Rail Delivery Group

National Rail

Concept of Operations – Stock and Crew System

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PART A:
INTRODUCTION

Rail Delivery Group

National Rail

1 Purpose, Objectives, Rationale and Scope

1.1 Purpose

1.1.1 The Stock and Crew system proposed in this concept of operations aims to bring benefits to the industry by:

- improving recovery time from disruption,
- improving the customer experience,
- digitising some current practices, procedures and communications,
- improving day-to-day operations,
- 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.

1.1.2 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.

1.1.3 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.

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

1.1.5 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.

1.1.6 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 this Concept of Operations.

1.1.7 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 aims to promote and advance the development and eventual deployment of Stock and Crew systems.

1.1.8 This document provides a high-level description of a Stock and Crew system which intends to meet the aims listed in 1.1.1. 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.

1.1.9 Essentiality of different Stock and Crew system capabilities identified in this document are defined in an associated document also published by RDG – the Common System Capabilities report [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. The Common System Capabilities document defines whether a capability is a: 'short-term must have', 'long-term must have', 'nice to have' or 'long term aspiration'. This can be used by RUs to begin tailoring potential systems towards their specific business needs and informs suppliers on potential customer priorities.

1.1.10 As a Concept of Operation, this document does not attempt to provide solutions or specify system, operational or technical requirements – it describes a green field, utopian operating environment and is intended to be technology and supplier agnostic.

1.2 Objectives

1.2.1 This document intends to:

- Provide a common vision of Stock and Crew system operation in GB,
- Describe the operational environment that the Stock and Crew system is part of including a high-level description of potential system boundaries and interfaces,
- Identify potential users of the system and how they could interact with it,
- Provide context for the potential supplier(s) of Stock and Crew systems,
- Identify information or other systems which may benefit from data managed by the Stock and Crew system, and likely required interfaces,
- Describe operational scenarios and activities involved in system use,
- Provide a system overview for the industry and supply chain,
- Describe outputs expected from RUs, to provide a common understanding to the supply chain,
- Inform the development of Stock and Crew System Outcome Specifications,
- Provide information relevant to (but not limited to) the following:
  - Railway Undertakings (RU), i.e. passenger Train Operating Companies, Freight Operating Companies and rail owning groups,
  - Infrastructure Managers (IM), e.g. Network Rail, High Speed 2 (HS2).
  - System suppliers and system integrators,
  - Department for Transport (DfT) and other governmental funders or service specifiers,
  - Rail Delivery Group (RDG),
  - Rail Safety and Standards Board (RSSB),

- Office of Rail and Road (ORR),
- Rolling Stock leasing Companies (RoSCos) and other vehicle owners,
- Rolling stock maintenance companies and providers.

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

1.3 Rationale

1.3.1 A Stock and Crew system can bring benefits to today's operations by increasing and streamlining existing processes, improving availability of up to date information and connecting systems and data together. This can provide one version and single source of the truth.

1.3.2 The development and deployment of a Stock and Crew system, with the capability to communicate with Traffic Management systems, brings additional benefits to the industry. Deployment of Traffic Management without a Stock and Crew system remains reliant on retaining some of the existing manual communications and processes. This has the potential to severely limit benefits, particularly during service recovery.

1.3.3 The benefits and deployment of Traffic Management systems provides an opportunity to agree and prescribe operators' required outputs of Stock and Crew systems to enable a discussion with the wider industry and supply chain as to how these outputs may be met. This can then inform further development and deployment of Stock and Crew systems.

1.3.4 The table below summarises a number of perceived benefits of a Stock and Crew system, some of which were collected during RDG workshops with RUs and endorsed by the Digital Railway Early Contractor Involvement Programme (Stock and Crew Workstream). How the perceived benefit might be measured is also shown. Qualification and quantification of these perceived benefits of Stock and Crew systems, and further benefits not mentioned here, form part of the construction of business cases.

Perceived benefit	How the benefit may be measured
Improved customer experience	– Reduction in delays – Fewer missed connections – Improved customer information – Enhanced train running prediction information – Improved National Rail Passenger Survey scores – Increased customer advocacy – Fewer complaints – Increase in positive social media sentiments – Increased revenue and repeat custom – Increase in customer numbers
Improved staff engagement, welfare and understanding of the business.	– Improved staff survey results – Reduced sickness/ work related illness – Reduced staff turnover – Greater confidence in plans – fewer plans altered or rejected by the IM – Increased user-friendliness and efficiency of workflows and processes making activities faster and goals achieved earlier

Better control of unplanned staff costs	– Reduction in overtime costs – Reduction in fuel costs, diesel and electrical current for traction (EC4T)
Better operational performance	– More quickly allocate stock and crew to services – Reduction in delay minutes – Reduction in full and part cancellations – Improved performance statistics – Reduced delay-repay costs – Reduction on 'TOC-on-self' delay payments – Reduction in 'wrong route set' incidents with stock or crew constraints involved – Enhanced conflict resolution advice from Traffic Management systems
Increased industry revenue	– Increased farebox revenue – Increased customer numbers
Improved consistency in delivery	– Improved recovery time from incidents and perturbations – Faster decision making – Fewer 'bad days' – Fewer delay minutes per train per incident – Reduction in 'planning errors'
Reduced reliance on legacy systems	– Decreased prevalence of legacy systems – Reduced IT costs – Reduction in paper usage and environmental impact
Increased commonality and usability in business systems – a common Human Machine Interface for different departments	– Fewer IT systems and reduced licencing costs – Reduced system compatibility issues – Reduction in staff time spent on menial tasks – Increased time spent on day job rather than 'battling systems'
Enabler for other new systems	– Number of staff using new systems – Amount of digitised data feeding other systems – Amount of further innovation
Capability to; simulate, learn lessons, capture best practice	– Increased and improved data quality for use from long-term planning to post-incident reviews – Digitised, richer data with improved statistics and monitoring in comparison to legacy methods

1.4 Document Scope

1.4.1 This document provides a high-level description of a Stock and Crew system capable of interacting with other systems, such as Traffic Management. It intends to explain how the system may be used, establish how the railway may operate in the future and what the industry wants and needs may be in that environment.

1.4.2 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 how certain roles within the industry may interact with a Stock and Crew system.

1.4.3 Section 5 details that 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 document scope is expanded to include these.

1.4.4 As the document only intends to provide a high-level description of the system, 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) The specific method by which staff communicate to crews,

h) 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.

1.4.5 Section 4.3.1 and Appendix A.3 summarise interactions between Stock and Crew systems and Traffic Management systems. Current thinking suggests that the Stock and Crew system provides sets of relevant information to Traffic Management systems at the start of service – messages are then passed between the systems as data is updated. This information is provided to Traffic Management either for note or to make simplistic calculations / Boolean responses. It is projected that an eventual utopian state will be Traffic Management systems using stock and crew information 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. For more complex situations, a bid-offer process between the systems is used such that the legal obligations of both RUs and IMs is respected. 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.

1.4.6 This document has been written to take into account the conceptual operation of the following systems, although assumes that they are not deployed over all areas of the rail network and, as such, makes allowances for where these systems will not be operating (see assumption 3.2.14). This was previously described as ‘Digital Railway Migration State 9’ [RD6].

- Traffic Management.
- European Train Control System (ETCS).
- Connected Driver Advisory Systems (C-DAS).
- Incident Management System (IMS).

2 Context

2.1 Current Railway Operations

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 Stock and Crew system which also has the potential to connect to Traffic Management or signalling systems.

2.1.2 To understand how planning and alterations of services are undertaken, a simplified, conceptual level model of an RU's current workflow was created – this is shown in Figure 1 below. This visualises the connections between planning, resourcing and controlling the operational railway, the order in which activities are completed and where feedback is provided. It also highlights where the RU is connected to external systems. It is from this diagram that the concept is built.

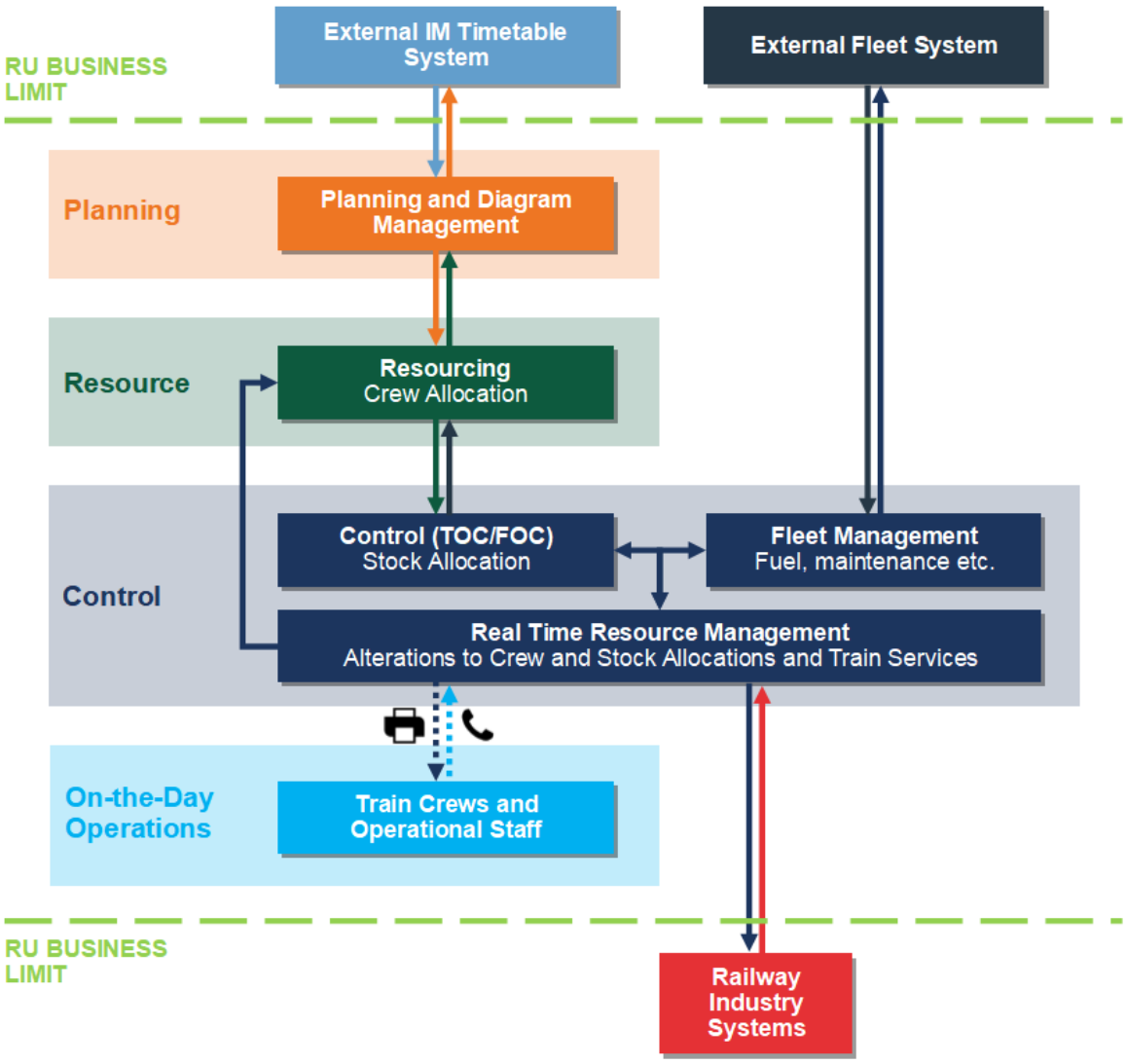

Figure 1: Simplified current railway operations and practices – indicative of information flows.

2.1.3 The **External IM Timetable System** is a planning and publication system that produces timetable information. It contains train schedules, train associations and details of timing point locations and their associated location code. At the time of writing, this is the Integrated Train Planning System (ITPS).

Planning:

2.1.4 Incorporates long term (LTP) and short-term planning (STP) of timetables and stock and crew diagrams. A diagram is a list of planned activities that a member of crew or rolling stock is expected to undertake, based on available resource. At this stage, specific members of crew or rolling stock are not identified – these are assigned at Resourcing and/or Control.

2.1.5 All diagrams together should cover all services that the RU plans to run over a period of time.

2.1.6 Long term planning incorporates timetable changes up to 26 weeks before the day of operation and involves bidding to the IM for paths on the network [RD3]. Paths that the RU have bid to use are checked and validated by the IM for availability (capacity constraints) and conflicts with other RU's services. The IM can accept or alter the path before offering the path back to the RU. The RU can then accept the offered path or alter their bid for a path to satisfy the IM. For RUs, long term alterations can involve adjustments to meet customer demands and needs. Note that the planning of some services, platforming and diagrammed activities may occur post 26 weeks before the day of operation.

2.1.7 Short-term planning incorporates alterations to the long-term plan usually within the 'informed traveller timescales' of 30-12 weeks before the day of operation (for passenger services) [RD3], but can manage alterations up to the day before.

2.1.8 On the day of operation, changes are managed by Control and the Very Short-Term Planning process (see below).

Resourcing (Prior to the day of operation)

2.1.9 Includes the management of links for each depot and assigning crews to diagrams / rosters. A link is a subdivision of crews within a depot that are based on route knowledge, competencies and Terms and Conditions. These will generally be aligned to diagrams, as described in 2.1.4.

2.1.10 A roster for each link is created for each depot which cover a pattern of shifts to be worked by crews in each link. As part of the rostering, planned diagrams (created at the planning stage above) are assigned to crews.

Control and Resourcing on the day of operation

2.1.11 RU control and resource offices manage service delivery and can be separate, co-located or integrated with an IM Control. This can include the live management of train services, staffing, fleet management, operational perturbations, very short-term planning and stock and crew allocation changes. A list of responsibilities and tasks for a control office can be found in section 6.9 of the Institution of Railway Operators: Operators' Handbook [RD5]. An essential interface in Control is with fleet managers/engineers, irrespective of whether fleet maintenance is undertaken by the RU or by an external company (e.g. train manufacturer). In a Control environment and when stock is allocated to diagrams, Fleet will consider parameters relating to: the depot, maintenance plan requirements, train plan requirements replenishment of consumables (fuel, water etc.) and critical facilities and alternatives. These factors are critical when planning alterations to the train service during times of disruption. Many of these parameters are contained in a 'Rules of the Depot' document for each RU. It is possible that Fleet will continue to use some external systems after implementation of a Stock and Crew system, particularly when maintenance is undertaken by an external company. Other systems could also include the Train Coupling Compatibility Matrix (TCCM) and R2.

2.1.12 'Industry systems' referred to in this document can include (non-exhaustive):

- External IM Timetable System – as described in 2.1.3.
- 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.
- 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 automatically and manually recorded. The historic records of train journeys and delays can be amended for up to one week after the trains run. Train consist information (including unit and coach numbers) is also available.
- GEMINI – contains details of multiple unit and locomotive-hauled passenger rolling stock. Data is passed via an open interface and allows engineers, rolling stock and performance managers to examine information about their vehicles without the need to access individual, 'lower level' systems – the data is fed directly to GEMINI. This has the advantage of allowing users in other businesses to track the whereabouts of particular vehicles (for maintenance purposes) or to establish the vehicles working a particular service.
- 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 operators' customer information system (CIS), and combines it with train location data provided by the IM. This system is managed by National Rail Enquiries, part of RDG.
- 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. Communication with Traffic Management is undertaken using the Layered Information Exchange (LINX).
- Signalling software – modern signalling software, which may not have the full capabilities of Traffic Management but can be developed, or is advanced enough, to communicate with other railway systems such as Stock and Crew. The software is in control of all signalling and points (interlocking) within its area of operation.
- Train Describer (TD) – a data feed providing details on train positions and their reporting number.
- Train Data 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 Service Information (TSI) and Train Service Information Access System (TSIA) – a database of train schedules formatted for use by train operations systems and is updated daily with information from Train Service Data Base. TSI holds all the train schedules to be used by TRUST and related systems – information is passed forward to TRUST. The user interface to TSI is TSIA.

- R2 – a database for rolling stock registration, maintenance planning and component tracking, managed and owned by the RSSB. R2 is a replacement for two systems – the Rolling Stock Library (RSL) and the Rail Vehicle Records System (RAVERS).

- Control Centre of the Future (CCF) – a control system that integrates all train running monitoring functions and provides a map based display of current and historical train running information. Data is collected from Train Describers, compared against schedules, and displayed on a map.

- External Fleet Management Systems – software that may be required by a train's manufacturer or leasing company and could contain significantly more detail about stock than the Stock and Crew system. This is particularly relevant where all stock maintenance is managed by external companies, outside of the RU.

2.2 RDG Stock and Crew System Support

2.2.1 To further develop Stock and Crew systems and support the industry, the RDG has completed the following actions, which were agreed by a number of governance groups with TOC, FOC and Network Rail attendance:

- Research current TOC/FOC systems and summarise in a report.

- Collate all existing Stock and Crew requirements into one document.

- Hold a series of TOC/FOC workshops to validate/compile a suite of agreed operator outcomes and identify possible roles impacted.

- Produce a Stock and Crew system Concept of Operations.

- Produce a Stock and Crew Common System Capabilities document.

- Hold a series of Supplier Showcase events where Stock and Crew System suppliers demonstrated their system capabilities to train operators.

- Facilitate and coordinate a Task and Finish Group, producing a report to address:

  - Interactions with Traffic Management,

  - Additional LINX messages,

  - Interfaces with other systems,

  - Legacy file formats,

  - Who owns the interface requirements etc.

- Update the Concept of Operations to take cognisance of the Task and Finish Group conclusions and recommendations (ConOps version 1.1 upwards).

PART B:

CONCEPT OF OPERATIONS

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3 Assumptions

3.1 Introduction

3.1.1 The assumptions listed below document the context in which Stock and Crew systems operate and identifies other systems that interact with them.

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

3.2.2 Information transfer time between systems is minimal.

3.2.3 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.

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

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

3.2.6 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.

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

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

3.2.9 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.

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

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

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

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

3.2.14 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.

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

4 Principles

4.1 Introduction

4.1.1 In this section, a high level, outline of the concept is presented which summarises the aims of the concept and behaviour of the system at a basic level. It describes the philosophies on which Stock and Crew systems function (as opposed to the previous section, assumptions, which describe how other systems / real world are idealised).

4.2 System Principles

4.2.1 The Stock and Crew system can understand the current and planned schedules and diagrams for all RU stock and crew.

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).

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.

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.

4.2.5 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. 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’).

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)

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.

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.

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.

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.

4.2.11 Industry systems can utilise stock and crew data managed by the Stock and Crew system (see section 4.3).

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).

4.2.13 Data can be easily interpreted and modified by the system user via the HMI.

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. This can include:

a) Creation of Very Short-Term Plan (VSTP) forms with auto-population of fields and autogenerated emails / electronic transfer. An example VSTP form is shown in Appendix A.1.

b) Assistance with updates for the Control Centre Incident Log (CCIL). This might include autocompletion of service details from shorter strings of text (like train headcode).

c) Logs of changes made to any stock or crew allocations.

d) Any forms required for Special Stop Orders or Station Skips.

4.2.15 Communication to stakeholders is made using information from the Stock and Crew system. Stakeholders can include:

a) Train crew,

b) Station staff,

c) Customers,

d) The Infrastructure Manager (e.g. Network Rail, High Speed 2 etc),

e) Depots and third-party maintenance providers,

f) Roster Teams,

g) Payroll,

h) Other RUs.

4.2.16 The Stock and Crew system is reliable and available to support the operational demands made of it.

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).

4.2.18 When the Stock and Crew system loses communication with industry systems, the system user is alerted.

4.2.19 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).

4.3 Interaction with Railway Industry Systems

4.3.1 Traffic Management

4.3.1.1 Traffic Management is not essential to the functioning of a Stock and Crew system.

4.3.1.2 The user experience of a Stock and Crew system is similar whether or not Traffic Management is present in the RU's operating area.

4.3.1.3 A Stock and Crew system can interact with one or more Traffic Management system(s). So that interactions are consistent, information between the systems can be passed via the Layered Information Exchange (LINX) – a list of current LINX messages can be found in Appendix A.2. Process Maps of how these systems interact can also be found in Appendix A.3.

