RDG-GN/NTI/015
Issue Two
Date September 2017

RDG Guidance Note Managing ERTMS Performance

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Synopsis

This document provides guidance to train operators on managing performance of the ERTMS signalling system.

Applicability

This Guidance Note has been prepared for passenger and freight operators. However, its content may also be of use to others.

Issue record

Issue	Date	Comments
One	March 2016	First issue
Two	September 2017	Reformatted to new RDG standard and updated

Contents

Part 1 About this Document

1.1 Responsibilities

1.1.1 Copies of this Guidance Note should be distributed by RDG members to persons within their respective organisations for whom its content is relevant.

1.2 Explanatory note

1.2.1 RDG produces Guidance Notes for the information of its members. RDG is not a regulatory body and compliance with RDG Guidance Notes is not mandatory.

1.2.2 RDG Guidance Notes are intended to reflect good practice. RDG members are recommended to evaluate the guidance against their own arrangements in a structured and systematic way. Some or all parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not to adopt) elements of the guidance should be documented.

1.3 Guidance Note status

1.3.1 This document is not intended to create legally binding obligations between railway duty holders. This note is provided for guidance only.

Part 2 Introduction & Knowledge Summary

2.1 Introduction

2.1.1 The introduction of ERTMS is a major business change for the UK rail industry. This Guidance Note has been written to help railway staff who are involved in the performance management of the railway understand how the introduction of ERTMS will affect train service performance and the way in which it will need to be managed.

2.1.2 The management of train service performance is a key part of many different job descriptions, so not everything in this Guidance Note will be applicable to everyone who might read it.

2.1.3 This Guidance Note covers the types of issues that could affect TOC/FOCs performance. The document assumes a basic understanding of what ERTMS is, the different levels of deployment, and how it differs from conventional signalling and train protection systems in use nationally.

2.2 ERTMS Performance Management Knowledge Summary

2.2.1 The following bullet points provide a brief overview of important topics to be covered in more detail in this Guidance Note.

a) The benefits and disbenefits to performance which come from implementing ERTMS.
b) The top risks to performance delivery during the different stages of ERTMS development and deployment.
c) How to estimate the performance impact of introducing ERTMS.
d) The different performance measures used to assess the impact of ERTMS.
e) The national DRACAS process:
    - Identification of best practice and learning from other ERTMS deployments.
    - The stakeholders involved in ERTMS performance management and their different responsibilities.
    - The process for identifying, diagnosing and resolving problems with ERTMS.
    - The different systems used to investigate and manage ERTMS faults and incidents.

Part 3 Understanding and Managing ERTMS Performance

3.1 Introduction

3.1.1 The introduction of ERTMS changes the way in which the train service is planned and operated. The new way of working can provide benefits to train service performance through improvements to the permanent timetable and to the way the service is managed. However, ERTMS could create disbenefits if the changes are implemented without considering the effect upon train service performance.

3.2 Performance benefits

Train planning

Increased line speed

3.2.1 ETCS removes the need for permanent speed restrictions to be applied due to signal sighting constraints, because the driver can continuously manage the train's speed and braking using information on the route ahead from the Driver Machine Interface (DMI).

Improved traffic flow

3.2.2 On ETCS Level 2 deployments without lineside signals, block section lengths are no longer constrained by restrictions such as sighting (as mentioned above) or the need for uniformity between parallel running lines. This allows the section lengths to be optimised for traffic flow, speed or capacity.

3.2.3 On ETCS Level 2 overlay deployments, existing signal sections could be split with additional marked block sections (also referred to as virtual sections) to allow ETCS fitted trains to move closer to the train in front, thereby reducing congestion.

3.2.4 The introduction of ETCS means that approach control protection at junctions is no longer required, improving flow through junctions.

Ability to run trains closer together

3.2.5 ETCS constantly supervises trains' speed, therefore trains can be safely spaced based on their braking capability rather than that of the worst performing train on the route.

Removal of speed restrictions for light engines and short-formed trains

3.2.6 Speed restrictions for light engines are no longer required because ETCS supervises the speed and braking performance of fitted trains and ensures they can be brought to a stand before they pass the End of Authority (EoA).

Removal of TPWS for terminal platforms

3.2.7 Speed restrictions imposed by TPWS on the approach to terminal platforms are no longer required as trains are supervised by ETCS This allows faster approach to platforms which will help with capacity approaching and departing from stations.

Service management

Improved implementation of reduced speed profiles (ESRs / TSRs)

3.2.8 ETCS allows reduced speed profiles to be programmed directly into the system. This ensures that the duration, magnitude and area over which the speed reduction applies is kept to a minimum. This is possible because ETCS reduces the time required to apply and remove reduced speed profiles, provides continuous speed supervision to all trains through the affected area, and supervises each train to its own braking capability. ETCS also allows the speed restriction to be applied to any length independent of sections or sighting of signs, meaning shorter affected areas than with traditional means. In fitments of ETCS Level 2 without Lineside Signals, the application of TSRs can be done efficiently without warning boards or cautioning via the signaller. This reduces the need for staff to be on track which improves safety.

