'). This can include shadow plans (as defined in 6.2.27) and multiple changes to numerous services or allocations, which, once the user is satisfied, can be applied in batch.	Must Have (Short Term)
6.2.26	The user of the Stock and Crew system can quickly codify the location of a line blockage into the system. Details of the line blockage could be provided by Traffic Management systems where available, assuming a common geographical database. Details of planned line blockages or possessions could also be entered. Once codified, the blockages / possessions are used as route constraints and may require deconfliction by a Stock and Crew system user.	Nice to Have
6.2.28	At the point of publication and once published, the Stock and Crew system alerts users to the following, although this can be overwritten in the case of long-forming trains or using additional crew in another portion of the train for example: a) more than one crew member is assigned to a crew diagram, and, b) more than one stock set is assigned to a stock diagram.	Must Have (Short Term)
6.2.29	The Stock and Crew system can record and share information about hired resources from other RUs.	Nice to Have
6.2.30 - 6.2.32	The Stock and Crew system logs and can generate reports on activities undertaken on the system and provide feedback to the Controller on planned alterations. Users of the Stock and Crew system can query data known to the system with customisable database searches.	Must Have (Short Term)
6.2.33	The Stock and Crew system can utilise a 'vehicles with defective equipment guide', including rule book and fleet requirements for removing a train from service. This could be user interactive (e.g. decision tree format) or employ a separate, existing system.	Nice to Have
6.2.34	The Stock and Crew system can plan road transportation when necessary ['Integrated' only]. This can include staff taxis or bus replacement services.	Must Have (Short Term)

4.6   System Outputs

Clause ID	Clause	Capability
6.3.2	The Stock and Crew system can display to the user all information listed in 6.1 (Data for use by the system) in a clear and concise manner.	Must Have (Short Term)
6.3.4 - 6.3.5	The Stock and Crew system can: a) emulate a departure board for particular locations and display it (including live running information) to system users. b) display a summary of live running information of RU trains. For controllers, the trains displayed can be limited to the geographical area or set of services ('service group') that they control.	Must Have (Short Term)
6.3.6	Where the information is available, the Stock and Crew system user can view the live passenger loading of any train. This can also include typical / historical loading information for that train service.	Nice to Have
6.3.8 - 6.3.10	The Stock and Crew system can alert users to stock and crew restrictions and restrict users in allocating stock or crew to an unsuitable diagram or service.	Must Have (Short Term)
6.3.11	The Stock and Crew system can assist users in finding appropriate crew for uncovered diagrams. This may include suggesting crews that can fully or partially cover the diagram (as they are available, travelling as passenger or spare for example, and are not 'unsuitable' for the services as deemed by the criteria above).	Must Have (Long Term)

6.3.12 - 6.3.13	The Stock and Crew system can generate reports on: a) Stock utilisation, b) Stock and crew resources availability, c) Crew location simplifiers, d) Changes made to crew working hours, for use by payroll. e) specified headcodes, including the full (planned) crew and stock diagrams related to it, any alterations made in the system related to this headcode (over a defined time period) and performance data (if available).	Must Have (Short Term)
6.3.14	The Stock and Crew system can present users (or recipients) with data in a format designed by the RU. This could be for remote printing, email or applications.	Must Have (Short Term)
6.3.15	The Stock and Crew system can visualise platform occupation times to assist planners and controllers plan platform allocations.	Must Have (Short Term)
6.3.17	To aid understanding and quality control information held in the Stock and Crew system, users can see the Terms and Conditions translated into individual logic statements (requirements) used by the system.	Must Have (Short Term)
6.3.7 & 6.3.18	The Stock and Crew system has configurable displays that allow the user to assess current resources (available and in use) as well as utilisation statistics in real-time.	Must Have (Short Term)

PART C:

CONTINUED SYSTEM DEVELOPMENT

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5 System Constraints and Future Development

5.1 Constraints

The following details some of these constraints, recognising current standards, practices and software implementations.

Data within and used by the Stock and Crew system must be accurate and up-to-date at all times, particularly if connected to a number of industry systems such as DARWIN and Traffic Management. As such, the importance of usability cannot be understated – in high pressure, time critical situations, users should find the system easier to use and more efficient than resorting to pen and paper. It is by achieving this that information can be kept live and up to date for the benefit of other systems, stakeholders and customers.