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). 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. *See Process Map 3.04 and Path Details or Path Not Available messages).*

4.3.1.5 Changes to schedules made within Traffic Management are automatically communicated to relevant Stock and Crew systems for RU assessment (see 4.3.1.13). This can include:

a) Predicted / actual arrival times at a location (Train Running Information and Train Running Forecasts),

b) Train routing information,

c) Very Short-Term Plan (VSTP) Path Details,

d) Current Plan Path Details, including Train ID changes,

e) Train journey modifications and / or interruptions,

f) Changes to routing / track, including changes to platform.

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.

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 (crew association information). 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.

4.3.1.8 Traffic Management systems can utilise data provided by the Stock and Crew system to authenticate some routing decisions. These queries can include:

a) Whether the stock forming a certain service can travel via the planned route or via another route / platform than that planned.

b) Whether the crew has the relevant route knowledge for an altered routing.

c) Whether the train is ETCS and/or ATO fitted, where required by the route.

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.

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.

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.

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 *(Train Ready To Go messages)*.

4.3.1.13 Where change(s) to train schedule(s) are proposed by the Traffic Management System, the RU / Stock and Crew System assesses the path modification / request (see Process Map 2.02) and can:

a) Accept the path without further modification *(Path Accepted message)*,

b) Suggest an alternative (see Process Map 3.03, Stock and Crew System Path Modification), or,

c) Reject the path *(Path Rejected message).*

4.3.2 Signalling Software

4.3.2.1 Modern signalling software based on Visual Display Units (VDUs), which may not have the full capabilities of Traffic Management, can also make use of Stock and Crew data, if reconfigured.

4.3.2.2 As per 4.3.1.3, Stock and Crew systems can interact with more than one signalling location.

4.3.2.3 Signalling systems can provide the Stock and Crew system with train location information, if desired by the RU.

4.3.2.4 As per 4.3.1.8, the signalling software can utilise stock and crew data to authenticate some routing decisions.

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.

4.3.3 Driver Advisory Systems (DAS)

4.3.3.1 The Stock and Crew system can provide schedule updates to RU DAS Trackside Systems (which in turn feed on-board units) where the RU either:

- utilises Standalone or Networked Driver Advisory Systems (S-DAS, N-DAS), or,

- does not have a Traffic Management system in its operational area.

4.3.3.2 For Connected Driver Advisory Systems (C-DAS), schedule and routing updates originate from Traffic Management systems. However, the RU may also connect the Stock and Crew system to the RU DAS Trackside so that updates can be provided outside the Traffic Management area (akin to 4.3.3.1), if it wishes.

4.3.4 TOPS / TRUST

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.

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).

4.3.5 DARWIN

4.3.5.1 Stock and crew data that is of use to customers is available to be utilised by DARWIN.

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.

4.3.6 Train Data via Internet (TD.net)

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 areas not covered by Traffic Management system(s).

4.3.7 European Train Control System (ETCS)

4.3.7.1 Stock and Crew systems do not interface with ETCS directly (trackside or on-board).

4.3.8 Automatic Train Operation (ATO)

4.3.8.1 Should an RU choose, Stock and Crew systems can connect, and provide information to, ATO Trackside systems. This is of particular relevance in areas where Traffic Management systems are not available as these generally provide updates to the ATO Trackside.

4.3.8.2 Where Traffic Management systems are not available, the Stock and Crew system can provide the ATO Trackside with information regarding; additional stop orders, not to stop orders, part-cancellations and operational re-timings (that are within the gift of the RU).

4.3.9 Incident Management System (IMS)

4.3.9.1 Data and information published by Incident Management Systems is consumed by Traffic Management Systems before being republished for consumption by Stock and Crew Systems. Information consumed by Stock and Crew Systems may include:

- Emergency and Temporary Speed Restrictions (location, restriction speed (in mph or km/h), restriction applicability times / dates.
- Asset Status
- Emergency Possessions
- Possessions (Actuals)

4.3.9.2 For areas which are not covered by Traffic Management Systems, the RU can subscribe directly to information provided by IMSs. This may include positions / extents of line blockages or possessions, or incident resolution timescales.

5 Operating Models

5.1 Introduction and Rationale

5.1.1 Three different operating models are proposed for a Stock and Crew system:

a) An ‘Interchange’ Stock and Crew system,

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

c) An ‘Integrated’ Stock and Crew system.

5.1.2 Three operating models are 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.

5.1.3 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.

5.1.4 All three operating models proposed follow the concepts defined in section 4. As such, the interactions with industry systems (such as Traffic Management) are comparable irrespective of the RU’s chosen operating model.

5.1.5 The remainder of section 5 and section 6 describe and examine the differences between the different operating models.

5.2 'Interchange' Stock and Crew System

5.2.1 Conceptual system boundaries for an 'Interchange' Stock and Crew system are shown in figure 2, which references figure 1 in section 2.1.2 – a high level schematic of the current planning, resourcing and control workflow in today's railway. The red dotted line depicts the conceptual system boundary.

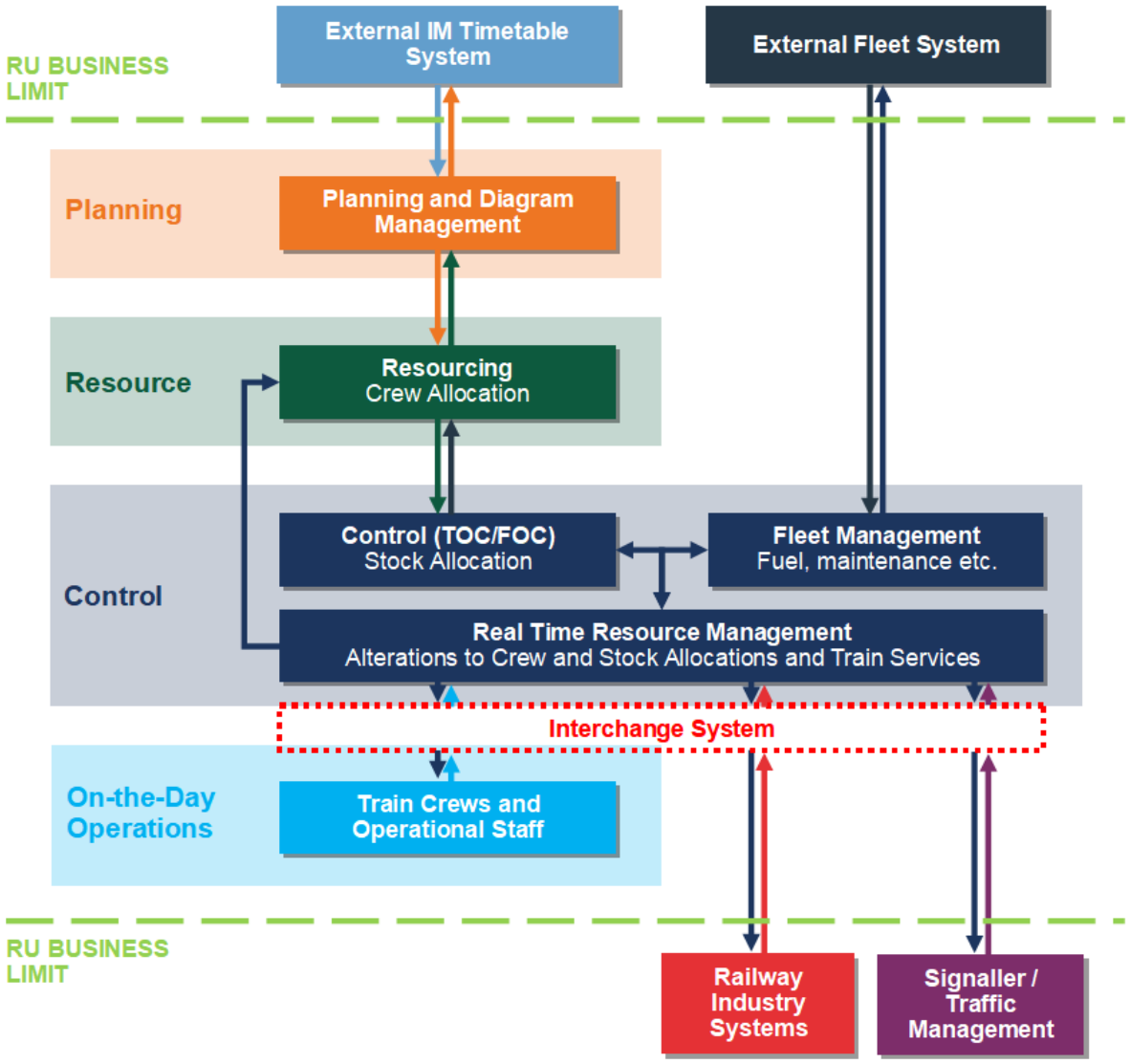


Figure 2: Interchange Stock and Crew system with system boundaries highlighted.

5.2.2 An 'Interchange' Stock and Crew system consumes data from existing crew, control and fleet management systems and can present it to users of the Stock and Crew system on a unified HMI, common to both controllers and fleet management. This data can be modified via the HMI, with changes passed back to the original source - existing control and fleet management systems (see 4.2.9).

5.2.3 An 'Interchange' Stock and Crew system can replicate functions available within existing control and fleet management systems.

5.2.4 Data consumed and/or modified by the 'Interchange' Stock and Crew system can be passed onwards to industry systems, including Traffic Management systems either automatically or by operator request (see 4.2.10). Data received back from industry systems can be presented to the user and/or automatically passed on to the original source systems (see 4.2.9 and 4.2.11).

5.2.5 Queries raised by industry systems are responded to by the 'Interchange' Stock and Crew system, which may need to query the original source if information is not stored persistently.

5.3 'Real-time Management' Stock and Crew System

5.3.1 Conceptual system boundaries for a 'Real-time Management' Stock and Crew system are shown in figure 3, which references figure 1 in section 2.1.2 – a high level schematic of the current planning, resourcing and control workflow in today's railway. The red dotted line depicts the conceptual system boundary.

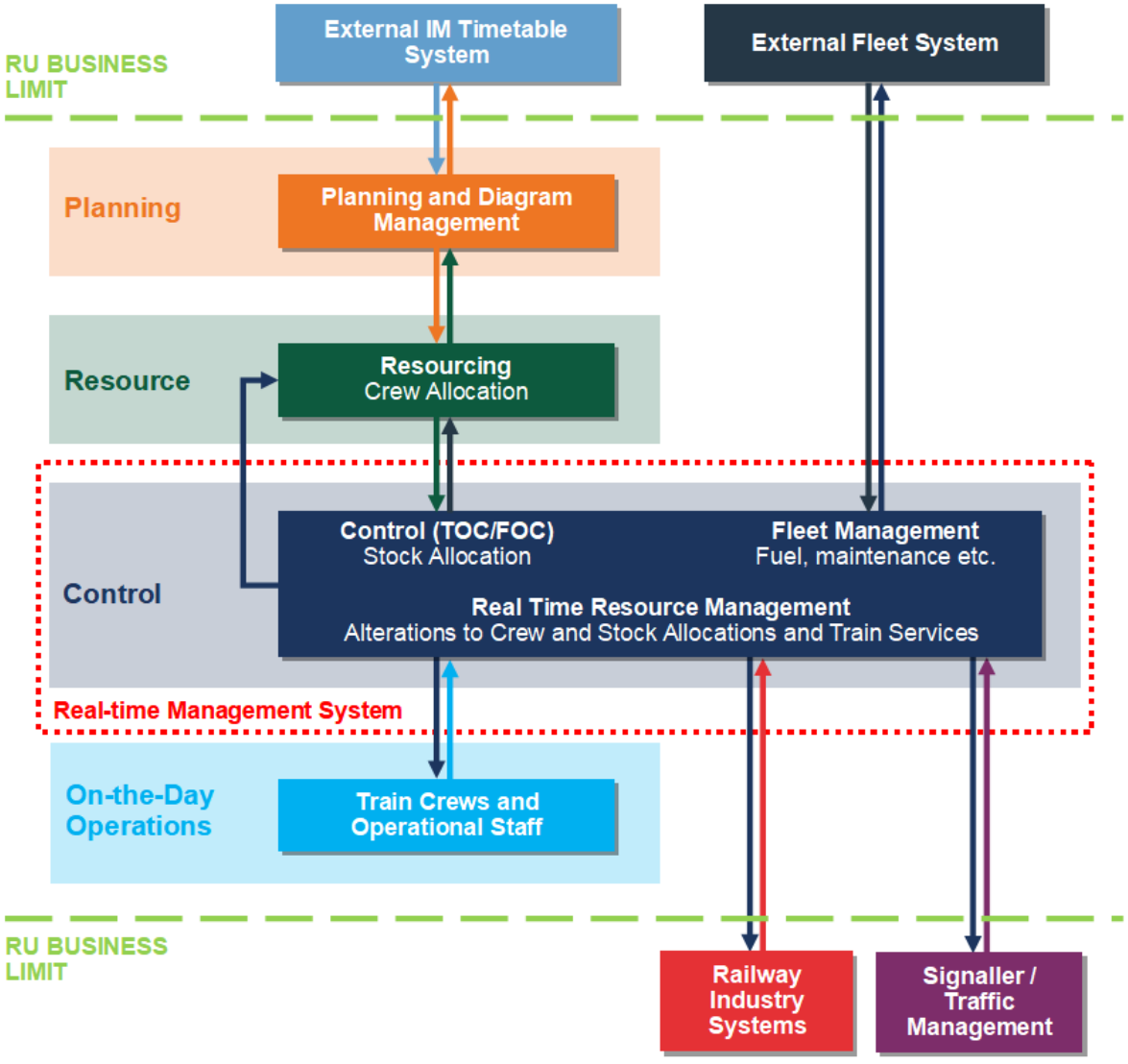


Figure 3: Real-time Management Stock and Crew system with system boundaries highlighted.

5.3.2 A 'Real-time Management' Stock and Crew system is a combined control and fleet management software which can communicate with existing planning, resourcing and other fleet maintenance systems as well as industry railway systems, as per principle 4.2.10.

5.3.3 A ‘Real-time Management’ Stock and Crew system consumes data from existing planning, resourcing and fleet maintenance systems and utilises it for internal functionalities relating to the running of a train service.

5.3.4 Data is presented to users of the system on a unified HMI, common to both controllers and those handling fleet maintenance.

5.3.5 Any alterations to data in the Real-time Management Stock and Crew system are made in conjunction with the original source (resource and fleet systems).

5.3.6 Feedback loops are available to consider longer term alterations to the source data held in existing planning, resourcing and fleet systems (see 4.2.9).

5.3.7 Data managed by the ‘Real-time Management’ Stock and Crew system can be passed onwards to industry systems, including Traffic Management systems either automatically or by operator request (see 4.2.10). Data received back from industry systems can be presented to the user and/or used to modify control data held by the system (see 4.2.9 and 4.2.11). If appropriate, data modifications can be communicated to existing diagramming resourcing and fleet systems.

5.3.8 Applicable queries raised by industry systems are responded to by the ‘Real-time Management’ Stock and Crew system only.

5.4 'Integrated' Stock and Crew System

5.4.1 Conceptual system boundaries for an 'Integrated' Stock and Crew system are shown in figure 4, which references figure 1 in section 2.1.2 – a high level schematic of the current planning, resourcing and control workflow in today's railway. The red dotted line depicts the conceptual system boundary.

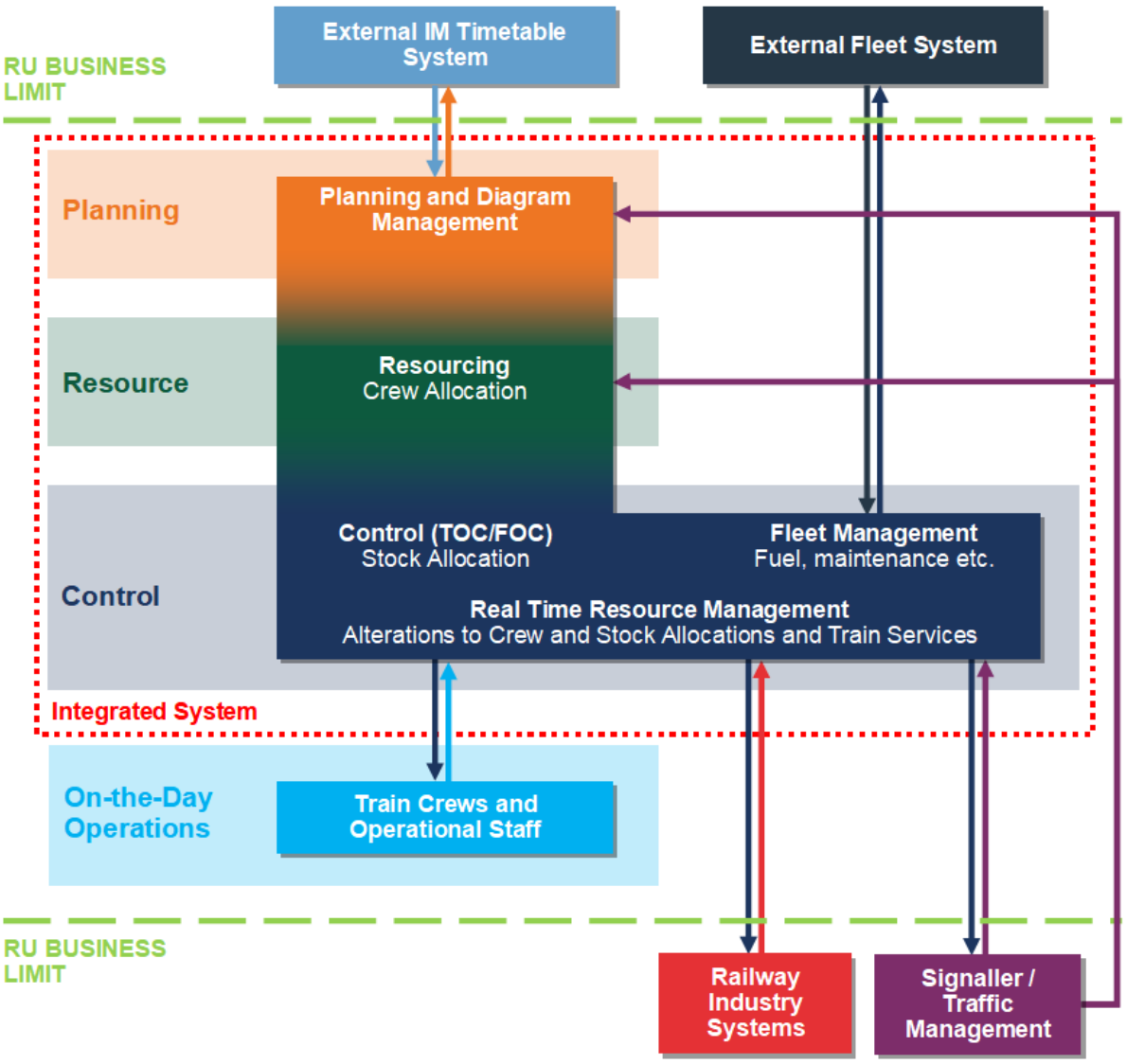


Figure 4: Integrated Stock and Crew system with system boundaries highlighted.

5.4.2 A 'Integrated' Stock and Crew system encompasses all planning, resourcing and control elements and can communicate with and consume data from: the IM external timetable system (at the time of writing, ITPS), existing fleet systems and industry systems, as per principle 4.2.10.

5.4.3 As an integrated system, data is more easily accessible and transparent between departments (planning, resourcing and control). As data is already stored within the system, importing and exporting times are minimal and the transfer of data can be convenient and prompt.

5.4.4 A unified operating environment and HMI is presented to all users of the system across the RUs business. This incorporates (non-exhaustive): train planners, resource clerks/managers, train running controllers and fleet managers.

5.4.5 Any alterations to data, if required, can be passed back to the original source (existing fleet systems and the External IM Timetable System) should they be of benefit to those systems (see 4.2.9).

5.4.6 Data generated by the 'Integrated' Stock and Crew system can be passed onwards to industry systems, including Traffic Management systems either automatically or by operator request (see 4.2.10). Data received back from industry systems can be presented to the user and/or used to modify any data held by the system (see 4.2.9 and 4.2.11).