Reduced performance impact from Signals Passed at Danger (SPADs)

3.2.9 ETCS provides improved safety supervision over traditional train protection systems (e.g. TPWS). Therefore, when a Movement Authority (MA) exceedance occurs (passing an End of Authority - like a SPAD) there are opportunities to manage the affected train without compromising safety but reducing the negative effect on train service performance. Also, in the event of an MA exceedance, the ETCS Emergency Brake Curve is protecting the Supervised Location (comparable to the end of the overlap) so that the MA exceedance is likely to be low impact.

Improved performance and incident management

3.2.10 ERTMS enables monitoring of the on-board system and the infrastructure which can be used to improve performance and reliability.

3.2.11 Traffic Management, coupled with a Connected Driver Advisory System (C-DAS), improves traffic flow and provides a new way to manage recovery from incidents, reducing train service disruption.

Bi-directional signalling

3.2.12 The Digital Railway Programme states that bi-directional signalling must be provided. Not providing bi-directional signalling is a major risk, leading to like-for-like renewals with no capacity improvement. ERTMS enables easier deployment of bi-directional running on routes, as it only involves some additional Eurobalise Groups and data within the Radio Block Centre (RBC).

3.3 Performance disbenefits

Train planning

Braking capabilities of trains may increase their headways

3.3.1 The timing values which train planners use to space trains depend on their theoretical braking capability. Trains with poorer braking capabilities could find that these values increase. This could affect both freight and passenger locomotive hauled trains or those with vacuum braking systems.

System design

Increased system complexity

3.3.2 Introducing new systems without removing or streamlining existing systems can reduce reliability (e.g. older fleet which are retrospectively fitted with ETCS, or existing infrastructure and signals having ETCS added in overlay).

Harder to implement improvements

3.3.3 System improvements which require changes to software (e.g. changes in functionality or display of driving information on DMI) could take much longer to implement. This is because many of the ERTMS specifications are contained within European legislation and can take time to change through due process (Change Requests). This may change with Brexit, but at time of writing, we cannot be sure of this. Currently, it is thought that on leaving the EU, it will take several years before Railway Interoperability legislation in GB law can be repealed and we could change the system outside of EU process. ERTMS specifications do support compatibility between different suppliers of track and train.

Increased reliance on GSM-R for service delivery

3.3.4 As well as the GSM-R network requirements for voice radios currently in service, all ETCS-fitted trains will require additional network capacity to support data transmissions. The reliance on GSM-R for service delivery means that issues such as network capacity, coverage, availability and interference for Public Mobile Network Operators (PMOs) can affect train service performance more than they do at present.

3.3.5 Network capacity risks can be mitigated using packet switching protocols. These allow multiple radios to make use of the same telecoms channel where previously it would have only supported one (circuit switching protocol, as used today). GSM-R coverage risks could be reduced through strategic use of overlapping telecoms coverage areas. Availability of the GSM-R network is being addressed by Network Rail Telecoms and their Performance Improvement Project (ARTEMIS). Interference risks should be mitigated by ensuring that the ETCS data radio has the latest specification in line with the Technical Specification for Interoperability and the European Telecoms Standards Institute for to protect the train against potential causes of interference.

Risk from cyber-attacks and poor compliance with technological processes

3.3.6 It is thought that cyber-attacks could disrupt services as ETCS is a software system using a data radio. It should be noted this has been assessed as a performance rather than a safety risk.

Increased Movement Authority exceedances

3.3.7 There are more potential causes of Movement Authority exceedances than there are for SPADs, although it is thought that some of these new situations will occur very rarely. As discussed above, when these MA exceedances do occur, it is likely that they will be of low impact.

Increased chance of wrong routing events

3.3.8 On ETCS Level 2 deployments without lineside signals, lineside routing information and route indicators are not provided, therefore the driver cannot confirm the route is correct. This risk can be mitigated through the additional use of Automatic Route Setting (ARS), Traffic Management (TM) and text messages over ETCS at high risk locations.

Extension of speed reductions

3.3.9 In locations with line speed reductions, ETCS treats the point of speed change as the supervised location and supervises the train's speed down to a point before this, thereby extending the lower speed duration. This is more of a risk to trains with poorer braking capabilities. Care should be given to checking the time in which NR expects a train running through a restriction to decelerate then recover back to line speed – a lesson learned from the Cambrian implementation was that NR calculated this time to be too short and delay was wrongly attributed to the TOC.