During the implementation of the Stock and Crew system, a loss of users' trust or faith in the system can undermine its efficacy and the benefits. This can result in, for example, staff returning to older systems/methodologies or using pen and paper. For the system to be successful, it needs to maintain trust from the initial outset, and increase convenience, whether through an increase in efficiency or quickening of current tasks, lessening the chance of staff not using it.

The Stock and Crew system may interact with Traffic Management systems where available, or as a standalone system with the capability for future connectivity to a Traffic Management system. Under current/planned implementations, data from Stock and Crew systems would be published to the Layered Information Exchange (LINX) and be subscribed to by Traffic Management, and vice versa. Optimisation of the bandwidth between the two systems will, therefore, be an important consideration and possible constraint. Two possible implementations have been theorised at this stage - this document has been written so as to not preclude either implementation:

a) Relevant information from the Stock and Crew system is transferred to Traffic Management the night before with live updates published to Traffic Management when information changes (and vice versa). 'Relevant' information will depend on the implementation of the Traffic Management system although it is anticipated to be information pertinent for making regulation or routing decisions. No personal or commercially sensitive data is expected to be shared. For data queries, Traffic Management would use the information it already has rather than query the Stock and Crew system via LINX. This could reduce query response times but requires accurate and consistent information to be within both systems. The volume of live updates and their file size to be passed over LINX could be a constraint. This implementation is discussed further in the Digital Railway Early Contractor Involvement (ECI) workstream report [RD2].

b) Data contained within the Stock and Crew and Traffic Management systems remain segregated with each system publishing information to LINX for the other system to query when necessary. This published data should reflect the latest information in either system. Whilst this implementation would not require a large transfer of data the night before, it could slow query response times and generate a larger number of queries for the LINX layer as up-to-date data is not held in Traffic Management.

Publication and subscription to the Layered Information Exchange (LINX) requires an appropriate LINX message to be set up. Creation of a new LINX message flow is anticipated to have a cost impact and take time to set up and be approved.

An RU's operational area may be controlled by a number of different suppliers' Traffic Management systems - whilst LINX should provide uniformity in communication methods, some compatibility restraints could be discovered.

Stock and crew data may be used to provide information to both DAS (including connected DAS [C-DAS] systems) and ETCS on-board systems.

–   DAS implementations, which do not receive live updates during journeys (Standalone or Networked DAS), may require the Stock and Crew system to be connected to the RU's trackside DAS system. The stock and crew data could be used by DAS to provide more up to date information and decrease the amount of data entry for the driver. It may also decrease the number of manual updates that need to be entered into the RU trackside DAS system when plans change. It is unknown how the Stock and Crew system and RU DAS trackside may be connected and is likely to be supplier dependant.

–   Connected DAS (C-DAS), which is provided with live schedule updates from Traffic Management (via LINX, the IM and RU DAS trackside) may also make use of the stock and crew data. At the time of writing, it is unknown whether the data should be provided via LINX or whether the Stock and Crew system is connected directly to the RU DAS trackside (as per above), although the former seems most likely. Again, this is likely to be supplier dependant but may require further work. Schedule updates from Traffic Management could also be passed from LINX to the C-DAS RU trackside via the C-DAS IM trackside or via the Stock and Crew system (if the direct connection is provided). This may pose a risk if the systems do not hold corresponding information (e.g. one system updates the schedule information more quickly than the other).

–   ETCS on-board systems may use stock and crew data to minimise the amount of data entry required by the driver – in line with the Operational Concept for ERTMS [RD8]. It could also be used for the ETCS in-built DAS system. It is unknown how the ETCS on-board will receive any information from the Stock and Crew system and what safety or performance implications there may be for ETCS being reliant on an external system. Considering the safety critical nature of ETCS, identifying how the two systems could interact may be a substantial amount of work and thus the specifics of their interaction are considered out of the scope for this document.

Uptake of Stock and Crew systems can depend on a number of factors within an RU including (non-exhaustive): negative benefit to cost ratios, recent investment in similar or partially duplicated systems, size of RU operation etc. This is partially addressed by the Operating Models.

It is unknown whether procurement of the Stock and Crew system would be at an owning group level rather than an individual train or freight operating company.

Different crew Terms and Conditions may be difficult to fully capture and model as part of the system – this information is used for calculation of advisory outputs.