5.4.7 Applicable queries raised by industry systems are responded to by the 'Integrated' Stock and Crew system only.

5.5 Summary

5.5.1 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 Operational 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	✗	✗	✓

6 Operational Concept

6.1 Data for use by the system

6.1.1 The following data listed can be of use to the Stock and Crew system and is applicable to all operating models unless otherwise stated. The concepts are organised into:

- Longstanding stock and crew details,
- Crew competency details,
- Route details,
- Stock and crew diagrams details,
- Stock diagram details after stock is allocated,
- Crew diagram details after crew is allocated,
- 'On the day of operation' stock and crew details.

6.1.2 Longstanding stock details contained in the Stock and Crew system can include (non-exhaustive):

a) Unit class and number, weight, length, number of vehicles, gauge (to related to route availability), passenger capacity, tilt fitted and maximum speed.

b) Power modes available (diesel, AC, DC, bi-mode).

c) R2 data including status, service entry data, date registered, category.

d) Coupler type, defect and compatibility with different traction types (in and out of service) – related to the Train Coupling Compatibility Matrix (TCCM).

e) Typical timing load and train performance characteristics (braking and traction parameters and resistance coefficients).

f) Global System for Mobile Communications – Railway (GSM-R) fitment details including which software version is installed.

g) European Train Control System (ETCS) fitment details and to which baseline. ETCS level capability is also known.

h) Driver Advisory System (DAS) fitment details, including type of DAS (standalone, networked or connected).

i) Automatic Train Operation (ATO) fitment details, including to what level of automation.

j) Passenger facilities fitted.

k) Accessibility and passenger assistance requirements.

l) Whether selective door operation (SDO) or unit deselect is fitted.

m) Whether a corridor connection allowing transfer between trains is available.

n) Number of cycle spaces fitted (if applicable).

o) Exam and maintenance details and allocation to avoid the operator allocating stock to a diagram which will breach exam/maintenance requirements.

p) Defect records: record ID, code, criticality (including rule book reference), report location, description of the defect, status of the defect.

q) Cleaning requirements.

r) Effluent removal and water refilling requirements, where applicable.

s) Responsible RU.

6.1.3 Longstanding crew details contained in the Stock and Crew system can include (non-exhaustive):

a) Crew name.

b) Crew member role.

c) Crew member ID (this may be a composite of several bits of data including a Driver ID compatible with ETCS systems or payroll number).

d) Crew contact information.

e) Crew member home depot.

f) Crew Link membership, as defined in 2.1.9.

g) Responsible RU.

h) Copy of applicable Terms and Conditions for reference.

i) Current Train / traction type competence – related to 6.1.4.

j) Current route knowledge – related to 6.1.4.

6.1.4 Crew competency details can be managed in the Stock and Crew system. This can include:

a) A record of crew competency (route, traction knowledge and Link).

b) Updating crew competency in real-time as they pass over routes.

c) A Learning Management System (LMS).

6.1.5 Details of the routes that are served by the RU (including diversions) contained in the Stock and Crew system can include:

a) Infrastructure Geography, Network Model, maximum linespeed and permissible speeds.

b) The most recent copy of the Sectional Appendix relevant to the all areas served by the RU (including diversion routes).

c) Limits of electrification (overhead or third-rail) or where diesel / steam trains are not permitted or restricted. This might also include typical power changeover points.

d) Route availability and gauging.

e) Platform restrictions (e.g. stock and length).

f) Route restrictions including temporary restrictions such as electric sections that are isolated during an incident or line possession.

g) Definition of areas over which Traffic Management systems control.

h) Definition of Network Rail Route boundaries.

i) Definition of areas where ETCS signaling is in operation and to which baseline the trackside infrastructure is fitted to. Whether conventual signaling systems are also available is also shown.

j) Definition of areas where ATO is available and to which grade of automation.

k) Definitions of areas where tilt functionality is available.

l) Depot and stabling locations.

m) Locations where trains can be turned around / reversed.

n) Platforms where permissive working is available.

o) Approved crew relief locations.

p) Cleaning locations.

q) Effluent removal and water refilling locations, where applicable.

6.1.6 The Stock and Crew system can distinguish between diagrams and diagrams with resources allocated (allocated diagrams). 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). Examples of both stock and crew diagrams are shown in Appendix A.1. ‘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 an 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.

6.1.7 Stock diagram details in the Stock and Crew system can include:

a) The unique stock diagram ID.

b) Dates and days over which the diagram is applicable.

c) Traction type and/or suitable traction class allotted (timing load).

d) Start and finish locations and times with applicable working day duration and distance covered.

e) A schedule of the day’s activity (and following day if applicable/available).

f) Applicable Operational Train Number (headcode) for each service – this could be both the legacy UK alpha-numeric train running numbers and the all numeric format required by ETCS.

g) A summary of stopping patterns, via locations and termination points.

h) Route clearance required to cover the diagram.

i) Details of stock which is only allocated for part of the journey – time and location of allocation / deallocation and to which end of the stock any coupling/uncoupling takes place.

j) Planned number of carriages and set length / wagons for each part of the journey.

k) Points at which the train is planned to be refueled (if applicable).

l) Whether SDO or unit deselect is required to operate a service (see 6.1.2).

m) Whether ATO capability is required and/or planned to be used in service.

n) Whether dangerous goods are planned to be carried.

o) Whether the service is subject to any RT3973 restrictions (advise to train crew of exceptional load).

p) Whether a service is a non-standard train (Royal Train for example).

q) Essential (primary) members of staff required to run a particular service.

6.1.8 Crew diagram details in the Stock and Crew system can include:

a) The unique crew diagram ID (including to which depot the diagram belongs).

b) Job role.

c) Dates and days over which the diagram is applicable.

d) Start and finish locations and times with applicable working day duration.

e) Traction type and/or traction class knowledge required (and assigned).

f) Route knowledge required to cover the diagram.

g) A schedule of activities for the day, including:

- When and where the crew will change over or ‘relieve’ another member of train crew (identified by diagram ID).
- When and where the crew will change over or be ‘relieved’ from a service and by who (diagram ID).
- Details of crew members (primary and secondary) also working on the train. This can also include crew members travelling as a passenger.
- Expected rolling stock for the individual service that they will operate.
- Applicable Operational Train Number (headcode) for each service – this could be both the legacy UK alpha-numeric train running numbers and the all numeric format required by ETCS.
- Details of services on which the crew will be travelling as a passenger.
- Services where the crew are: being route conducted, route conducting, route refreshing/learning or ‘travelling and assisting’.
- Train movement specific instructions, including: reversing movements, changing ends of the train, train preparation, attach/detaching movements.

- Scheduled break times (including personal needs breaks) and expected location. The minimum agreed break period is also shown.
- Whether the crew is travelling by taxi to another location.
- Whether lodging is required.
- Important notes relating to the diagram.

h) A summary of stopping patterns, via locations and termination points.

i) Details of stock which are only allocated for part of the journey – time and location of allocation / deallocation and to which end of the stock any coupling/uncoupling takes place.

j) Timing details of non-train running activities, to assist in the creation of diagrams and predicting minimum turnaround times in times of disruption (see 6.2.23). This can include, but is not necessary shown to crew:

- Disembarkation / embarkation of crew (and customers) timings,
- Customer notification and walking time / distance to platform,
- Train preparation time (including seat reservations etc.),
- Loading of supplies,
- Cleaning time,
- Crew walking / travelling time to train from anticipated location,
- Train disposal time.

k) Essential (primary) members of staff also required to run a particular service. A summary of non-essential (secondary) members of crew can be shown.

l) Whether dangerous goods are planned to be carried.

m) Whether a service is a non-standard train (Royal Train for example).

6.1.9 Stock diagrams (with stock allocated), in the Stock and Crew system can include, beyond those details listed in 6.1.7 which are assumed to be updated as appropriate:

a) Details of the crew assigned to each service.

b) Notes as to which diagram each activity is referenced from.

c) Whether dangerous goods are being carried.

d) The last time data was updated.

6.1.10 Crew diagrams (with crews allocated) in the Stock and Crew system can include, beyond those details listed in 6.1.8 which are assumed to be updated as appropriate:

a) Details of the stock assigned to each service.

b) Notes as to which diagram each activity is referenced from.

c) Summary of stopping patterns, termination points and relief locations for each service to be operated by the member of traincrew.

d) Other activities as part of the diagram. This can include passenger assistance requirements (if known in advance).

e) Summary of engineering works and / or possessions, if appropriate and known (for advice only).

f) Whether dangerous goods are being carried.

g) The last time data was updated.

6.1.11 Stock and crew diagrams ['Integrated' and Real-time Management only] and allocations to those diagrams can be created and modified within the system.

6.1.12 On the day of operation, stock details in the Stock and Crew system can also include:

a) Current location and assigned service including headcode, destination details and the date and time it will arrive at locations on its assigned diagram (predicted and actual times).

b) Orientation of the train and/or the location of first class area.

c) Details of any additional units or resources the train is planned / currently working with – forming a resource group. This can include: multiple units coupled together or the details of wagons / other locomotives forming a freight train.

d) Location within a multiple unit set / resource group.

e) Total set length and number of carriages / wagons now forming a service.

f) Live (or average historic) passenger loading information, where available. For freight, this can include current train weight.

g) Maintenance and fueling requirements including mileage countdown, location where required maintenance is to take place and amount of fuel available (with approximate mileage until empty). If under maintenance, this can include forecasted dates and times when the vehicle will be available for service.

h) Any relevant additional information from external fleet management systems. The Stock and Crew system can also pass information to external fleet management systems where relevant.

6.1.13 On the day of operation, crew details in the Stock and Crew system can also include:

a) The crew's diagram from the previous day (including any alterations) and the following day's planned diagram.

b) Crew scheduled book on / book off times.

c) Hours remaining on shift and required rest between shifts.

d) Which train service the crew member is currently associated with (headcode and diagram ID).

e) Approximate current crew location (derived from current location of a train).

f) Live running information for trains that a member of train crew is or is to be travelling on as a passenger.

g) Crew rest days and unavailability – any time periods when the individual is not available to be assigned to a diagram.

h) Whether the member of crew is spare, on training or on a route refresh.

6.2 System Processes

6.2.1 The following is applicable to all operating models unless otherwise stated.

6.2.2 Users of the Stock and Crew system can create a resource diagram for either stock or crew that is not included in the current plan.

6.2.3 The Stock and Crew system has sectional running times available to use for planning and planning modifications.

6.2.4 The system uses sectional running times to auto-calculate appropriate timings between specified locations.

a) Any timing changes made, cascade forward (forward timed) to the remaining schedule.

b) Timing allowances that must form part of the timetable are respected (including engineering, pathing, adjustment and performance allowances).

6.2.5 The system can use sectional running times and auto-calculated appropriate timings between specified locations to create a service schedule (assuming route is known):

a) With a chosen start time at origin, the system can generate an approximate, earliest possible arrival time at the destination and a schedule for the train between the origin and destination.

b) If a 'reference time' is used (i.e. train must be at a specific location at a specific time), timings cascade forward and backward (forward and back timed) to the origin and destination.

6.2.6 When a service schedule has been edited or altered, it can be compared back to the original schedule. This could be used for comparing an altered STP schedule to the original LTP schedule.

6.2.7 The Stock and Crew system, where possible, has Timetable Planning Rules codified within the system for use when creating train schedules.

6.2.8 The Stock and Crew system can alert the user when a schedule may infringe on a Timetable Planning Rule and/or is below the minimum headway for a stretch of line.

6.2.9 The Stock and Crew system automatically checks 'stock balances'.

6.2.10 Planning users of the Stock and Crew system can customise their planning screen to display different information ['Integrated' only].

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.

6.2.12 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.

6.2.13 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.

6.2.14 The routes that specific links cover can be displayed as a list of routes and graphically over geographic areas.

6.2.15 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).

6.2.16 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.

6.2.17 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). See also constraint 9.1.11.

6.2.18 The Stock and Crew system can advise and provide options for users on how to configure crew for maximum productivity. This can include making more effective use of (non-exhaustive):

a) Spare time within a diagram,

b) Time travelling as a passenger within a diagram.

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.

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'. See also 6.3.11 for assistance in allocation of uncovered diagrams. 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.

6.2.21 The Stock and Crew system can advise users on the most efficient allocation of diesel stock so as to minimise: the amount of re-fuelling and end-of-day fuel consumption. This may also link to information on subsequent day workings and whether the train can be refuelled mid-diagram or the next day.

6.2.22 The Stock and Crew system can advise users on the most efficient allocation of all stock so as to maximise available mileage before scheduled maintenance.

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. The non-train running activities can include:

a) Disembarkation / embarkation of crew and customers,

b) Customer notification and walking time / distance to platform,

c) Train preparation time (including seat reservations etc.),

d) Loading of supplies,

e) Cleaning time,

f) Crew walking / travelling time to train from expected location,

g) Train disposal time.

6.2.24 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 and 6.2.25).

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 multiple changes to numerous services or allocations, which, once the user is satisfied, can be applied in batch. Further information can be found in [RD2].

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.

6.2.27 The Stock and Crew system can hold contingency or 'shadow plans' which can be quickly activated and implemented with the current plan withdrawn or amended (over a certain time period). This can include times of unplanned disruption and cover train running, stock and/or crew plans.

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.

6.2.29 The Stock and Crew system can record and share information about hired resources from other RUs.

6.2.30 The Stock and Crew system logs and can generate reports on activities undertaken on the system. This can include:

a) Logs of changes to planned Stock and Crew allocations, paths or links including system user, time, resource location when changes were made (see also 4.2.14),

b) Analysis of changes made to stock and crew data,

c) A record of previous plans implemented and the ability to review these,

d) Reports on alterations to the plan made within a defined time period. This can be: resource swaps, additional time in any diagram (including overtime), additional or abandoned splits and joins of stock, short formations, defects arising, lack of customer facilities and reservation information.

6.2.31 Users of the Stock and Crew system can query data known to the system with customisable database searches.

6.2.32 The Stock and Crew system can provide feedback to the Controller on planned alterations including information such as stations that would be without a service as a result of the alterations, how many trains per hour would serve a station under the new plan in comparison to the original plan, any service requirements that are broken, trains without associations etc.

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.

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. The system is aware of or can predict the following and can display this information to system users:

a) the predicted journey time to the destination(s),

b) the predicted arrival time of the crew / customers,

c) the contact details for the RUs preferred taxi, bus company or managing agent.

6.3 System Outputs

6.3.1 The following is applicable to all operating models unless otherwise stated.

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.

6.3.3 The Stock and Crew system can display, graphically, any planned resource changes prior to a final decision being made and information cascaded to other systems ['sandbox'] (see also 6.2.24).

6.3.4 The Stock and Crew system can emulate a departure board for particular locations and display it (including live running information) to system users.

6.3.5 The Stock and Crew system can display a summary of live running information of RU trains (e.g. current location and current delay information). For controllers, the trains displayed can be limited to the geographical area or set of services ('service group') that they control.

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.

6.3.7 The Stock and Crew system can display crew utilisation statistics in real-time. This can include displaying the number of: crews on duty, crews travelling as passenger and spare crews available. See also 6.2.18. This data may be recorded for later future analysis.

6.3.8 The Stock and Crew system can alert users to crew restrictions which can include:

a) Infringements on rest requirements,

b) Crew competency,

c) Overtime and policy infringements.

6.3.9 The Stock and Crew system can restrict users in allocating stock to an unsuitable diagram or service. This can include:

a) Electric stock assigned to travel over an unelectrified line.

b) Train is out of gauge / not cleared for the route.

c) Train too long for planned platforms.

d) Train is not fitted with or has non-functioning SDO, unit deselect, ETCS or ATO where it is required for the service.

e) The train ETCS baseline is not suitable for the ETCS trackside baseline.

f) Train has an insufficient amount of fuel to complete the diagram.

g) Train will contravene maintenance or exam requirements.

h) Train has a defect that would prevent it running this service (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)).

i) An RT3973 (advice to train crew of exceptional load) restriction may apply.

j) Commercial specifications may apply (e.g. seating capacity).

k) A crew restriction may apply (if crews are already assigned to the diagram / service).

6.3.10 The Stock and Crew system can restrict users in allocating crews to an unsuitable diagram or service. This can include:

a) A member of the traincrew does not sign the stock.

b) A member of the traincrew is not ETCS or ATO competent.

c) A member of the traincrew does not sign the route and/or is not being conducted over a route.

d) A member of essential (primary) traincrew is not assigned.

6.3.11 The criteria listed above (6.3.10) can also be used to assist the user 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).

6.3.12 The Stock and Crew system can generate reports on 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).

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.

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 and can include:

a) Job cards for crews (see example in Appendix A.1),

b) Late notices,

c) Diagrams (see examples in Appendix A.1),

d) Rosters,

e) Crew lists,

f) Train lists,

g) Details of diagrams not covered,

h) Work related messages for recipients.

6.3.15 The Stock and Crew system can visualise platform occupation times to assist planners [‘Integrated’ only] and controllers plan platform allocations.

6.3.16 The Stock and Crew system provides a method by which crew competency (and their link) can be monitored and visualised for ease.

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.

6.3.18 The Stock and Crew system has configurable displays that allow the user to assess current resources (available and in use). This information can be grouped into: stock information (i.e. showing all RU stock), crew information, diagram information and route information. The data can be reordered and includes:

a) Stock information: as listed in 6.1.12,

b) Crew information: as listed in 6.1.13,

c) Diagram information: diagrams currently allocated, unallocated or part-allocated, resources assigned to the diagram, dates applicable, any temporary changes made to the diagram for the day of operation, and,

d) Route information: stock and/or crew located at a station and those currently available, train running information for arrivals and departures (delays etc.) at stations or locations, current station platform occupancy, (approximate) locations of RU resources (stock and crew) on a real-world map or simplifier.

6.3.19 The Stock and Crew system can monitor and alert users to trains / passenger services which have been at a stand for over an hour (where not at a station or booked dwell). This is to alert users to increased risks around, for example, customers without facilities, self-evacuation etc.

PART C:

OPERATIONAL USE

Rail Delivery Group

National Rail

7 Day in the Life of a Stock and Crew System

This section aims to describe how a Stock and Crew system may function in a non-exhaustive list of scenarios. Each scenario is described from the perspective of a defined individual and references the principles and concepts described above where appropriate. The functionality described is intended to be indicative and actual systems may have different or increased capabilities than that conceptualised here.

The applicability of the scenario to each Stock and Crew System Operating Model is also highlighted.

The following scenarios are included in this section:

7.1 Conceptual operation from the perspective of a Train Planner

7.1.1 Creation of a new, planned service (LTP, STP)

7.1.2 Divert / Alter a Service

7.1.3 Create a Diagram

7.1.4 Alter a Diagram

7.1.5 Planning of Non-Train Running Activities

7.2 Conceptual operation from the perspective of Resourcing

7.2.1 Assign a Crew Member to a Train Service / Diagram

7.2.2 Alter a diagram

7.2.3 Crew Management

7.2.4 Data Preparation for Publication

7.3 Conceptual operation from the perspective of Fleet

7.3.1 Assign Stock to a Train Service / Diagram

7.4 Conceptual operation from the perspective of a Controller

7.4.1 Creation of a Very-Short Term Plan (VSTP) Service

7.4.2 Divert a Service (RU Initiated)

7.4.3 Divert a Service (Signaller / Traffic Management Initiated)

7.4.4 Cancel a Service (RU Initiated)

7.4.5 Change Service Association

7.4.6 Alter an ‘Allocated Diagram’ – A Diagram with Stock / Crew Allocated.

7.4.7 Line Blockage

7.4.8 Alteration from Traffic Management

7.4.9 Service Delivery with Reduced Planned Resource

7.5 Conceptual operation from the perspective of a Signaller

7.5.1 Divert a Service (Signaller / Traffic Management Actioned)

7.5.2 Cancel a Train Service (Signaller / Traffic Management Actioned)

7.1 Conceptual operation of Stock and Crew systems from the perspective of a Train Planner

7.1.1 - CREATION OF A NEW, PLANNED SERVICE (LTP, STP)			
Applicable System	Interchange *NO*	Real-time Management *NO*	Integrated *YES*
Step	Operation		
1	The Train Planner enters the following details to start the creation of a new timetabled service: – Origin and destination points, – Timing load, – Planned start time at origin or time at a 'reference point' (e.g. time at a key junction). If preferred, the Train Planner can also include: – Planned headcode, – Planned station call points / timing point / passing point / loop locations, – Anticipated class of train (particularly if timing load is not descriptive enough to build schedule).		
2	The Train Planner can be offered (by the system), 'via route points' or TIPLOC locations to help populate waypoints between the origin and destination. The Stock and Crew system can validate whether the routing selected is appropriate for the planned train class (if specified in step 1).		
3	Timings between each TIPLOC location can be auto-populated using Sectional Running Times appropriate for the timing load (and therefore anticipated class of train). This can respect mandatory timing allowances that have to form part of the timetable. See 6.2.4 for a list of allowances. This can generate an approximate, earliest possible arrival time at the destination and a schedule for the train between the origin and destination. If a 'time at reference point' is used, the Train Planner is also advised of the earliest possible departure time from the service origin to meet this reference time. See 6.2.5.		
4	The Train Planner can add additional allowances or increased dwell times to the auto-generated schedule from step 3. Any timing changes made to the schedule are forward or back timed to the remaining schedule (i.e. an additional 5 minute dwell at an intermediate station defers the destination arrival time by 5 minutes).		
5	The timetabled service can be converted to a public timetable (GBTT) version (which may be a duplication). For ease, the service can be duplicated at regular time intervals to populate the rest of the timetable (e.g. every 30mins for 6hours) to create regular service patterns. This can also involve auto-population of headcodes (e.g. 1G14 becomes 1G16 for the following service).		

6	The Train Planner can visualise planned services and detect any conflicts. Where available and applicable, the Train Planner can overlay services from other RUs to proactively detect possible conflicts before IM validation.
7	When ready for validation, the timetable can be sent to the IM in an agreed, appropriate electronic format.
8	Post-validation, the Train Planner can easily import data received back from the IM – as per 6.2.11.

7.1.2 - DIVERT / ALTER A SERVICE (STP)			
Applicable System	Interchange *NO*	Real-time Management *NO*	Integrated *YES*
Step	Operation		
1	The Train Planner needs to divert / alter a train from its LTP booked route onto an alternative route – creating a provisional STP schedule. *Note that the schedule is not published to industry systems at this stage – this is utilising the 'sandbox' functionality.* The Train Planner can: – select an LTP schedule and duplicate it as an STP schedule over a selection of dates, – recycle an STP schedule from a previous, similar diversion, or, – create a completely new STP schedule. *For the 'creation of a completely new STP schedule', see scenario 7.1.1.*		
2	The Train Planner can edit the schedule created in step 1 and is able to select 'divert service via' a known diversionary route or TIPLOC location if needed.		
3	The Stock and Crew system alters the schedule and diverts the train via the specified diversionary route, auto-populating TIPLOC locations along the desired route and removing those from the booked route. Timings between each TIPLOC location are then auto-populated using Sectional Running Times appropriate for the timing load (and therefore anticipated class of train). This can respect mandatory timing allowances that have to form part of the timetable. See 6.2.4 for a list of allowances.		
4	Once the above timings are calculated, the Stock and Crew system notifies the Train Planner: – What the predicted time impact will be when the train returns to its booked route (if applicable) – see 6.2.5, – What stopping points will be missed as part of the diversion – see 6.1.7, 6.1.8 and 6.1.10, – Will the diversion have an impact on either the stock's or crew's following work – see 6.1.7, 6.1.8 and 6.1.10, – Whether the stock can travel over this route, if the timing load is specific enough to identify the class of train to be used – see 6.1.2, 6.1.5 and 6.1.12,		
5	The Train Planner can edit the service further and include other diversion if required. The Train Planner can add additional allowances or increased dwell times to the auto-generated schedule from step 3. Any timing changes made to the schedule are forward or back timed to the remaining schedule (i.e. an additional 5 minute dwell at an intermediate station defers the destination arrival time by 5 minutes).		

	The Train Planner can compare the altered STP service to the original LTP schedule.
6	The STP service can be converted to a public timetable (GBTT) version (which may be a duplication). For ease, the service can be duplicated at regular time intervals to populate the rest of the timetable (e.g. every 30mins for 6hours) to create regular service patterns. This can also involve auto-population of headcodes (e.g. 1G14 becomes 1G16 for the following service).
7	The Train Planner can visualise planned services and detect any conflicts. Where available and applicable, the Train Planner can overlay services from other RUs to proactively detect possible conflicts before IM validation.
8	When ready for validation, the timetable can be sent to the IM in an agreed, appropriate electronic format.
9	Post-validation, the Train Planner can easily import data received back from the IM – as per 6.2.11.

7.1.3 - CREATE A DIAGRAM			
Applicable System	Interchange *NO*	Real-time Management *NO*	Integrated *YES*
Step	Operation		
1	The Train Planner needs to create a new diagram. *See 7.1.4 for altering an existing diagram.* The Train Planner can create a new diagram ID which may contain a depot code.		
2	The Stock and Crew system assists the Train Planner with compiling the activities and scheduled services to be undertaken as part of the diagram. This involves considering: – Terms and Conditions applicable to the Crew, including breaks. – The calculated impact of non-train running activities (as listed in 6.2.23) on turnaround times for either stock or crew. – Stock specific activities. – Which activities are critical, non-critical or could be done in parallel. – Where the stock or crew must return to at the end of the diagram. The Stock and Crew system alerts the Train Planner if any rules are infringed upon or if non-parallel activities overlap. The Stock and Crew system can advise and provide options for users on how to configure stock and crew for maximum productivity – as per 6.2.18.		
3	As activities are added, the Stock and Crew system automatically calculates the diagram length and miles covered – this can be monitored by the Train Planner. When complete, the diagram forms a timeline of activities for the shift which the Train Planner can review and edit if necessary.		
4	*If desired by the RU, the Stock and Crew system can validate the completed diagram against known stock and crew data. For instance, this could involve confirming that the crew at the nominated depot are competent on the stock they are diagrammed to use.*		
5	Once the Train Planner is satisfied with the diagram, it is made available to other users of the Stock and Crew system and can be published to other industry systems where required.		

7.1.4 - ALTER A DIAGRAM			
Applicable System	Interchange *NO*	Real-time Management *NO*	Integrated *YES*
Step	Operation		
1	The Train Planner needs to alter/edit an existing diagram. *See 7.4.6 for altering an existing diagram that already has allocations.* The Train Planner can select and choose to edit current diagrams.		
2	The Stock and Crew system assists the Train Planner with editing and compiling the activities and scheduled services to be undertaken as part of the diagram. This involves considering: – Terms and Conditions applicable to the Crew, including breaks. – The calculated impact of non-train running activities (as listed in 6.2.23) on turnaround times for either stock or crew. – Stock specific activities. – Which activities are critical, non-critical or could be done in parallel. – Where the stock or crew must return to at the end of the diagram. The Stock and Crew system alerts the Train Planner if any rules are infringed upon or if non-parallel activities overlap. The Stock and Crew system can advise and provide options for users on how to configure stock and crew for maximum productivity – as per 6.2.18. The Train Planner can choose to insert part of another diagram into this diagram. This can replace part of the other diagram or be used for reference / for ease of editing.		
3	As activities are added, the Stock and Crew system automatically calculates the diagram length and miles covered – this can be monitored by the Train Planner. When complete, the diagram forms a timeline of activities for the shift which the Train Planner can review and edit if necessary.		
4	*If desired by the RU, the Stock and Crew system can validate the completed diagram against known stock and crew data. For instance, this could involve confirming that the crew at the nominated depot are competent on the stock they are diagrammed to use.*		
5	Once the Train Planner is satisfied with the diagram, it is made available to other users of the Stock and Crew system and can be published to other industry systems where required.		

7.1.5 - PLANNING OF NON-TRAIN RUNNING ACTIVITIES			
Applicable System	Interchange *NO*	Real-time Management *NO*	Integrated *YES*
Step	Operation		
1	A Planner is assessing the time impact of non-train running activities on a diagram - 6.1.8 details these possible activities. In this scenario, a train and train crew are planned to arrive at a terminal station on platform 1, leave the train and start a new service on a new train on platform 2. The Planner would like to assess the time impact of non-train running activities in changing the outbound train to depart from platform 3 rather than 2. The Planner alters the outbound train to depart from platform 3.		
2	When diagrams are changed in such a way, the Stock and Crew system considers, as listed in 6.1.8: – Disembarkation / embarkation of crew (and customers) timings, – Customer notification and walking time / distance to platform, – Train preparation time (including seat reservations etc.), – Loading of supplies, – Cleaning time, – Crew walking / travelling time to train from anticipated location, – Train disposal time. In this scenario, the Stock and Crew system calculates the cumulative effect of the following (noting that some activities can be done in parallel and that some may require work to estimate the time): 1. Train disposal time and disembarkation time of customers and crew from the arriving train on platform 1. 2. Crew walking time from the cab to the end of platform (particularly if mandated in crew terms and conditions). 3. Crew walking time from platform 1 to platform 3. 4. Crew walking time from the end of platform 3 to the train - expected crew location / front cab (particularly if mandated in crew terms and conditions). 5. New train (on platform 3) preparation time, which can include parallel activities such as driver ‘mobilise’ time, seat reservation set up, customer notification and walking time / distance to platform as well as embarkation time. Note that activities such as train cleaning, maintenance and loading of supplies (catering, water etc.) may take place before the arrival of the crew. The cumulative time taken to complete the above activities allows an estimation of the minimum turn-around time at the station.		

3	The Planner is informed of the time taken to complete the activities and minimum turnaround time. The Planner can compare this value to the value calculated if the outbound train were to depart from platform 2. *In this case, it is likely to be only a small difference.*
4	If the Planner is satisfied with the change, the diagram can be altered. See also steps as part of scenario 7.1.2.
5	*On the day of operation, the same steps can be applied to estimate and predict minimum turnaround times between services – as highlighted in 6.2.23 and scenario 7.4.5 (step 5).*

7.2 Conceptual operation of Stock and Crew systems from the perspective of Resourcing

7.2.1 - ASSIGN A CREW MEMBER TO A TRAIN SERVICE / DIAGRAM			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	A Resourcer needs to assign a crew member to a diagram (and associated train services). The Resourcer is informed where the start location of the diagram is (and crew home depot) and whether the diagram is for primary (essential) or secondary (non-essential) crew. If the crew member is only essential for part of the diagram, this is also noted.		
2	The Resourcer is informed of the available crews at the starting location. Crew that have pre-approved booked annual leave are marked as unavailable but may still be shown for note. Crews booked on training or route learning are also marked. The Stock and Crew system can automatically mark/filter out crew that may be unsuitable for the diagram. As listed in 6.3.10, unsuitability criteria can include: – A member of the traincrew does not sign the stock. – A member of the traincrew is not ETCS or ATO competent. – A member of the traincrew does not sign the route and/or is not being conducted over a route. – A member of essential (primary) traincrew is not assigned. – The crew's job role or link is not suitable for this diagram		
3	The remaining suitable crews can then be assessed by the Resourcer. *Where multiple crews and diagrams are available at the starting location, the Stock and Crew system can advise and provide options on how to configure crews for maximum productivity – as per 6.2.18.* The Resourcer is restricted from allocating crew which the Stock and Crew system deems unsuitable although may be offered 'mitigating options' if appropriate. For instance, assigning a traincrew that does not sign the route, the Stock and Crew system may offer the option of allocating a 'route conductor'.		
4	The Resourcer assigns the crew member to a diagram.		
5	Details of the allocation are published to industry systems. Staff are informed where necessary. *For Traffic Management and LINX, this involves publishing at 'Crew Allocations' message.*		

7.2.2 - ALTER A DIAGRAM			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Resourcer needs to alter/edit an existing diagram. *See 7.4.6 for altering an existing diagram that already has allocations (on the day of operation).* The Resourcer can select and choose to edit current diagrams.		
2	The Stock and Crew system assists the Resourcer with editing and compiling the activities and scheduled services to be undertaken as part of the diagram. This involves considering: – Terms and Conditions applicable to the Crew, including breaks. – The calculated impact of non-train running activities (as listed in 6.2.23) on turnaround times for either stock or crew. – Stock specific activities. – Which activities are critical, non-critical or could be done in parallel. – Where the stock or crew must return to at the end of the diagram. The Stock and Crew system alerts the Resourcer if any rules are infringed upon or if non-parallel activities overlap. The Stock and Crew system can advise and provide options for users on how to configure stock and crew for maximum productivity – as per 6.2.18. The Resourcer can choose to insert part of another diagram into this diagram. This can replace part of the other diagram or be used for reference / for ease of editing.		
3	As activities are added, the Stock and Crew system automatically calculates the diagram length and miles covered – this can be monitored by the Resourcer. When complete, the diagram forms a timeline of activities for the shift which the Resourcer can review and edit if necessary.		
4	*If desired by the RU, the Stock and Crew system can validate the completed diagram against known stock and crew data. For instance, this could involve confirming that the crew at the nominated depot are competent on the stock they are diagrammed to use.*		
5	Once the Resourcer is satisfied with the diagram, it is made available to other users of the Stock and Crew system and can be published to other industry systems where required.		

7.2.3 - CREW MANAGEMENT			
Applicable System	Interchange *NO*	Real-time Management *YES*	Integrated *YES*
	Operation		
Terms and Conditions	The Stock and Crew system allows users to view crew Terms and Conditions electronically (in its original format). 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.		
Links	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.		
Crew Competence	Crew competency details can be managed in the Stock and Crew system. This can include: – A record of crew competency (route, traction knowledge and Link). – Updating crew competency in real-time as they pass over routes. – A Learning Management System (LMS). The Stock and Crew system provides a method by which crew competency (and their link) can be monitored and visualised for ease. This may include displaying the routes over which a crew member can cover on a geographical map or simplifier.		
Sick Leave	The Stock and Crew system can assist users in easily managing crew sick leave. 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. Once the crew is booked off sick, any allocated diagrams are updated to be uncovered. See below for uncovered diagrams.		
Uncovered Diagrams	The Stock and Crew system can display crew utilisation statistics in real-time. This can include displaying the number of: crews on duty, crews travelling as passenger and spare crews available. As per 6.3.14, the Stock and Crew system can present users with data in a format designed by the RU. This could be for remote printing, email or applications and can include details of diagrams not covered. (Preparation and distribution of this material is covered in scenario 7.2.4). The Stock and Crew system can assist the user in finding appropriate crew for uncovered diagrams. This may involve automatically marking/filtering out crew that		

	may be unsuitable for the diagram as well as checking any crews that the user attempts to allocate. The Stock and Crew system may also suggest crews that can partially cover the diagram (as they are available, travelling as passenger or spare for example, and are not 'unsuitable' for the services). As listed in 6.3.10, unsuitability criteria can include: – A member of the traincrew does not sign the stock. – A member of the traincrew is not ETCS or ATO competent. – A member of the traincrew does not sign the route and/or is not being conducted over a route. – A member of essential (primary) traincrew is not assigned. – The crew's job role or link is not suitable for this diagram.

7.2.4 - DATA PREPARATION FOR PUBLICATION			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Resourcer needs to prepare data contained within the Stock and Crew system for publication to staff – examples such as Diagrams, crew lists and train lists are included in 6.3.14. The Resourcer has an option to generate the desired output. *This could be from a list of desired outputs (templates) pre-programmed into the system.*		
2	Data is organised into a familiar format for both Resourcers and intended recipients. The format and layout of the information is customisable by the RU – the user is able to alter this.		
3	Once the Resourcer is satisfied, they can choose the data for which they will use this template for.		
4	The desired output can then either be used by the Resourcer or published via remote printing, email or applications.		

7.3 Conceptual operation of Stock and Crew systems from the perspective of Fleet

7.3.1 - ASSIGN STOCK TO A TRAIN SERVICE / DIAGRAM			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	A (Fleet) Controller needs to assign a piece of rolling stock to a diagram (and associated train services). The Controller is informed where the start location of the diagram is (assumed to be a depot or stabling location).		
2	The Controller is informed of the available stock at the starting location. Stock that may be under maintenance are marked and, where available / known, the estimated return to service time is also shown. The Stock and Crew system can automatically mark/filter out stock which may be unsuitable for the diagram. As listed in 6.3.9, unsuitability criteria can include: – Electric stock assigned to travel over an unelectrified line. – Train is out of gauge / not cleared for the route. – Train too long for planned platforms. – The driver cannot safely reverse the train due to a lack of corridor connection between train units. – Train is not fitted with or has non-functioning SDO, unit deselect, ETCS or ATO where it is required for the service. – The train ETCS baseline is not suitable for the ETCS trackside baseline. – Train has an insufficient amount of fuel to complete the diagram. This may also need to account for whether the train can be refuelled: at the diagram end location or mid-diagram. – Train will contravene maintenance or exam requirements. – Train has a defect that would prevent it running this service (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)). – An RT3973 (advise to train crew of exceptional load) restriction may apply. – Commercial specifications may apply (e.g. seating capacity). – A crew restriction may apply (if crews are already assigned to the diagram). The Controller is restricted from allocating stock which the Stock and Crew system deems unsuitable.		

3	The remaining suitable stock can then be assessed by the Controller. *Where multiple pieces of rolling stock and multiple diagrams are available at the starting location, the Stock and Crew system can advise on how to assign stock most effectively – as per 6.2.12 and 6.2.22. This can be by considering factors such as: amount of mileage to maintenance/exam, amount of fuel remaining, end of diagram location etc.* Defects that could affect the running of the train / diagram are shown for noting.
4	The Controller assigns suitable stock to a diagram.
5	Details of the allocation are published to industry systems. Staff are informed where necessary. *For Traffic Management and LINX, this involves publishing at 'Passenger Train Allocation and Consist' message*

7.4 Conceptual operation of Stock and Crew systems from the perspective of a Controller

7.4.1 - CREATION OF A VERY SHORT-TERM PLAN (VSTP) SERVICE			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller enters the following details into the system to start the creation of a VSTP request: – Origin and destination points, – Planned start time at origin, – Traction type (to determine timing load), – Planned headcode. The Stock and Crew system may offer autocompletion of service details from shorter strings of text (e.g. three letter location codes). As many fields as possible are auto-populated with information held in the system (for example, number of carriages, maximum speed, Stanox codes etc.) (See also 4.2.14)		
2	The user is advised of the earliest possible arrival time at the destination using the specified start time and sectional running times (as demonstrated in 7.1.1). This may require specification of waypoints / via points. This information is to note only and may not consider possible timetable conflicts – it is intended that this advice could be used to revise the start time at origin. The path request may be delivered to the IM with RU advised 'time constraints' around the start and end times – this allows the IM some flexibility in altering the path request (so that path conflicts can be mitigated for example).		
3	The Controller completes any remaining fields and examines the completed information. Once complete, the information is sent (electronically) to the IM for assessment and validation – the Stock and Crew System publishes an 'RU VSTP Path Details' LINX Message. IM systems subscribe to this message with internal IM processes determining which Traffic Management / Signalling Software Systems the message is applicable to. See also Appendix A.3, Process Maps 2 03 and 3 04. *Depending on the implementation and arrangements with the IM, the Controller may be able to create a detailed, full train path which could lead to quicker validation by the IM. Creation of this full path is quick and user-friendly.*		
4	*Assuming a time lag between sending and receiving the VSTP validation and in circumstances where the specific stock and crew to be allocated are known, the Stock and Crew system could 'pre-allocate' resources. This would allow the Controller to allocate the stock and crew before a validated path is received back from the IM – saving time.*		

<table>
<tr><td></td><td colspan="3">When the path is validated, the Stock and Crew system re-checks that the pre-allocated stock and crew are still appropriate for the diagram and informs the Controller if there are now stock or crew conflicts with the validated path. If no conflicts are detected, the Controller is advised of this and the path validation – no further action is required.</td></tr>
<tr><td></td><td colspan="2">PATH ACCEPTABLE</td><td>PATH NOT ACCEPTABLE</td></tr>
<tr><td>6</td><td colspan="2">The IM creates a new, full train path to reflect the VSTP request (if not already created and submitted by the Stock and Crew System).