Not all activities in a crew diagram have enough granular detail, particularly if previously constructed in legacy systems. For example:

a)   Walking times between (all) locations.

b)   The amount of time between planned activities that are required Personal Needs Breaks (PNB), which may have a minimum length defined in the crew terms and conditions. For instance, in a diagram, an hour break is shown but the crew is entitled to a 40-minute break and allowed 5 minutes walking time to the train. The remaining 15-minute 'slack' in the diagram needs to be known by the Stock and Crew system to decipher whether diagrams have any manoeuvrability. This can include whether a crew is infringing on required break/rest times or whether the crew are 'available' should they be required for another service.

c)   Which activities could be done in parallel, if allowed under the crew terms and conditions. For instance, taking a PNB whilst travelling as a passenger on a train.

d)   Detail of which service the crew member may be travelling as a passenger.

e)   The distance and anticipated time duration of a taxi transfer.

Current industry procedures and data transfers between the RU and IM are reliant on legacy file formats – for instance, the transfer of timetable and schedule data. Allowance need to be made for new file formats or the current standard modernised. This may require defining a new, industry agreed file format based on what the RU can provide and the IM requires. Support must also be given to new or impending standards or information, such as ETCS compliant driver and service IDs.

5.2   Further Work Identified

Qualification and quantification of potential benefits of the system will need to be undertaken. Depending on the revenue stream, a detailed benefits assessment may be required at an early stage. This aims to make initial quantifications of potential benefits of the system although this would require some initial funding and resources.

Optimisation of the bandwidth between Stock and Crew systems and Traffic Management will be an important consideration and possible constraint.

New LINX message flows may need to be set up to accommodate new data flows.

Details of how stock and crew data is communicated to and used by ETCS and DAS, including C-DAS, will need to be examined.

Activities that are undertaken as part of a diagram may require more granular detail and may require measurement and agreement with crew representative.

Industry procedures and data transfers between the RU and IM are reliant on legacy file formats - allowances need to be made for new file formats or the current standard modernised. This may require defining a new, industry agreed file format based on what the RU can provide and the IM requires. Support must also be given to new standards or information such as ETCS compliant driver and service IDs, for example.

As part of the ConOps, the following interactions with Traffic Management systems have been identified – each require detailed analysis as to what Traffic Management and Stock and Crew systems will do, what LINX messages will need to be developed and which system makes the decision. It is intended to develop the list below into a full appendix with significantly more information in later versions of the ConOps:

−   Are stock and/or crew allocated to a service and can depart?

−   Cancelation of service(s).

−   Alterations to train schedules to avoid conflict(s).

−   Provide train running forecasts.

−   Check if any stock, crew or route restrictions / conflicts apply, should a service be diverted from its booked route.

−   Calculate the impact of non-train running activities to provide better train running predictions (and customer information).

−   What are the impacts on subsequent workings and diagrams should a service be altered?

−   Inform Traffic Management when the Stock and Crew system alters a diagram or train service association.

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5.3 Work Indirectly Identified

For the 'Interface' and 'Real-time Management' Operating Models, how the Stock and Crew system interacts with existing RU systems will need to be ascertained.

Development work on the HMI may be required with the supplier to meet the RUs needs.

Communication methods to RU staff (particularly train crew) will need to be carefully considered but will be RU and supplier dependant.

The RU may require IT changes in order to support the system.

The Operational Scenarios in Section 7 of the Concept of Operations require further development, once the exact methodology within the Stock and Crew system is identified.

PART D: SUPPLEMENTARY INFORMATION

Rail Delivery Group

National Rail

BRITAIN RUNS ON RAIL

6 Definitions and Abbreviations

6.1 Definitions

Advisory

Recommended but not compulsory.

Allocated Diagram

Allocated diagrams show the activities currently assigned to a member of crew or piece of rolling stock on the day. It is possible that as part of a allocated diagram, a member of crew or piece of rolling stock may be assigned parts of several planned diagrams over the course of a day. This can happen in times of disruption or to cover additional services, stock faults or crew sickness. See also 'Diagram'.

Applicable Timetable

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

Controlled area

An area controlled by a Traffic Management system.

DARWIN

Train running information engine, providing real-time arrival and departure predictions, platform numbers, delay estimates, schedule changes and cancellations. It takes feeds directly from every TOC customer information system (CIS), and combines it with train location data provided by the IM. This system is managed by National Rail Enquiries (NRE), part of RDG.

Diagram

Diagrams are planned activities that a member of crew or piece of rolling stock is anticipated to undertake as part of the working day – all diagrams together should cover all planned services. At this point, a specific crew or piece of rolling stock is not yet identified (although the diagram may stipulate a train class). See also 'Allocated Diagram'.