The IM publishes either a ‘VSTP Path Details [CS]’ or ‘TM Current Plan Path Details’ LINX message.</td><td>The IM cannot accommodate the path in the Current Plan.

The IM publishes a ‘Path Not Available’ LINX message.

The IM can provide reasoning as to why the path request was rejected to assist the RU in understanding constraints.</td></tr>
<tr><td>7</td><td colspan="2">The Stock and Crew System subscribes to the LINX message.

The RU validates that the path details received from the IM reflects what was requested.</td><td>The Stock and Crew System subscribes to the ‘Path Not Available’ LINX message.</td></tr>
<tr><td></td><td>RU AGREES</td><td>RU REJECTS</td><td></td></tr>
<tr><td>8</td><td>The Stock and Crew System publishes a ‘Path Confirmed’ LINX message.

The Controller sees that the VSTP path is confirmed in the Stock and Crew System and can allocate resources to the service (if not already pre-allocated).</td><td>The Stock and Crew System publishes a ‘Path Details Refused’ LINX message.

The RU can provide reasoning as to why the path was rejected e.g. alterations not acceptable, change of circumstances etc..</td><td>The Stock and Crew System alerts the Controller that the VSTP Request has been rejected.</td></tr>
<tr><td>9</td><td>The IM subscribes to the ‘Path Confirmed’ message.

The IM publishes a ‘Path Confirmation Acknowledge’ LINX message. The path details are also published to legacy systems (via internal IM processes) and train running information / forecasts start, where appropriate.</td><td>The IM subscribes to the ‘Path Details Refused’ LINX message.

The IM may then be expected to find a different path or wait to expect a new request, based on the RU reasoning in Step 8.</td><td>The Controller is guided by the Stock and Crew System to alter the current request or create a new request.

Pre-allocated resources can be deallocated or transferred to the altered / new request</td></tr>
</table>

7.4.2 - DIVERT A SERVICE (RU INITIATED)			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller observes that a blockage is preventing a train from taking its booked route – a diversionary route is available to avoid it. The Controller selects the train and an option to divert is available. Once selected, this initiates an assessment as to whether the train can be diverted.		
2	The Stock and Crew system, using the information it knows about the train, assesses: – Whether the stock can travel over this route – see 6.1.2, 6.1.5 and 6.1.12, – Whether the crew are competent over this route – see 6.1.3, 6.1.5 and 6.1.13, – Whether stopping points will be missed as part of the diversion – see 6.1.7, 6.1.8 and 6.1.10, – What the predicted time impact will be when the train returns to its booked route – see 6.2.5, – Will the diversion have an impact on either the stock's or crew's following work – see 6.1.7, 6.1.8 and 6.1.10, – How might customers be affected (this could involve using: live passenger loading information or details of broken connections, if available) – see 6.3.6. – Whether an RT3973 (advice to train crew of exceptional load) restriction may apply.		
3	The Controller is presented with the results of the assessment for their consideration. The Controller can either continue with developing the diversion request or cancel to consider other options.		
4	Should the diversion require the following (non-exhaustive), an 'RU Train Journey Modification Request' LINX message is published by the Stock and Crew System: cancellation, part-cancellation (including terminate short and starting forward), 'not to stop orders', additional station stops, changes to pick-up / drop-off only restrictions.		
5	As the diversion will require an alteration to the allocated path, the RU must get approval from the IM. To facilitate this, the Stock and Crew System publishes a 'Path Request: Modification' LINX message. *Depending on the implementation and arrangements with the IM, the Controller may be able to create a detailed, full train path which could lead to quicker validation by the IM. Creation of this full path is quick and user-friendly. For multiple alterations, the 'sandbox' functionality may be used to plan all alterations and request them in batch.*		
6	IM systems subscribe to the 'RU Train Journey Modification Request' and/or 'Path Request: Modification' LINX messages with internal IM processes determining which Traffic Management / Signalling Software Systems the message is applicable to.		

	The IM assesses the proposed path alteration against the Current Plan.		
	PATH ACCEPTABLE	PATH ACCEPTABLE WITH ALTERATION	PATH NOT ACCEPTABLE
7	The IM creates the full train path to reflect the request (if not already created and submitted by the Stock and Crew System). The IM publishes a 'TM Current Plan Path Details' LINX message.	The IM could accommodate the path in the Current Plan if some alterations are made. The IM modifies the path with these alterations and publishes a 'Path Details: Modification' LINX message.	The IM cannot accommodate the path in the Current Plan - the IM publishes a 'Path Not Available' LINX message. *The IM can provide reasoning as to why the path request was rejected to assist the RU.*
8	The Stock and Crew System subscribes to the 'TM Current Plan Path Details' LINX message. The RU validates that the path details received from the IM reflects what was requested / proposed alteration(s) are acceptable	The Stock and Crew System subscribes to the 'Path Details: Modification' LINX message. The RU assesses whether the IM's proposed alteration(s) are acceptable	The Stock and Crew System subscribes to the 'Path Not Available' LINX message.
	RU ACCEPTS	RU REJECTS	
9	The Stock and Crew System publishes a 'Path Confirmed' LINX message. The Controller sees that the path is confirmed in the Stock and Crew System. Resources can be altered / assigned if required (see Scenario 7.4.6).	The Stock and Crew System publishes a 'Path Details Refused' LINX message.	The Stock and Crew System alerts the Controller that the Path Modification Request has been rejected.
10	The IM subscribes to the 'Path Confirmed' message. The IM publishes a 'Path Confirmation Acknowledge' LINX message. The path details are also published to legacy systems (via internal IM processes) and train running information / forecasts are updated / start, where appropriate.		The Controller is guided by the Stock and Crew System to alter the current request or create a new request.

7.4.3 - DIVERT A SERVICE (SIGNALLER / TRAFFIC MANAGEMENT INITIATED)			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	A blockage is preventing a train from taking its booked route – a diversionary route is available to avoid it. This could be discovered via observations by the Signaller or a Traffic Management system detecting a conflict. The Signaller or Traffic Management system attempts to alter the routing of the train off the booked path. [See also 7.5.1 for the scenario from the perspective of the Signaller / Traffic Management system. In this instance, the Signaller has an upgraded signalling system that can connect to Stock and Crew data]. Note that the IM / Traffic Management can only request / make path modifications – it cannot make stock or crew alterations.		
2	Stock data (held in Traffic Management and dynamically updated by the Stock and Crew system) is used to assess whether the stock can travel over the planned route – see 6.1.2, 6.1.5 and 6.1.12. This is to narrow down options so that unsuitable plans are discounted before communication with the Stock and Crew system. If the Stock data within Traffic Management indicates that the stock is unsuitable, Traffic Management discounts this option. *If the service crosses over multiple Traffic Management control boundaries, the findings of other Traffic Management systems are taken into account – this is internal to IM(s).*		
3	*Alterations to the booked route could be planned pre-emptively, particularly with Traffic Management systems - this would follow the same steps as below.* *For certain diversions, the RU will need to be consulted before the service is re-routed. There may be some instances when this is pre-agreed – in these instances, skip to Step 6 "No Restriction".* When a suitable plan is found, the Traffic Management user can publish a 'TM Path Request / Modification' message for the RU to assess. See also Appendix A.3 Process Map 2 02.		
4	The Stock and Crew system uses stock and crew data to assess: – Whether the stock can travel over this route – see 6.1.2, 6.1.5 and 6.1.12. – Whether the crew are competent over this route – see 6.1.3, 6.1.5 and 6.1.13. *And depending on the implementation of the Stock and Crew system, it could also assess:* – *Will the diversion have an impact on either the stock's or crew's following work.* – *How might customers be affected (this could involve using: live passenger loading information or details of broken connections, if available).* The Stock and Crew system user decides whether the proposal can be implemented as suggested, could be implemented but with alteration or is unacceptable.		

	IMPLEMENT AS SUGGESTED	IMPLEMENT WITH ALTERATION	CANNOT BE IMPLEMENTED
5	The Stock and Crew system publishes a 'Path Accepted' message. Traffic Management subscribes to the 'Path Accepted' message.	The Stock and Crew system publishes a 'Path Rejected' message. The Signaller / Traffic Management system is provided with a clear reason for the unsuitability and the route is not set.	The Stock and Crew system publishes a 'Path Rejected' message. The Signaller / Traffic Management system is provided with a clear reason for the unsuitability and the route is not set.
6	Traffic Management determines the appropriate message(s) to publish depending on how the service has been altered. This may involve: – 'TM Train Journey Modification' messages. – 'TM Change of Track / Platform' messages. Other industry systems, including the Stock and Crew system and other Traffic Management systems are informed of the change through LINX.	The RU can propose an alternative diversion – see Scenario 7.4.2.	The Signaller / Traffic Management system can either: consider other options or ask the RU for alternatives.

7.4.4 - CANCEL A SERVICE (RU INITIATED)			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The RU plans to cancel a train service. Note that the same processes would be used for: Not to Stop Orders, Additional Stop Orders, Part-Cancellations (including terminate short or start forward) and changes to pick-up/drop-off only calls. The Controller marks the service as cancelled in the Stock and Crew system.		
2	Both the stock and crew are provisionally deallocated from the service and can be reassigned to a new one. The user of the Stock and Crew system is notified of the implications on the stock and crew's future allocated work (i.e. will the subsequent service also need to be cancelled) and the system assists the Controller in quickly reallocating and planning the service. *For multiple alterations, the 'sandbox' functionality may be used to plan all the alterations/cancellations and then apply them in batch.*		
3	The IM is notified about the intention to cancel the service(s) via the Stock and Crew System publishing an 'RU Train Journey Modification Request' LINX message and the IM subscribing to the message.		
4	The Stock and Crew system marks the service as cancelled (in all systems 'views' and for all staff) and the Controller is notified. Deallocation of the resources from the service(s) are confirmed and crews and fleet are notified of the cancellation.		
5	Notice of the cancellation is published to industry and internal systems. This could be directly from the 'RU Train Journey Modification Request' LINX message or a separate 'TM Train Journey Modification' LINX message generated by the IM.		

7.4.5 - CHANGE SERVICE ASSOCIATION			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller needs to change the 'service association' (i.e. the service this train will form once terminated / the service this train was formed from at the start of journey). *This is as defined in the Network Rail Common Interface Format (CIF) file specification.* The Controller is offered the choice to 'change the service association'.		
2	The Controller is offered a selection of services arriving or departing from the terminal station (dependant on whether the association is being altered for the start or end of a service). The Controller can quickly alter the associations of services. *For multiple alterations, the 'sandbox' functionality may be used to plan all the alterations and then apply them in batch.*		
3	When an association is changed, the Controller is offered whether the stock and/or crew should pick up the remaining diagram associated with the new service and its subsequent activities. The Controller can also choose whether to alter the diagram further – this would follow scenario 7.4.6.		
4	When the Controller allocates either the stock or crew to a new service or diagram, the Stock and Crew system assesses whether: – Members of the traincrew sign the stock. – Members of the traincrew are ETCS or ATO competent (where required). – Members of the traincrew sign the route and/or will be conducted over a route. – Any traincrew Terms and Conditions (including breaks) are infringed on. – Members of the traincrew can return to their booking off point at the end of the diagram. – All members of essential (primary) traincrew are assigned. – The crews' job role and link are appropriate for the new diagram. – Sufficient hours remain on the crews' shift to complete the diagram. – Electric stock is not assigned to travel over an unelectrified line. – Train is within gauge / is cleared for the route. – Train is not too long for planned platforms. – Train is fitted with and has functioning SDO, unit deselect, ETCS or ATO where it is required for the service.		

	– The train ETCS baseline is suitable for the ETCS trackside baseline. – Train has sufficient fuel to complete the new diagram. – Train will not contravene maintenance or exam requirements. – Train has no defects that would prevent it running this diagram (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)). – External maintenance companies need to be contacted / informed about the change in mileage for stock. – An RT3973 (advice to train crew of exceptional load) restriction may apply. The Controller is informed, with clear reasoning, if the Stock and Crew system believes any attempted allocation is unsuitable.
5	The Stock and Crew system can also consider the impact of non-train running activities (as listed in 6.2.23) on turnaround times for either stock or crew to allow a more accurate prediction of train running and future performance. When complete, the diagram forms a timeline of activities for the shift which the Controller can review and edit further if necessary.
6	Once a Controller has an idea of how to alter services, it is expected that the traincrew are asked if they will accept their new 'allocated diagram'. This may be done electronically or verbally depending on how the Stock and Crew system is implemented. Depending on local arrangements, further stakeholders may need to be informed. *Note that under certain crew Terms and Conditions, any alterations to the allocated diagram assigned at the start of the shift is allowed to be refused by the member of traincrew. When refused, the member of traincrew continues with the diagram and services they were originally assigned.*
7	Once the Controller is satisfied with the association changes, it is made available to other users of the Stock and Crew system and is published to other industry systems via the Stock and Crew System publishing 'Path Request: Modification' (for stock) and/or 'Crew Shift Allocation' LINX messages. *Publishing 'Passenger Train Consist', 'Freight Train Consist' and 'Crew Allocation' LINX messages may also be required depending on the implementation.*

7.4.6 - ALTER AN 'ALLOCATED DIAGRAM' - A DIAGRAM WITH STOCK/CREW ALLOCATED			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller needs to alter/edit an allocated diagram – a diagram which already has a piece of rolling stock or member of traincrew assigned. *See scenario 7.2.2 for altering an existing diagram that has no allocation. Note that some diagram alterations are covered under the 'Line Blockage' scenario – see scenario 7.4.7.* The Controller can select and choose to edit current allocated diagrams.		
2	The Stock and Crew system assists the Controller with editing and compiling the activities and scheduled services to be undertaken as part of the diagram. This involves considering: – Terms and Conditions applicable to the Crew, including breaks. – The calculated impact of non-train running activities (as listed in 6.2.23) on turnaround times for either stock or crew. – Stock specific activities. – Which activities are critical, non-critical or could be done in parallel. – Where the stock or crew must return to at the end of the diagram. The Stock and Crew system alerts the Controller if any rules are infringed upon or if non-parallel activities overlap. The Stock and Crew system can advise and provide options for users on how to configure stock and crew for maximum productivity – as per 6.2.18. The Controller can choose to insert part of another diagram into this diagram. This can replace part of the other diagram or be used for reference / for ease of editing.		
3	As activities are added, the Stock and Crew system automatically calculates the diagram length and miles covered – this can be monitored by the Controller. As per 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 multiple changes to numerous services or allocations. For any alterations in allocation, the Stock and Crew system also assesses, beyond that list above, whether: – Members of the traincrew sign the stock. – Members of the traincrew are ETCS or ATO competent (where required). – Members of the traincrew sign the route and/or will be conducted over a route. – All members of essential (primary) traincrew are assigned. – The crews' job role and link are appropriate for the new diagram.		

	– Sufficient hours remain on the crews' shift to complete the diagram. – Electric stock is not assigned to travel over an unelectrified line. – Train is within gauge / is cleared for the route. – Train is not too long for planned platforms. – Train is fitted with and has functioning SDO, unit deselect, ETCS or ATO where it is required for the service. – The train ETCS baseline is suitable for the ETCS trackside baseline. – Train has sufficient fuel to complete the new diagram. – Train will not contravene maintenance or exam requirements. – Train has no defects that would prevent it running this diagram (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)). – External maintenance companies need to be contacted / informed about the change in mileage for stock. – An RT3973 (advice to train crew of exceptional load) restriction may apply. The Controller is informed, with clear reasoning if the Stock and Crew system believes any attempted allocation is unsuitable. When complete, the diagram forms a timeline of activities for the shift which the Controller can review and edit further if necessary.
4	Once a Controller has an idea of how to alter services, it is expected that the traincrew are asked if they will accept their new 'allocated diagram'. This may be done electronically or verbally depending on how the Stock and Crew system is implemented. Depending on local arrangements, further stakeholders may need to be informed. *Note that under certain crew Terms and Conditions, any alterations to the allocated diagram assigned at the start of the shift is allowed to be refused by the member of traincrew. When refused, the member of traincrew continues with the diagram and services they were originally assigned.*
5	Once the Controller is satisfied with the association changes, it is made available to other users of the Stock and Crew system and is published to other industry systems via the Stock and Crew System publishing 'Path Request: Modification' (for stock) and/or 'Crew Shift Allocation' LINX messages. *Publishing 'Passenger Train Consist', 'Freight Train Consist' and 'Crew Allocation' LINX messages may also be required depending on the implementation.*

7.4.7 - LINE BLOCKAGE			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller observes that a blockage is preventing all trains from travelling along one stretch of line. It is decided to terminate and restart services at stations either side of the blockage. The Controller can quickly codify the location of the blockage into the Stock and Crew system. Details of the line blockage could be provided by Traffic Management systems where available, assuming a common geographical database (as per 6.2.26), using 'Possessions (Actuals)' and 'Emergency Possession' LINX messages.		
2	The Controller is presented with the arrival and departure information from stations (of their choosing) either side of the blockage. This information contains both stock and crew details about each service and which services are related (i.e. are worked by the same stock or crew / is the same service at the chosen locations).		
3	The Controller can easily manipulate the service to work around the constraints at the now terminal stations – these constraints could be stock, crew or infrastructure/route related. This may involve changing the allocated diagrams for stock and/or crews and assignment to parts of other diagrams. As per 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 multiple changes to numerous services or allocations. The Stock and Crew system can provide feedback to the Controller on planned alterations including information such as stations that would be without a service as a result of the alterations etc. For any alterations in allocation, the Stock and Crew system assesses whether: – Members of the traincrew sign the stock. – Members of the traincrew are ETCS or ATO competent (where required). – Members of the traincrew sign the route and/or will be conducted over a route. – All members of essential (primary) traincrew are assigned. – The crews' job role and link are appropriate for the new diagram. – The diagram allows the crew to travel back to their booking off point before the end of their shift. – Sufficient hours remain on the crews' shift to complete the diagram. – Break requirements and any other Terms and Conditions are not infringed upon. – Electric stock is not assigned to travel over an unelectrified line. – Train is within gauge / is cleared for the route.		

	– Train is not too long for planned platforms. – Train is fitted with and has functioning SDO, unit deselect, ETCS or ATO where it is required for the service. – The train ETCS baseline is suitable for the ETCS trackside baseline. – Train has sufficient fuel to complete the new diagram. – Train will not contravene maintenance or exam requirements. – Train has no defects that would prevent it running this diagram (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)). – External maintenance companies need to be contacted / informed about the change in mileage for stock. – An RT3973 (advice to train crew of exceptional load) restriction may apply. The Controller is informed, with clear reasoning if the Stock and Crew system believes any attempted allocation is unsuitable.
4	Once a Controller has an idea of how to alter services, it is expected that the traincrew are asked if they will accept their new allocated diagram, if altered. This may be done electronically or verbally depending on how the Stock and Crew system is implemented. Depending on local arrangements, further stakeholders may need to be informed. *Note that under certain crew Terms and Conditions, any alterations to the allocated diagram assigned at the start of the shift is allowed to be refused by the member of traincrew. When refused, the member of traincrew continues with the diagram and services they were originally assigned.*
5	When the Controller (and stakeholders) are satisfied with the alterations to the train service, the Controller can apply the changes in batch (if using the sandbox functionality). The alterations are published to industry systems: – Association changes are published by the Stock and Crew System as 'Path Request: Modification' (for stock) and/or 'Crew Shift Allocation' LINX messages. *Publishing 'Passenger Train Consist', 'Freight Train Consist' and 'Crew Allocation' LINX messages may also be required depending on the changes made and system implementation.* – Changes to the service follow steps as outlined in scenario 7.4.4 which includes 'RU Train Journey Modification Request' and 'TM Train Journey Modification' LINX messages – see also Process Map 303. – Changes to the path follow steps as outlined in scenario 7.4.2. This may include LINX messages such as; 'RU Path Request : Modification', 'RU VSTP Path Details', 'Path Details' – see also Process Map 304.

7.4.8 - ALTERATION FROM TRAFFIC MANAGEMENT			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	A Traffic Management system intends to slightly alter the schedule or route of a service. A list of changes that could come from a Traffic Management system are listed in 4.3.1.5. See also 7.4.4 for more complex schedule or routing changes or Appendix A.3 Process Map 2 02. *For certain alterations, the RU (Controller) will need to be consulted before the service is changed.*		
2	Stock and crew data is used, without the need for Controller intervention, to assess: – Whether the stock can travel over this route – see 6.1.2, 6.1.5 and 6.1.12. – Whether the crew are competent over this route – see 6.1.3, 6.1.5 and 6.1.13. *Depending on the implementation of Traffic Management and the Stock and Crew system, stock and crew data could also be used to assess:* – *Will the diversion have an impact on either the stock's or crew's following work.* – *How might customers be affected (this could involve using: live passenger loading information or details of broken connections, if available).* *If the service crosses over multiple Traffic Management control boundaries, the findings of other Traffic Management systems are taken into account.*		
	NO RESTRICTION	RESTRICTION	
3	If there are no restrictions highlighted from the assessment, the routing is set for the train. No action is required from the Controller.	No action required from the Controller. *If the assessment highlights restrictions on the proposed routing, the Signaller / Traffic Management system is provided with a clear reason for the unsuitability and the route is not set.*	
4	Other industry systems, including the Stock and Crew system are informed of the change. *This may be via a Train Journey Modification or Change of Track / Platform message.*	The Signaller / Traffic Management system can either: consider other options or ask the RU Controller for alternatives. *As the Traffic Management system is making use of internally stored data, there is no need for any LINX message.*	

7.4.9 - SERVICE DELIVERY WITH REDUCED PLANNED RESOURCE			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	The Controller becomes aware that the level of disruption has resulted in available resources being unable to deliver the timetable (this may include being unable to meet the requirements of a contingency timetable). The Controller can quickly assess the resources that are available and their location (this may be approximate in the case of train crew). Information can be displayed in various ways (e.g. number of trains and train crew available at a terminal station, estimated time of arrival for stock at a station etc.). A summary of possible constraints for each resource are also shown to assist the Controller in designing the service. This can include; crew on or about to have a Personal Needs Break (PNB), electric or diesel traction or stock near a maintenance mileage limit. Constraints are detailed in step 3.		
2	The Controller can view a summary of service information and minimum service requirements. This can involve the display of information pertaining to: passenger loadings, stopping pattern requirements, information on connecting services, freight requirements (including those of the customer), lateness of passengers already delayed, passengers in need of assistance and platform loadings (where available or assessed). The Controller can start designing a planned service and easily manipulate any existing services to work around constraints – this may require changing services a number of hours ahead. The Stock and Crew system can provide feedback to the Controller on planned alterations including information such as stations that would be without a service as a result of the alterations, how many trains per hour would serve a station under the new plan in comparison to the original plan, any service requirements that are broken, trains without associations etc.		
3	The Controller can easily allocate resources to the initial planned service from step 2. This may involve changing the allocated diagrams for stock and/or crews and assignment to parts of other diagrams. As per 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 multiple changes to numerous services or allocations. For any alterations in allocation, the Stock and Crew system assesses whether: – Members of the traincrew sign the stock. – Members of the traincrew are ETCS or ATO competent (where required). – Members of the traincrew sign the route and/or will be conducted over a route. – All members of essential (primary) traincrew are assigned. – The crews’ job role and link are appropriate for the new diagram.		

	– The diagram allows the crew to travel back to their booking off point before the end of their shift. – Sufficient hours remain on the crews' shift to complete the diagram. – Break requirements and any other Terms and Conditions are not infringed upon. – Electric stock is not assigned to travel over an unelectrified line. – Train is within gauge / is cleared for the route. – Train is not too long for planned platforms (and SDO requirements). – Train is fitted with and has functioning SDO, unit deselect, ETCS or ATO where it is required for the service. – The train ETCS baseline is suitable for the ETCS trackside baseline. – Train has sufficient fuel to complete the new diagram. – Train will not contravene maintenance or exam requirements. – Train has no defects that would prevent it running this diagram (e.g. ETCS fault or coupler fault (on a diagram with attaching moves)). – External maintenance companies need to be contacted / informed about the change in mileage for stock. – An RT3973 (advice to train crew of exceptional load) restriction may apply. The Controller is informed, with clear reasoning if the Stock and Crew system believes any attempted allocation is unsuitable. If the planned service from step 2 is still unable to be delivered with the available resources, the Controller can iteratively, further alter the service as per step 2 and further develop a resourcing plan (step 3).
4	Once a Controller has an idea of how to alter services, it is expected that the traincrew are asked if they will accept their new allocated diagram, if altered. This may be done electronically or verbally depending on how the Stock and Crew system is implemented. Depending on local arrangements, further stakeholders may need to be informed. All of the above is subject to local and individual Terms and Conditions. *Note that under certain crew Terms and Conditions, any alterations to the allocated diagram assigned at the start of the shift is allowed to be refused by the member of traincrew. When refused, the member of traincrew continues with the diagram and services they were originally assigned.*
5	When the Controller (and stakeholders) are satisfied with the alterations to the train service, the Controller can apply the changes in batch (if using the sandbox functionality). The alterations are published to industry systems: – Association changes are published by the Stock and Crew System as 'Path Request: Modification' (for stock) and/or 'Crew Shift Allocation' LINX messages. *Publishing 'Passenger Train Consist', 'Freight Train Consist' and*

	'Crew Allocation' LINX messages may also be required depending on the changes made and system implementation. – Changes to the service follow steps as outlined in scenario 7.4.4 which includes 'RU Train Journey Modification Request' and 'TM Train Journey Modification' LINX messages – see also Process Map 303. – Changes to the path follow steps as outlined in scenario 7.4.2. This may include LINX messages such as; 'RU Path Request : Modification', 'RU VSTP Path Details', 'Path Details' – see also Process Map 304.
6	Post publication, the Controller can monitor the plan as per step 1 and may need to repeat steps 2-5 later in the day. The Controller can easily reinstate the (original) planned as resource or service delivery constraints lessen or are resolved.

7.5 Conceptual operation of Stock and Crew systems from the perspective of a Signaller

7.5.1 - DIVERT A SERVICE (SIGNALLER / TRAFFIC MANAGEMENT ACTIONED)			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	A blockage is preventing a train from taking its booked route – a diversionary route is available to avoid it. This could be discovered via observations by the Signaller or a Traffic Management system detecting a conflict. The Signaller or Traffic Management system attempts to alter the routing of the train off the booked path. In this instance, the Signaller has an upgraded signalling system that can connect to Stock and Crew data.		
2	Stock data (held in Traffic Management and dynamically updated by the Stock and Crew system) is used to assess whether the stock can travel over the planned route – see 6.1.2, 6.1.5 and 6.1.12. This is to narrow down options so that unsuitable plans are discounted before communication with the Stock and Crew system. If the Stock data within Traffic Management indicates that the stock is unsuitable, Traffic Management discounts this option. *If the service crosses over multiple Traffic Management control boundaries, the findings of other Traffic Management systems are taken into account – this is internal to IM(s).*		
3	*Alterations to the booked route could be planned pre-emptively, particularly with Traffic Management systems - this would follow the same steps as below.* *For certain diversions, the RU will need to be consulted before the service is re-routed. There may be some instances when this is pre-agreed – in these instances, skip to Step 6 "No Restriction".* When a suitable plan is found, the Traffic Management user can publish a 'TM Path Request / Modification' message for the RU to assess.		
4	The Stock and Crew system uses stock and crew data to assess: – Whether the stock can travel over this route – see 6.1.2, 6.1.5 and 6.1.12. – Whether the crew are competent over this route – see 6.1.3, 6.1.5 and 6.1.13. *Depending on the implementation of the Stock and Crew system, it could also assess:* – *Will the diversion have an impact on either the stock's or crew's following work.* – *How might customers be affected (this could involve using: live passenger loading information or details of broken connections, if available).* The Stock and Crew system user decides whether the proposal can be implemented as suggested, could be implemented but with alteration or is unacceptable.		

	IMPLEMENT AS SUGGESTED	IMPLEMENT WITH ALTERATION	CANNOT BE IMPLEMENTED
5	The Stock and Crew system publishes a 'Path Accepted' message. Traffic Management subscribes to the 'Path Accepted' message.	The Stock and Crew system publishes a 'Path Rejected' message. The Signaller / Traffic Management system is provided with a clear reason for the unsuitability and the route is not set.	The Stock and Crew system publishes a 'Path Rejected' message. The Signaller / Traffic Management system is provided with a clear reason for the unsuitability and the route is not set.
6	Traffic Management determines the appropriate message(s) to publish depending on how the service has been altered. This may involve: – 'TM Train Journey Modification' messages. – 'TM Change of Track / Platform' messages. Other industry systems, including the Stock and Crew system and other Traffic Management systems are informed of the change through LINX.	The RU can propose an alternative diversion – see Scenario 7.4.2.	The Signaller / Traffic Management system can either: consider other options or ask the RU for alternatives.

7.5.2 - CANCEL A TRAIN SERVICE (SIGNALLER / TRAFFIC MANAGEMENT ACTIONED)			
Applicable System	Interchange *YES*	Real-time Management *YES*	Integrated *YES*
Step	Operation		
1	Following instruction from the RU, the Signaller / Traffic Management system will cancel an RU service. *Note that in some implementations, the RU may allow Steps 1-5 below to happen automatically without Controller Assessment in Step 4. In these circumstances, go to Step 6 "Agreed".*		
2	Traffic Management publishes a 'TM Path Request / Modification' message.		
3	The Stock and Crew system subscribes to the 'TM Path Request / Modification' message and notifies user(s) of the planned cancellation – the service is clearly marked in all system 'views' and for all staff.		
4	The Stock and Crew system user must confirm agreement with the proposed cancellation to mitigate against unintended / mistaken cancellation of service(s).		
	AGREED	NOT AGREED	
5	The Stock and Crew system publishes a 'Path Accepted' message. Traffic Management subscribes to the 'Path Accepted' message.	The Stock and Crew system publishes a 'Path Rejected' message. Traffic Management subscribes to the 'Path Rejected' message.	
6	Traffic Management publishes a 'TM Train Journey Modification' message. Confirmation of the cancellation is publicised to industry systems, including other Traffic Management systems. Both stock and crew are deallocated from the cancelled service and are available to assign to new services (including VSTP).	The RU and IM must establish why the cancellation was not agreed (e.g. wrong service selected etc.) and restart from Step 1.	

8 Roles and Responsibilities

8.1 Introduction

8.1.1 The introduction of a Stock and Crew system changes, and often simplifies, current procedures and activities. As such, roles and their associated responsibilities may change as the system is introduced.

8.1.2 Section 6 and 7 have broadly described how the Stock and Crew system interacts with certain roles and indicates how some responsibilities may change. As the amount of change depends on the implementation and capability of the Stock and Crew system, it is challenging to predict how each of the roles may be affected, if at all. In the majority of cases, the change is to 'become familiar with the new system' – those which may be more affected have been highlighted as part of Section 7.

8.1.3 This section aims to list more specific roles which may be affected by the implementation of a Stock and Crew system, noting that the specific job title may vary depending on the organisation. The section has been split into RU and IM roles.

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

8.2 RU Roles and Responsibilities

8.2.1 Within the RU, the following roles may be affected by the implementation of a Stock and Crew system – applicability to certain Operating Models is highlighted where appropriate:

- Train Planner [Integrated only].
- Rolling Stock Diagrammer [Integrated only].
- Train Crew Diagrammer [Integrated only].
- Resourcing Managers [Integrated only].
- Fleet Managers and Teams (this may be external to the RU).
- Operations Controllers.
- Train Running Controllers.
- Information Controllers.
- Duty Control Managers.
- Area Co-ordinators (stations, operations, on-board, line managers etc.).
- Train Crew (including Drivers).
- Driver Managers.

8.2.2 The RU is responsible for training all RU employees who interact with the Stock and Crew system on how to use it.

8.2.3 The RU, along with the supplier, are responsible for the maintenance of the system and ensuring that it is undertaken at a time agreed to by all industry partners.

8.2.4 The RU is responsible for ensuring that all operational information held within the Stock and Crew system is up to date. When changes occur, the RU is responsible for updating the information, within reasonable timescales.

8.2.5 The RU is responsible for ensuring that all procedures where decisions are required to be approved by the IM, are followed.

8.3 IM Roles and Responsibilities

8.3.1 Within the IM, the following roles may be affected by the implementation of Stock and Crew systems and are applicable to all Operating Models:

- Signaller / automatic setting of routes / Traffic Management Operator.
- Route Control Manager / Lead Operations Controller.
- Train Running Controller.
- Operations Managers (including Mobile Operations Managers – MOMs).
- Incident Controllers.

8.3.2 The IM is responsible for training IM employees on how RUs Stock and Crew systems interact, and affect, any procedures or software used as part of their role.

8.3.3 The IM is to agree, along with the RU and industry partners, when maintenance of the Stock and Crew systems can take place.

8.3.4 The IM is responsible for ensuring that any changes made to data originally held in Stock and Crew systems are passed back to the RUs system.

8.3.5 The IM is responsible for ensuring that all procedures where decisions are required to be approved by the RU, are followed.

8.3.6 The IM is responsible for the communication method from Stock and Crew systems to Traffic Management systems – LINX. The IM is also responsible for the LINX messages and message flows. The IM will inform the RU when LINX is unavailable or not functioning.

PART D:

CONTINUED SYSTEM DEVELOPMENT

Rail Delivery Group

National Rail

9 System Constraints and Future Development

9.1 Constraints

9.1.1 Stock and Crew systems could be constrained by several factors. The following details some of these constraints, recognising current standards, practices and software implementations.

9.1.2 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 (see also assumption 3.2.6). 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.

9.1.3 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.

9.1.4 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, relevant 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. Based on the work of the Stock and Crew Task and Finish Group [RD11], implementation has been theorised as the following:

- 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 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].
- For certain situations (generally complex changes to schedules), a bid-offer process between the systems is used such that the legal obligations of both RUs and IMs is respected (i.e. the IM cannot make changes to stock and crew allocations). These bid-offer processes are described in Appendix A.3.

9.1.5 Publication and subscription to the Layered Information Exchange (LINX) requires an appropriate LINX message to be set up. A summary of the current LINX messages is shown in Appendix A.2. A Process Mapping exercise undertaken by a Better Operations Programme Board Task and Finish Group showed that several required LINX messages have not been created or tested yet (see Appendix A.3). This is likely to have a cost impact and take time to set up and be approved.

9.1.6 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.

9.1.7 Stock and crew data may be used to provide information to DAS (including connected DAS [C-DAS]) 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. 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).

9.1.8 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 as part of section 5.

9.1.9 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.

9.1.10 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 (see assumption 3.2.15).

9.1.11 Not all activities in a crew diagram have enough granular detail. 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.

9.1.12 Current industry procedures and data transfers between the RU and IM are reliant on legacy file formats and systems – 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 data schema based on what RUs and IMs can provide and require. Support must also be given to new or impending standards or information, such as ETCS compliant driver and service IDs. In the medium to long term, a national strategy for migration away from legacy file formats will likely be required – a first stage of this activity would be to determine which specific formats to target

9.2 Future Development

9.2.1 Scope for further work has been identified within the document – the following sections aim to summarise this and cross-references the appropriate section where this development work is identified.

9.3 Further Work Identified

9.3.1 [Withdrawn, work now complete].

9.3.2 Further development of the system from this point is dependent on the funding available and client for the potential system (see also 1.1.2 and constraint 9.1.8).

9.3.3 Qualification and quantification of potential benefits of the system will need to be undertaken, expanding on those identified in section 1.3. 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 and identify lessons learnt from current implementations. This would require some initial funding and resources but is likely to be challenging to complete.

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

9.3.5 New LINX messages need to be written to accommodate new data flows [9.1.5].

9.3.6 Details of how stock and crew data is communicated to and used by Automatic Train Operation (ATO) system will need to be examined.

9.3.7 Activities that are undertaken as part of a diagram may require more granular detail and may require measurement and agreement with crew representatives [9.1.11].

9.3.8 Industry procedures and data transfers between the RU and IM are reliant on legacy file formats and systems - allowances need to be made for new file formats or the current standard modernised. This may require defining a new, industry agreed data schema based on what RUs and IMs can provide and require. Support must also be given to new standards or information such as ETCS compliant driver and service IDs, for example. In the medium to long term, a national strategy for migration away from legacy file formats will likely be required – a first stage of this activity would be to determine which specific formats to target [9.1.12].

9.3.9 Process Maps of the interactions between Traffic Management and Stock and Crew systems (Appendix A.3), whilst agreed by the industry, may require some refining when tested in real-world conditions. However, the maps as shown, are thought to be an accurate representation of which system does what and which makes decisions. The processes were designed such that the legal obligations of both RUs and IMs could be respected.

9.4 Work Indirectly Identified

9.4.1 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.

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

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

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

9.4.5 Planning coordination between Traffic Management systems is not mature – this is a particular concern for operators crossing multiple Traffic Management boundaries where the Traffic Management functionalities can be different. A National Planning Layer may be required.

9.4.6 The need for a National Geography Model, which is common across IM and RU systems, is becoming more pressing.

9.4.7 To support the roll-out of Traffic Management, C-DAS and Crew and Stock Systems, it is critical that the outputs of the timetabling process deliver the granularity that these systems require.

PART E:

SUPPLEMENTARY INFORMATION

Rail Delivery Group

National Rail

10 Definitions and Abbreviations

10.1 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 an 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.

Control Centre of the Future (CCF)

A control system that integrates all train running monitoring functions and provides a map based display of current and historical train running information. Data is collected from Train Describers, compared against schedules, and displayed on a map.

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 operators' 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. Several different forms of DAS are available including:

- **Standalone-DAS (S-DAS):** timetable information is downloaded to the train at or prior to journey start. It remains static for the entire journey, not receiving any updates once the journey has started. Should the train be delayed, or route changed, most advisory information is no longer useful to the driver.
- **Networked-DAS (N-DAS):** 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. This may not be communicated to the train in near real time.
- **Connected-DAS (C-DAS):** provision of information updates to trains in near real time, currently conceptualised to be from Traffic Management systems. C-DAS also offers the potential for the control system to use data received from trains to inform regulation decisions (e.g. location data). Note that outside of Traffic Management areas of control, the system reverts to S-DAS style of operation (no further updates are received).

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 to the meaning given to it in the Railways and Other Guided Transport Systems (Safety) Regulations 2006.

GEMINI

Contains details of multiple unit and locomotive-hauled passenger rolling stock. Data is passed via an open interface and allows engineers, rolling stock and performance managers to examine information about vehicles without the need to access individual, 'lower level' systems – the data is fed directly to GEMINI. This allows users in other businesses to track the whereabouts of particular vehicles (for maintenance purposes) or to establish the vehicles working a particular service.

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.

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. Forms available here.

R2

A database for rolling stock registration, maintenance planning and component tracking, managed and owned by the RSSB. R2 is a replacement for two systems – the Rolling Stock Library (RSL) and the Rail Vehicle Records System (RAVERS).

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.

Timing Point Location (TIPLOC)

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.

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.

Train Service Information (TSI) and Train Service Information Access System (TSIA)

A database of train schedules formatted for use by train operations systems and is updated daily with information from Train Service Data Base. TSI holds all the train schedules to be used by TRUST and related systems – information is passed forward to TRUST. The user interface to TSI is TSIA.

Working Timetable (WTT)

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.