Driver Advisory System (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, linespeed and schedule data. The system may be connected to an external source which can provide updated schedule information (Connected DAS [C-DAS]).

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.

Global System for Mobile Communications – Railway (GSM-R)

GSM-R is an international wireless communications standard for railway communication and applications. A sub-system of ERTMS, it is used for communication between train and railway regulation control centres. It forms an important part of ETCS signalling.

Headcode (Train Reporting Number)

A headcode (or train reporting number) in Great Britain identifies a particular train service. It consists of: a single-digit number, indicating the class (type) of train, a letter, indicating the destination area and a two-digit number, identifying the individual train or indicating the route (the latter generally for suburban services). The headcode may not be unique in a 24hour period and may even repeat over the same route for different services.

Human Machine Interface (HMI)

A Human Machine Interface is the user interface that connects an operator to a computer based system. The interface consists of hardware and software that allow user inputs to be translated as signals for machines that, in turn, provide the required result to the user.

Infrastructure Geography

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

− Track Geography – track centre line, altitude and curvature.

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

− Track Features – asset data, including location of points, stations, location markers, e.g. mileposts, tunnels etc., together with other parameters.

It should also include:

− Linkages (mapping) between Track Geography and Rail Network Model.

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

− 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.

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.

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.

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 a planned schedule or diagram, or include any number of schedule updates.

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.

Timing Point

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

Total Operations Processing System (TOPS)

Used for management and control of vehicles and locomotives, providing time information about location, loading, consignment, condition, etc. of freight vehicles.

Traffic Management

Operational control and information management systems. The train service delivery can be continuously planned with systems allowing prediction of conflicts and real-time timetabling and re-planning as required. This can be directly linked to the automatic setting of routes as part of the signalling system, depending on the type of system implementation.

Train Describer (TD)

A data feed providing details on train positions and their reporting number. Outside of Traffic Management areas, this system could be used to monitor train locations.

Train Describer via Internet (TD.net)

A "publish and subscribe" architecture designed to enable the publication of train-related data. The data includes: train describer (as above), TRUST movement data, Very Short Term Plan (VSTP) schedules, temporary speed restriction data and TRUST incident and delay messages.

Train Running Systems TOPS (TRUST)

Collects information about all train movements and compares this to actual times to those planned in the timetable. The actual train movement events can be both automatically and manually recorded. The historic records of train journeys and delays can be amended for up to one week after the trains run.

6.2   Abbreviations

ATO	Automatic Train Operation
C-DAS	Connected Driver Advisory System
CIS	Customer Information System
ConOps	Concept of Operations
DAS	Driver Advisory System
DfT	Department for Transport
DRP	Digital Railway Programme
ECI	Early Contractor Involvement
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
FOC	Freight Operating Company
GB	Great Britain
GSM-R	Global System for Mobile Communications - Railway
HMI	Human Machine Interface
IECC	Integrated Electronic Control Centre
IM	Infrastructure Manager
IMS	Incident Management System
ITPS	Integrated Train Planning System
LINX	Layered Information Exchange
LTP	Long-term Plan
ORR	Office of Rail and Road
PNB	Personal Needs Break
RDG	Rail Delivery Group
RSSB	Rail Safety and Standards Board
RoSCo	Rolling Stock Company
RU	Railway Undertaking
STP	Short Term Planning
TD	Train Describer
TD.NET	Train Data via Internet
TOC	Train Operating Company
TOPS	Total Operations Processing System
TRUST	Train Running Systems TOPS
TSI	Train Service Information
VSTP	Very Short-Term Planning

7 Related Documents

7.1 References

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[RD3] The Network Code, Part D (July 2017), Network Rail.

[RD4] The Railway Operational Code, Section 1 – Control Arrangements (September 2005) and Section 2 – Emergency Timetabling Procedure in the Event of Extended Disruption, Network Rail.

[RD5] Operators' Handbook (second edition, 2014), Institution of Railway Operators. ISBN 978-1-291-73510-9.

[RD6] Digital Railway Programme – Migration State M9 Concept of Operations (Issue 2, July 2017), DRD/00000/DRP2/SPE/100031.

[RD7] Digital Railway Programme – Stock and Crew Digital Railway Ready Specification (version 1.1, June 2017).

[RD8] Operational Concept for ERTMS (Issue 2, 2014), Rail Safety and Standards Board (RSSB).

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[RD10] Rail Delivery Group Concept of Operations – Stock and Crew System (Issue 1.0, April 2018), RDG-CONOPS/NTI/002.

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