10.2 Abbreviations

ATO	Automatic Train Operation
CCF	Control Centre of the Future
CCIL	Control Centre Incident Log
C-DAS	Connected Driver Advisory System
CIF	Common Interface File
CIS	Customer Information System
ConOps	Concept of Operations
CSC	Common System Capabilities
DAS	Driver Advisory System
DfT	Department for Transport
ECI	Early Contractor Involvement
ERTMS	European Railway Traffic Management System

ETCS	European Train Control System
FOC	Freight Operating Company
GB	Great Britain
GBTT	Great British Timetable (Public Timetable)
GSM-R	Global System for Mobile Communications - Railway
HMI	Human Machine Interface
IM	Infrastructure Manager
IMS	Incident Management System
IT	Information Technology
ITPS	Integrated Train Planning System
LINX	Layered Information Exchange
LMS	Learning Management System
LTP	Long-term Plan
MOM	Mobile Operations Manager
N-DAS	Networked Driver Advisory System
ORR	Office of Rail and Road
PNB	Personal Needs Break
RAVERS	Rail Vehicle Records System
RDG	Rail Delivery Group
RSSB	Rail Safety and Standards Board
ROGS	Railways and Other Guided Transportation System (Safety) Regulations 2006
RoSCo	Rolling Stock leasing Company
RSL	Rolling Stock Library
RU	Railway Undertaking
SDO	Selective Door Opening
STP	Short Term Planning
S-DAS	Standalone Driver Advisory System
TCCM	Train Coupling Compatibility Matrix
TD	Train Describer
TD.NET	Train Data via Internet
TIPLOC	Timing Point Location
TOPS	Total Operations Processing System
TRUST	Train Running Systems TOPS
TSI	Train Service Information
TSIA	Train Service Information Access System
VSTP	Very Short-Term Planning
WTT	Working Timetable

11 Related Documents

11.1 References

[RD1] Digital Railway Programme – Concept of Operations Strategy (Issue 1.0, April 2017), reference: 000000-NWR-PLN-MPM-000005.

[RD2] Workstream 1.9 Traffic Management interfaced to Stock and Crew – Early Contractor Involvement (ECI) Findings Report (Issue 1, November 2017), Digital Railway Programme.

[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).

[RD9] Catalogue of Railway Code Systems (Issue 9, October 2015), Network Rail.

[RD10] RDG-CSC-NTI-001 Common System Capabilities - Stock and Crew (Version v1.0, July 2018), Rail Delivery Group.

[RD11] RDG Crew and Stock Systems Task and Finish Group - Final Technical Report with Process Maps (Version 1.0, May 2019), Rail Delivery Group.

12 Appendices

A.1 Industry Forms

Below are a number of industry forms that may be relevant for background understanding. A brief description of the form is noted in the caption.

Turn Number		Loco/ Unit	Action	Location	Arr Time	Dep Time	Train	GSMR Code	Ref	Days
A TOC										
STP	ABC 123									
DVR										SO
On	09:00		MOB							
Off	17:00	416		London Broad Street		09:15	2U82 DOO	32564		
Hrs	8.00			(after working 08:50 from Primrose Hill)						
Days	SO			Norton Bridge	11:00					
From	01/01/2017		IMMO							
To	31/12/2017									
			TAXI	Norton Bridge		11:10			(A)	
				Standon Bridge	11:30					
			MOB							
		310		Standon Bridge		11+33	5S11	62351		
				(after working 10:23 from Weedon)						
				(via Relief Line)						
			RM	Hawick	12+17	12+20	5S11	62351		
				Deadwater	12+50					
			IMMO							
			PNB							
			MOB							
		316		Deadwater		13+50	5L54	87429		
				Claypole	15+25					
			IMMO							
			BREAK							
			MOB							
		373		Claypole		16:05	1A36	57238		
				(after working 15:16 from Heck)						
				Kings Cross York Road	17:00					
			IMMO							
			(A)	also conveys ABC456						
Routes	FH4 DL7 AK3 KR5 ER3 NH4									

Figure 5: Crew Job Card / Diagram

```
Diagram     :ABC   123 TO            14/11/2017 14/11/2017 STP
Fleet       :    421/7

OFF         :

VICTORIA CS            05+03  5S04
VICTORIA     05+10                 REVERSE
VICTORIA               06.00  1S04                          2752
DOVER MAR    07.37                 REVERSE
DOVER MAR              09.00  1P16                          2365
VICTORIA     10.37                 REVERSE
VICTORIA               12.00  1S28                          1274
DOVER MAR    13.37                 REVERSE
DOVER MAR              15.00  1P40                          8435
VICTORIA     16.37                 REVERSE
VICTORIA               18.00  1S52                          6432
DOVER MAR    19.37                 REVERSE
DOVER MAR              21.00  1P64                          3582
VICTORIA     22.37                 REVERSE
VICTORIA               23+00  5P64
VICTORIA CS  23+10

WORKS       :

MILES       : (LD)    484.2   (ETY)    6.4      (TOT)    490.6
```

Figure 6: Stock Diagram

VSTP SCHEDULE REQUEST FORM

(Note: only use for trains required to run within 48 hours)

Network Rail

TO:	NETWORK RAIL CONTROL:	WESTERN (CARDIFF)	DATE: 14/11/2017	TIME:	1400

FROM:	A TOC A TOC House 123 Railway Road London RA11 WAY	REF: Tel No: B.R.T.: Tel No: B.T.: Fax No: TOPS LATA	 01234567890 01234567890

TRAIN DETAILS Requested

Reporting Number:	5W14	Days Run:	ThO	Dates:	14/11/2017	Unit/Traction Type:	220

Train Category:	Sector:	27	Train Service Code (Profit Centre):
PE - Empty Coaching Stock	Sub-sector:	01	Voyager/HST ECS moves

Origin Location	Stanox	Requested Departure Time
Bristol Barton Hill Depot	81432	0530

Destination Location	Stanox	Requested Arrival Time
Birmingham New Street	65630	0720

Requested Route ("via") and comments:

No driver relief required. Set to form 1W14 0745 Birmingham New Street - Camp Hill. To depart depot North end.

Max speed of slowest vehicle	Number of Vehicles:
125 mph	4

Driver Only Operation:	Is return working involved?	If yes, Number of forms attached
YES	NO	

Intermediate Calling Points *NOTE - Network Rail to input all other timing, passing and TRUST points as required.*

Location Name	Stanox	Requested Arr/Dep/Dwell		Type of Consist	Power Change?	Remarks/Reversal Points etc.
None						

The Above Additional Train Movement To The Publicised Timetable is Requested To Run.

Representative (Print Name): A CONTROLLER

Signature: *A Controller*

Position/Job Title: ROUTE CONTROLLER

NETWORK RAIL CONFIRMATION

The above additional train movements to the publicised timetables is AGREED/DECLINED

Train Reporting No: (UWTTID) _____ Departure Time: _____

Train will be run by Regional Control arrangement and every endeavour will be made to meet the schedule requested but pathway and performance cannot be guaranteed. NOTE: The completed document forms a contract.

Representative (Print Name): _____ Signature: _____

Reference Number: _____ Date & Time Request Received: _____

Any queries regarding this pathway should be made to the above Regional Control on:

Telephone No: _____ Fax: _____ TOPS LATA: _____

Figure 7: RU VSTP Form for validation by the IM.

A.2 Layered Information Exchange (LINX) Message Flows

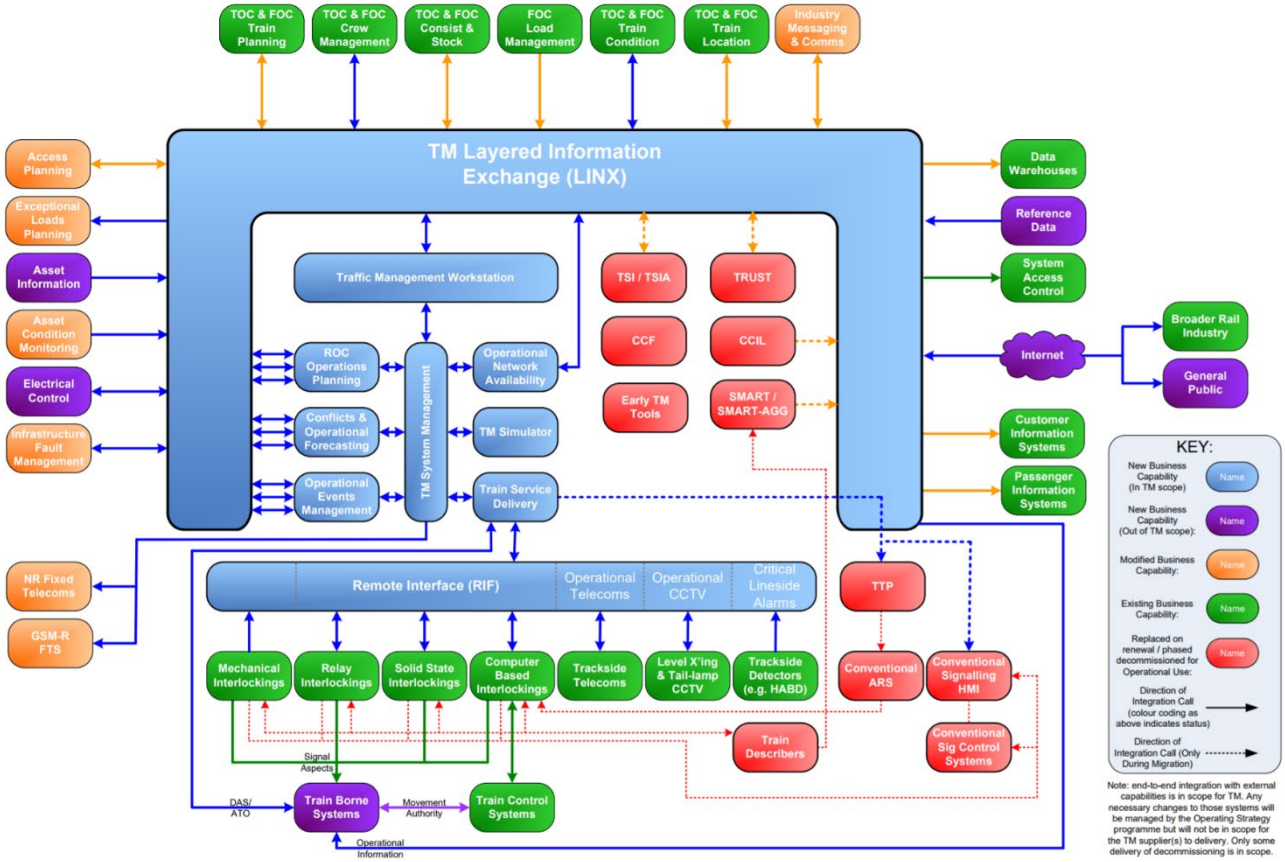
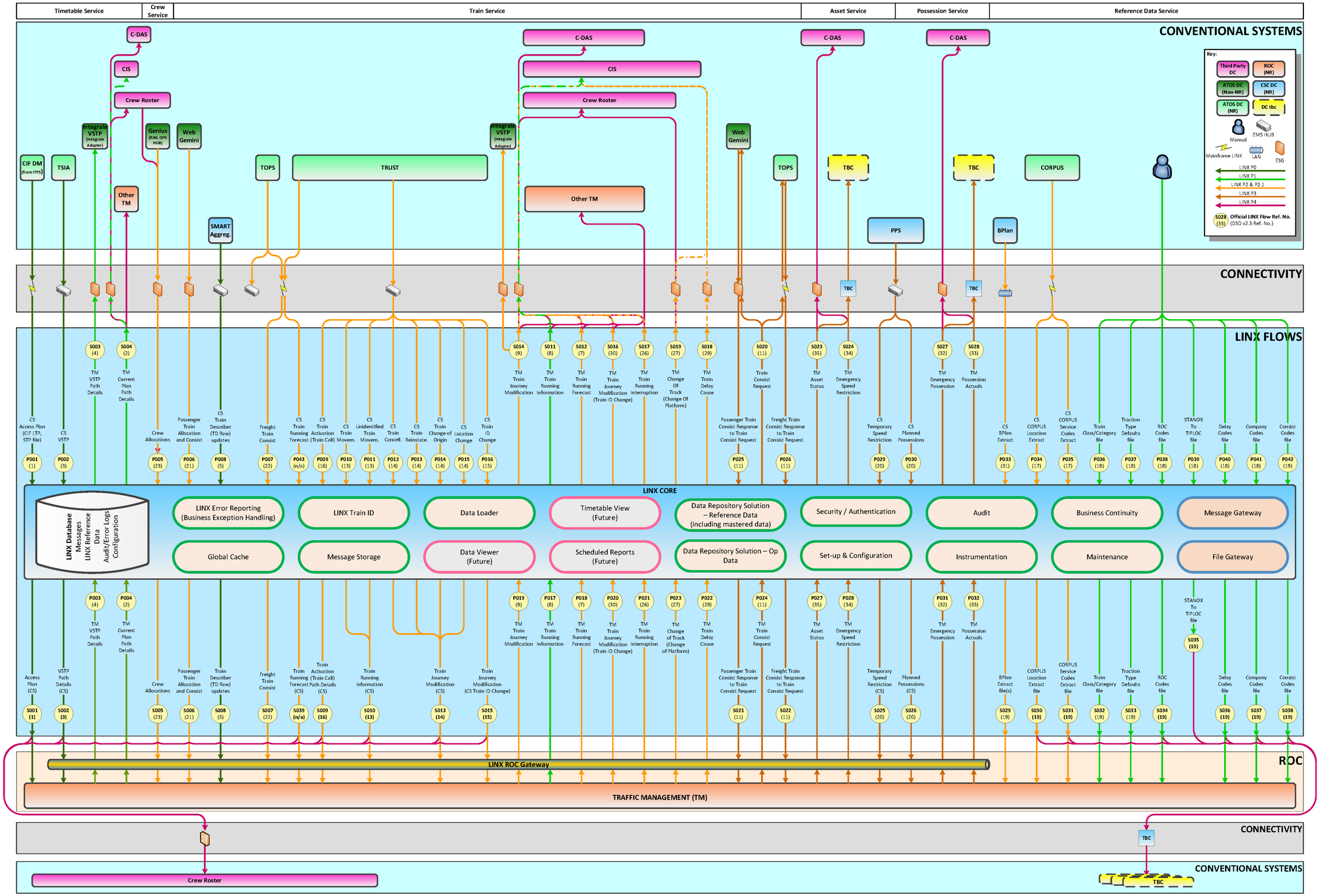
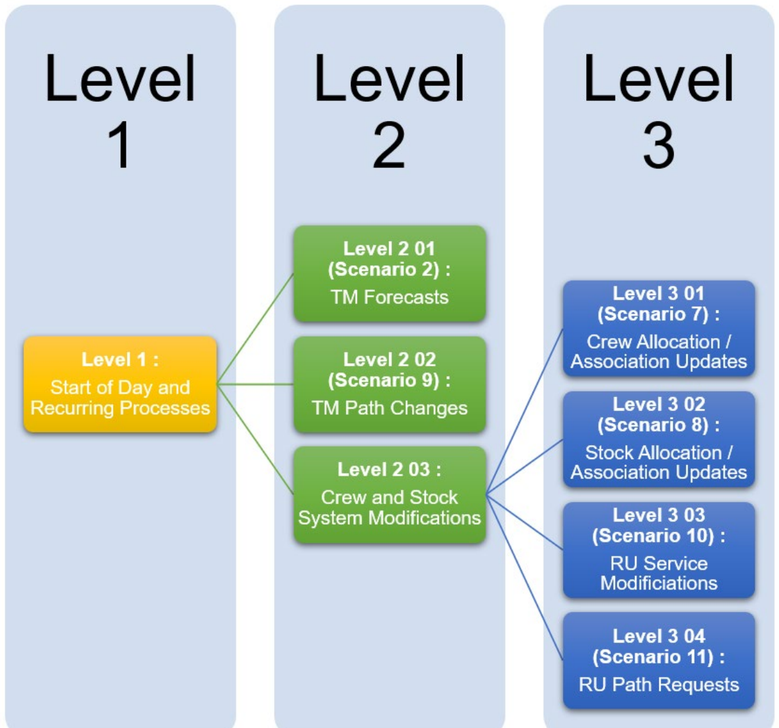


Figure 8: Systems capable of interacting with LINX


Timetable Service
Crew Service
Train Service
Asset Service
Possession Service
Reference Data Service
CONVENTIONAL SYSTEMS
C-DAS
CIS
Crew Roster
Integrale VSTP (Integrale Adapter)
Genius (RAIL OPS HUB)
Web Gemini
CIF DM (from ITPS)
TSIA
Other TM
SMART Aggreg.
TOPS
TRUST
Other TM
TBC
PPS
BPlan
CORPUS
Key:
Third Party DC
ROC (NR)
ATOS DC (Non-NR)
CSC DC (NR)
ATOS DC (NR)
DC tbc
Manual
EMS HUB
Mainframe LINK
LAN
ESG
LINX P0
LINX P1
LINX P2 & P2.1
LINX P3
LINX P4
S028 (33) Official LINX Flow Ref. No. (DSD v2.5 Ref. No.)
CONNECTIVITY
LINX FLOWS
S003 (4) TM VSTP Path Details
S004 (2) TM Current Plan Path Details
S014 (9) TM Train Journey Modification
S011 (8) TM Train Running Information
S012 (7) TM Train Running Forecast
S016 (30) TM Train Journey Modification (Train ID Change)
S017 (26) TM Train Running Interruption
S019 (27) TM Change Of Track (Change Of Platform)
S018 (29) TM Train Delay Cause
S020 (11) Train Consist Request
S023 (35) TM Asset Status
S024 (34) TM Emergency Speed Restriction
S027 (32) TM Emergency Possession
S028 (33) TM Possession Actuals
CS Access Plan (CIF LTP, STP file)
CS VSTP
Crew Allocations
Passenger Train Allocation and Consist
CS Train Describer (TD Raw) updates
Freight Train Consist
CS Train Running Forecast
CS Train Activation (Train Call)
CS Train Movem.
CS Unidentified Train Movem.
CS Train Cancell.
CS Train Reinstate.
CS Train Change of Origin
CS Location Change
CS Train ID Change
Passenger Train Consist Response to Train Consist Request
Freight Train Consist Response to Train Consist Request
CS Temporary Speed Restriction
CS Planned Possessions
CS BPlan Extract
CS CORPUS Location Extract
CS CORPUS Service Codes Extract
Train Class/Category file
Traction Type Defaults file
ROC Codes file
STANOX To TIPLOC file
Delay Codes file
Company Codes file
Consist Codes file
P001 (1)
P002 (3)
P005 (23)
P006 (21)
P008 (5)
P007 (22)
P043 (n/a)
P009 (16)
P010 (13)
P011 (13)
P012 (14)
P013 (14)
P014 (14)
P015 (14)
P016 (15)
P025 (11)
P026 (11)
P029 (20)
P030 (20)
P033 (31)
P034 (17)
P035 (17)
P036 (18)
P037 (18)
P038 (18)
P039 (18)
P040 (18)
P041 (18)
P042 (19)
LINX CORE
LINX Database Messages LINX Reference Data Audit/Error Logs Configuration
LINX Error Reporting (Business Exception Handling)
LINX Train ID
Data Loader
Timetable View (Future)
Data Repository Solution – Reference Data (including mastered data)
Security / Authentication
Audit
Business Continuity
Message Gateway
Global Cache
Message Storage
Data Viewer (Future)
Scheduled Reports (Future)
Data Repository Solution – Op Data
Set-up & Configuration
Instrumentation
Maintenance
File Gateway
P003 (4)
P004 (2)
P019 (9)
P017 (8)
P018 (7)
P020 (30)
P021 (26)
P023 (27)
P022 (29)
P024 (11)
P027 (35)
P028 (34)
P031 (32)
P032 (33)
S035 (19)
Access Plan (CS)
VSTP Path Details (CS)
Train Running Forecast (CS)
Train Activation (Train Call) Path Details (CS)
Train Running Information (CS)
Train Journey Modification (CS)
Train Journey Modification (CS Train ID Change)
Temporary Speed Restriction (CS)
Planned Possessions (CS)
BPlan Extract file(s)
S001 (1)
S002 (3)
S005 (23)
S006 (21)
S008 (5)
S007 (22)
S039 (n/a)
S009 (16)
S010 (13)
S013 (14)
S015 (15)
S021 (11)
S022 (11)
S025 (20)
S026 (20)
S029 (19)
S030 (19)
S031 (19)
S032 (19)
S033 (19)
S034 (19)
S036 (19)
S037 (19)
S038 (19)
LINX ROC Gateway
ROC
TRAFFIC MANAGEMENT (TM)
CONNECTIVITY
TBC
CONVENTIONAL SYSTEMS
Crew Roster
TBC

A.3 Interactions with Traffic Management Process Maps



A Task and Finish Group, reporting to the National Task Force Better Operations Programme Board, was set up to address some of the system constraints highlighted in version 1.0 of the Crew and Stock System Concept of Operations, published by the Rail Delivery Group (RDG) in 2018. Five meetings were held between October 2018 and March 2019 culminating in the publication of a Final Technical Report in May 2019 (available on the RDG website). The group considered:

– Interactions with Traffic Management,

– Additional Layered Information Exchange (LINX) messages,

– Interfaces with other systems,

– Legacy file formats,

– Who owns the interface requirements etc.

A major task for the group was to further expand on the interactions between Traffic Management and Stock and Crew Systems, developing a more detailed industry view on which systems have which responsibilities – this was completed via a set of Process Maps. The maps were reorganised into 'Levels' with series of interrelated tasks forming part of each level – see left-hand diagram. The Process Maps themselves are shown on the following pages – note that a symbology key is available on the final page.

The Process Maps detail where information/data is passed between different systems – where this is to be via LINX, an assessment has been carried out as to whether:

- An existing message is already available in the LINX Service Catalogue.
- An existing message is already available in the LINX Service Catalogue but requires alteration.
- A message to fulfil this function is not available in the LINX Service Catalogue at this time. Where possible, nomenclature from the European Telematics Applications for Freight/Passenger Services Technical Specification for Interoperability (TAF TAP TSI) has been used to give an indication of the messages' content.

The Process Maps demonstrate that there are 28 messages required for the interactions between the two systems. The table below highlights the number of messages which fall into the categories listed above.

Message Availability	Number of Messages
LINX message already available	13
Current LINX message requires alteration	2
New LINX message required	13

The following table lists of all the messages used in the Process Maps, grouped by message availability. The map in which the message is used is also included as well as: whether the message is subscribed to or published from the Crew and Stock System and the message maturity (as defined by Network Rail).

LINX MESSAGE	PROCESS MAP	C&S PUBLISHES OR SUBSCRIBES?	MATURITY	COMMENT
LINX message already available				
TM Train Running Forecast	2 01	SUBSCRIBES	Built, not tested	
CS Train Running Forecast	2 01	SUBSCRIBES	Live	
TM Train Running Information	2 01	SUBSCRIBES	Built, not tested	
CS Train Running Information	2 01	SUBSCRIBES	Live	
CS Train Activation	2.01	SUBSCRIBES	Live	
TM Train Running Interruption	2 01	SUBSCRIBES	Built, not tested	
TM Train Journey Modification	2 02	SUBSCRIBES	Live	
CS Train Journey Modification	2 02	SUBSCRIBES	Live	
TM Change of Track / Platform	2 02	SUBSCRIBES	Built, not tested	
Passenger Train Allocation and Consist	3 02	PUBLISHES	Built, not tested	
Freight Train Consist	3 02	PUBLISHES	Live	
TM VSTP Path Details	Not shown	N/A	Live	Not shown, part of TM VSTP process
CS VSTP Path Details	Not shown	N/A	Live	Not shown, part of TM VSTP process
Current LINX message requires alteration				
Crew Allocation	3 01	PUBLISHES	Built, not tested	Longer term aspiration
Path Details [including Path Details : Modification]	3 04	PUBLISHES AND SUBSCRIBES	Built, not tested	

LINX MESSAGE	PROCESS MAP	C&S PUBLISHES OR SUBSCRIBES?	MATURITY	COMMENT
New LINX message required				
Train Ready to Go	1 01, 3 03	PUBLISHES	Not built	3 03 adds 'Train Ready Time'
TM Path Request / Modification	2 02	SUBSCRIBES	Not built	
Path Accepted	2 02	PUBLISHES	Not built	
Path Rejected	2 02	PUBLISHES	Not built	
Crew Shift Allocation	3 01	PUBLISHES	Not built	Analogous to Crew Diagram
(RU) Path Request : Modification	3 02, 3 04	PUBLISHES	Not built	
RU Train Running Interruption	3 03	PUBLISHES	Not built	
RU Train Journey Modification Request	3 03	PUBLISHES	Not built	
RU Very Short-Term Plan (VSTP) Path Details	3 04	PUBLISHES	Not built	
Path Confirmed	3 04	PUBLISHES	Not built	
Path Confirmation Acknowledge	3 04	SUBSCRIBES	Not built	May not be required
Path Details Refused	3 04	PUBLISHES	Not built	
Path Not Available	3 04	SUBSCRIBES	Not built	

Rail Delivery Group

National Rail

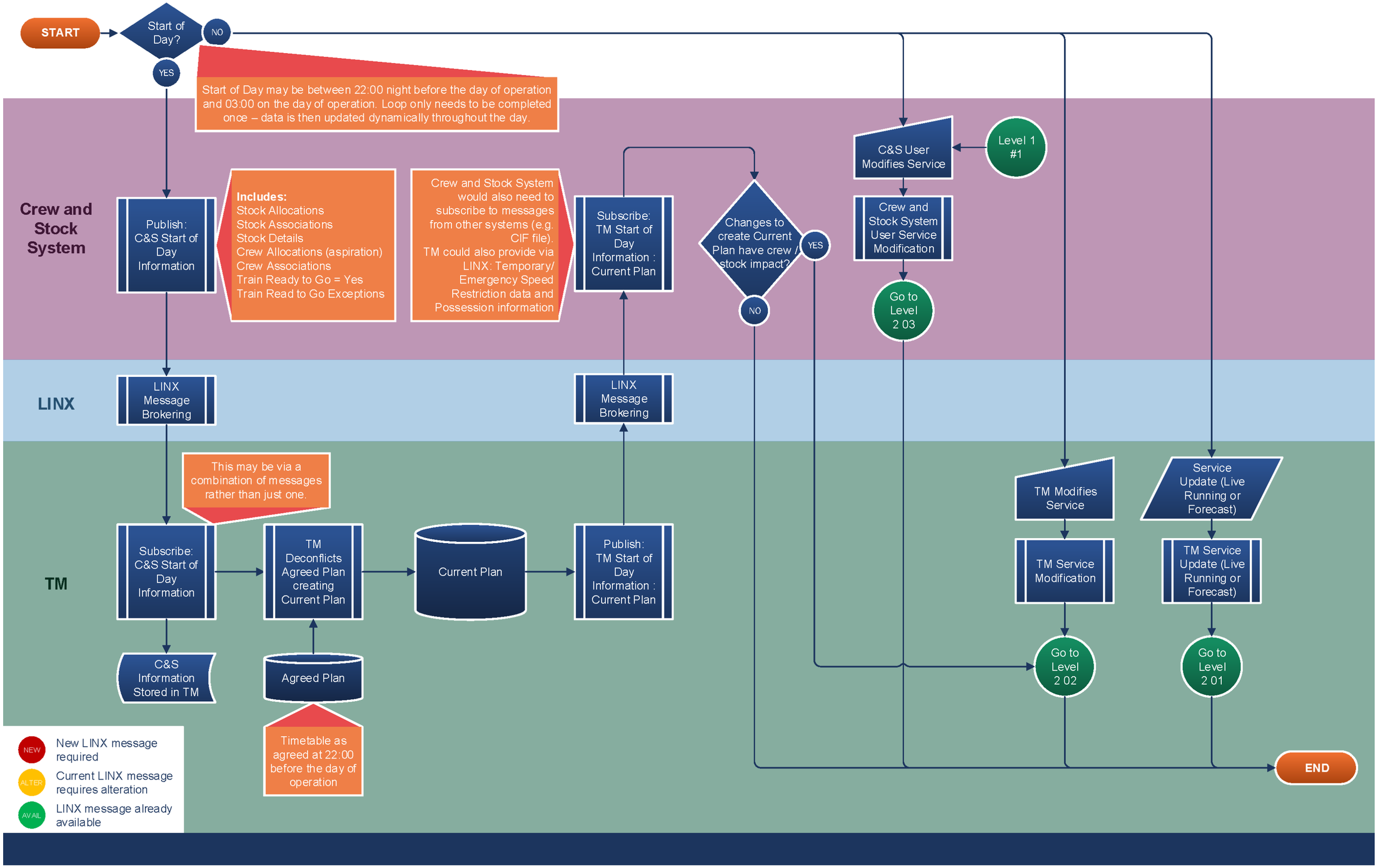
Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 1: Start of Day and Reoccurring Processes

Inbound Map(s): 2 02, 2 03, 3 04

Outbound Map(s): 2 01, 2 02, 2 03



Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 2 01 : Forecasts from TM to C&S System

Inbound Map(s): 1 2 02 3 03 3 04

Outbound Map(s): None

Crew and Stock System

LINX

TM

Legacy Systems

START

Train Ready Time must be provided to prevent 'indefinite delay'

Forecast can be estimated?

NO

YES

Publish: Train Running Interruption Message (P021) AVAIL

Publish: Train Running Information Message (P017) AVAIL

Publish: Train Running Forecast Message (P018) AVAIL

Publish: CS Train Running Information Message (S010) AVAIL

Publish: CS Train Running Forecast Message (P012) AVAIL

Publish: CS Train Activation Message (S009) AVAIL

LINX Message Brokering

Subscribe: Train Running Interruption Message (S017) AVAIL

Subscribe: Train Running Information Message (S011) AVAIL

Subscribe: Train Running Forecast Message (S012) AVAIL

Subscribe: CS Train Running Information Message (S010) AVAIL

Subscribe: CS Train Running Forecast Message (S039) AVAIL

Subscribe: CS Train Activation Message (S009) AVAIL

Train Service information updated in C&S System

END

Train Service Information

Crew and Stock System will also need to subscribe to forecasts from legacy systems – shown here for note. Coordination between legacy systems and TM(s) assumed to be designed by the IM.

NEW New LINX message required

ALTER Current LINX message requires alteration

AVAIL LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 2 02 : TM Path Changes

Inbound Map(s): 1

Outbound Map(s): 1, 2 01, 3 03

Crew & Stock System

Defined in Concept of Operations – see scenario 7.4.3. TM cannot ask for crew or stock changes so does not need to follow the same set of processes defined in "C&S Service Modification" process map

C&S System assesses path request / modification

Can crew or stock take route? NO / YES

Path alteration acceptable without modification? NO / YES

Path alteration acceptable with modification? NO / YES

If the C&S user is to propose alternative path, TM's suggestion must be rejected.

C&S System path modification

Go to Level 3 03

Note: could come from conventional systems (CS Train Journey Modification, S013 & S015)

TM updates forecasts / running information

Go to Level 2 01

Subscribe : TM Path Request / Modification (NEW)

Publish : Path Accepted Message (NEW)

Subscribe : TM Train Journey Modification (AVAIL)

Subscribe : TM Change of Track / Platform (AVAIL)

Publish : Path Rejected Message (NEW)

LINX

LINX Message Brokering

TM

TM can only make path modification, it cannot ask for crew or stock changes. Modification itself is done at Level 1

TM uses data supplied at Start of Day (updated as changes occur). Used to narrow down options so that unsuitable ideas are discounted before communication with C&S

START

TM Stock Allocation and Details Data

TM Stock Suitability Cross-Check

Publish: TM Path Request / Modification (NEW)

Subscribe : Path Accepted Message (NEW)

Publish: TM Train Journey Modification (AVAIL)

Publish: TM Change of Track / Platform (AVAIL)

Subscribe : Path Rejected Message (NEW)

Stock suitable for new route? NO / YES

Limited impact? NO / YES

Go to Level 1 #1

Small or limited changes could be accepted automatically – this would be predefined beforehand. A pre-agreed cancellation could be an example

Path alteration incorporated into Current Plan

TM determines appropriate message

Go to Level 1 #1

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 2 03: Crew and Stock System Modification

Inbound Map(s): 1, 3 04

Outbound Map(s): 1, 3 01, 3 02, 3 03, 3 04

Crew and Stock System

START

Note: the actual modification in the Crew and Stock System is done in Level 1

Modification has Crew Alteration? (NO / YES)

Level 2 03 #1

Allocate crew / stock to service

Modification has Stock Alteration? (NO / YES)

All Essential Crew Allocated? (YES / NO)

New Path Request / RU Path Modification? (NO / YES)

Service Mod. (inc. Cancellation, Service Change)? (NO / YES)

Crew Competence

Rolling Stock Details

Route Information

May be external database

Crew Competence Cross-check

Stock Suitability Cross-check

Crew Suitable? (NO / YES)

Stock Suitable? (NO / YES)

Train to be put on hold

Go to Level 3 03 #1

Go to Level 3 04

Go to Level 3 03 #1

Go to Level 3 01

Go to Level 3 02

Crew and Stock System Rejects Crew Alteration

Crew and Stock System Rejects Stock Alteration

Alternate allocation could be made? (NO / YES)

Alternate allocation could be made? (NO / YES)

C&S User Guided to Make Different Allocation

Train to be put on hold

C&S User Guided to Make Different Allocation

Go to Level 1 #1

Go to Level 3 03 #1

Go to Level 1 #1

END

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 3 01 : Crew Allocation / Association update from C&S to TM

Inbound Map(s): 2 03

Outbound Map(s): None

Crew & Stock System

START

Crew allocation data updated?

NO

YES

Publish: Crew Allocation Message (P005)

ALTER

This message may be required in the longer term when interactions between the two systems are more detailed. In the short-term, TM has no need to know the crew allocation. Note "whether all essential crew are allocated" forms part of Level 2 03

Crew association data updated?

NO

YES

Note: Crew Shift Allocation is analogous to Crew Diagram. Recommendation would be to change name. No crew names are transferred.

Publish: Crew Shift Allocation Message (P044)

NEW

LINX

LINX Message Brokering

LINX Message Brokering

TM

Subscribe: Crew Allocation Message (S005)

ALTER

Subscribe: Crew Shift Allocation Message (S040)

NEW

Crew allocation data (in TM) updated

Crew association data (in TM) updated

Crew Allocation Data Stored in TM

Crew Association Data Stored in TM

END

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 3 02 : Stock Allocation / Association update from C&S to TM

Inbound Map(s): 2 03

Outbound Map(s): None

Crew & Stock System

START

Stock allocation data updated?

NO

YES

ECS = Empty Coaching Stock

TOC Service (inc ECS)?

YES

NO

Publish: Passenger Train Consist Message (P006) — AVAIL

Publish: Freight Train Consist Message (P007) — AVAIL

Stock association data updated?

NO

YES

"Path Request : Modification" is also used in Level 3 04. Whilst this message can be used individually to only change stock association, it could be combined with main message in Level 3 04. 'Next Working' parameter (diagram dependence) is changed.

Publish: Path Request : Modification Message — NEW

LINX

LINX Message Brokering

LINX Message Brokering

LINX Message Brokering

TM

Subscribe: Passenger Train Consist Message (S006) — AVAIL

Subscribe: Freight Train Consist Message (S007) — AVAIL

Whilst termed a "Path Request Modification", does not require bid-offer process with TM / IM. Path change requests (e.g. for change of platform) is covered under Level 3 04.

Subscribe: Path Request : Modification Message — NEW

Passenger Stock allocation data (in TM) updated

Freight Stock allocation data (in TM) updated

Stock association data (in TM) updated

Stock Allocation Data Stored in TM

Stock Association Data Stored in TM

END

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 3 03 : RU Service Modification

Inbound Map(s): 2 02 2 03

Outbound Map(s): 2 01

Crew & Stock System

START

Level 3 03 #1

Service reforecast required?

NO

YES

END

Schedule modification made?

NO

YES

Would include (non-exhaustive):
- Not to Stop Orders.
- Additional Stop Orders.
- Cancellations.
- Part-Cancellations (inc. terminate short, start forward).
- Change to pick-up/drop off only calls.

Note: any path changes would be picked up in Level 3 04.

Train Ready Status may have been set to 'Not Ready' at Start of Day

Forecast can be estimated?

YES

NO

Current Train Ready Status = Not Ready?

NO

YES

Input Timing Amendments

YES

Service started journey?

YES

NO

Forecast now estimable?

NO

YES

External Event : (Wait for) Situation Change

Publish: RU Train Running Interruption NEW

Publish: Train Ready Msg. = Not Ready & Train Ready Time NEW

Publish: Train Ready Msg. = Ready & Train Ready Time NEW

Publish: RU Train Journey Modification Request Message NEW

Whilst termed a "Train Journey Modification", this portion of the flow does not require bid-offer process with TM / IM. In some cases, there is nothing the RU can do and the IM must accept (rejection would lead to infinite loop). There may be discussion and agreement with the IM before message is triggered, as per current procedures. Path change requests (e.g. for part cancellations, different platform etc.) are covered under Level 3 04.

LINX

LINX Message Brokering

LINX Message Brokering

LINX Message Brokering

LINX Message Brokering

TM

Subscribe: RU Train Running Interruption NEW

Subscribe: Train Ready Msg. = Not Ready & Train Ready Time NEW

Train Ready Time required to avoid 'indefinite delay'

Subscribe: Train Ready Msg. = Ready & Train Ready Time NEW

Subscribe: RU Train Journey Modification Request Message NEW

Go to Level 2 01

Train 'on hold'

Deconflict. Train Running Forecasts Updated

There may be an operational need to create (and keep separate) 'Public Facing' forecasts and 'Operational Forecasts'. This gives the RU the opportunity to alter information going to customers via DARWIN. Exactly how this would be done has not been considered at this stage.

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

Level 3 04 : RU Path Request

Inbound Map(s): 2 03

Outbound Map(s): 1, 2 01, 2 03

Crew & Stock System

START

Note that action to modify path or create new path (VSTP) is at Level 1

VSTP Request? NO / YES

Full VSTP Path Built up by C&S System

Uses assumption that this is an Integrated Crew and Stock System with train planning functionalities that can build up a full train path with appropriate running times etc.

Publish: RU VSTP Path Details Message (NEW)

Publish: Path Request : Modification Message (NEW)

May be a VSTP Path Detail (CS) [S002] message or TM Current Plan Path Details Message [S004]

Subscribe: Path Details Message (ALTER)

Path Details Validated

Publish: Path Confirmed Message (NEW)

To assign crew and stock to service

Go to Level 2 03 #1

Subscribe: Path Confirmation Acknowledge (NEW)

YES / Modifications acceptable? / NO

Subscribe: Path Details : Modification (ALTER)

Publish: Path Details Refused Message (NEW)

Go to Level 1 #1

C&S User Guided to Resubmit Path Allocation

Subscribe: Path Not Available Message (NEW)

LINX

LINX Message Brokering

TM

Subscribe: RU VSTP Path Details Message (NEW)

Assess request against current plan

VSTP Path could be delivered with RU advised 'time constraints' around the start and end time. This allows TM flexibility to alter path.

Path acceptable without alteration? YES / NO

Subscribe: Path Request : Modification Message (NEW)

Assess request against current plan

Publish: Path Details Message (ALTER)

Path acceptable without alteration? YES / NO

Subscribe: Path Confirmed Message (NEW)

Go to Level 2 01

Publish train running information & forecasts

Publish: Path Confirmation Acknowledge (NEW)

Legacy systems are also informed at this stage via internal TM process(es)

Publish: Path Details : Modification (ALTER)

Path acceptable with alteration? YES / NO

Subscribe: Path Details Refused Message (NEW)

END

Publish: Path Not Available Message (NEW)

NEW — New LINX message required

ALTER — Current LINX message requires alteration

AVAIL — LINX message already available

Rail Delivery Group

National Rail

Crew and Stock Systems: Task and Finish Group

Traffic Management Interactions: Process Mapping

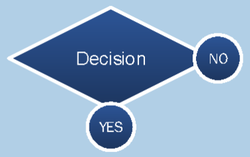
Symbol Index

Terminators (START and END)

Off-page reference / link **or** Inbound link on map (defined by previous step)

Process

Predefined Process (although may not be defined as part of the Process Mapping exercise)



Decision required (YES or NO)

Data is stored within system for later use

Data stored within system is accessed

Large database of information (may be external to system)

Manual input by system user required

Data input required by system

Manual operation must be undertaken by system user

External Event not controlled by the system or user

New LINX message required

Current LINX message requires alteration

LINX message already available