Service management

Higher performance impact in some service disruption scenarios

3.3.10 The complexities of ETCS and the way in which it is used to manage services during disruption means that delays for some types of incidents could be worse than they are at present.

a) Assisting failed trains (especially from the rear) is more complex than on a conventionally signalled railway. Processes and support for train crew will be an important part of reducing delay.
b) Unsignalled wrong direction moves are more difficult to undertake with ETCS. Fitting bi-directional signalling is the most appropriate way to mitigate the risks from this operation.
c) The system should be designed to prevent trains from having to run for long distances in restrictive modes with low ceiling speeds. Trains should be able to step up to Full Supervision mode at the earliest opportunity.
d) ETCS design and operational rules should be created to minimise the effect of situations where trains are stopped and talked past multiple block markers.

- **Change in skill set**

3.3.11 The introduction of ERTMS affects the knowledge and competency needed by operational staff (drivers, signallers, controllers, signal box Technical Officers, fleet maintainers etc.). Initial adjustment may impact train running performance until full confidence is acquired.

3.4 Performance risks and how they change over time

3.4.1 There are four distinct time periods from scheme development through to implementation. Each has different risks and opportunities which can influence the impact of ERTMS.

Scheme Development

3.4.2 ERTMS enables an entirely new way of operating the railway, therefore it is critical that the scheme specification enables performance benefits to be realised. Too often schemes are developed to an internal client's remit rather than industry requirements. This will have a huge impact on performance if the system doesn't meet all users' needs. **The biggest risk to train service performance is not considering the implications of ERTMS early enough in scheme development, or using the current signalling as the base approach to specification and design.** Therefore, a key skill is to be able to interpret the scheme so that its impact on operation and performance is clear.

3.4.3 Schemes need to be designed to handle both current service levels and the predicted service growth over the life of the system, otherwise they will need to be upgraded again to allow for predicted growth of the railway.

Pre Go-Live

3.4.4 Decisions which have an enduring effect on performance (i.e. scheme design, train fitment and train service specification) should have been taken, so at this point the greatest risks to performance come from:

a) Infrastructure fitment.
b) Fleet fitment.
c) The introduction of new or retro-fitted fleets.
d) System testing.
e) System commissioning.

3.4.5 Activities to mitigate these risks (*e.g.* First in Class programme and use of test tracks for confidence testing) are also part of this phase and should help operators to understand the size of the risk and keep it as low as possible. The risk to performance from infrastructure fitment, removal of redundant assets and fleet introduction is expected to be low because TOCs/FOCs are familiar with managing these activities.

3.4.6 As the Go-Live date is approached and system testing is undertaken, the risk to performance increases. The risk depends on the number of possessions which have been booked to do the testing, the amount of work which has been planned to take place within the possessions and the number/severity of issues which are discovered. As the latter, cannot be known in advance, the success of minimising the performance risk comes from having a realistic and achievable plan to complete testing and commissioning activities.

3.4.7 It is planned to have a section of overlay for each scheme, which will allow trains to be tested and on-train staff to gain experience and retain competence. This should prepare staff for the eventual removal of signals. However, releasing staff for initial training, and then again to maintain competency leads to a lack of confidence in using the system which would result in additional performance incidents.

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Go-Live System Infancy

3.4.8 When ERTMS is commissioned, the number of faults and delay incidents is expected to spike as unforeseen issues become apparent. Industry partners must have open and collaborative performance management systems to deal with any issues quickly. The biggest risks to performance during system infancy are:

a) Emergent issues (i.e. faults and system glitches which cannot be predicted prior to go-live). It will not always be possible to take specific learning from other deployments (such as the Cambrian implementation), although generic lessons can be learned.
b) Issues not being dealt with quickly. If there are more issues than staff can deal with it then attribution staff will not be able to accurately allocate delay and will use 'attribution bin's.
c) Staff lack of confidence in using the system and its procedures. This can affect the speed and efficiency of managing incidents.

3.4.9 As these issues are identified and fixed, performance will come under control (i.e. fewer issues and less variation) until a steady state is reached.

Business as Usual

3.4.10 By this time performance should be consistent, predictable and at an acceptable level. Most performance issues are expected to come from random failures and human error rather than systematic faults. The exception to this is systematic issues arising from software glitches. These tend to have a long lead time for fixes to be developed, approved and rolled out; they could continue even after performance has broadly come under control[1]. The top risks to performance once Steady State Performance has been reached are:

a) Inconsistent application of procedural fixes. If system design issues have been circumvented with operational procedures, there is a real risk that the underlying design cause is never solved and performance becomes reliant on people behaving in a consistent and reliable manner.
b) New failure modes being introduced via software. Software upgrades will be a regular feature of systems such as ERTMS. It is important to have a robust system for managing software upgrades to avoid new failure modes, or version control management issues [2].
c) Random equipment failures. Most systematic issues should have been identified and fixed (either by technical or procedural means).
d) General complacency with respect to collaborative performance management. After initial collaboration on the new scheme, it is easy to lose focus on performance improvement activities once the project team is no longer involved,

3.4.11 See Appendix A for further detail on how performance risks change over time.

3.5 Factors contributing to ERTMS performance issues

3.5.1 ERTMS is a complex system. When there is an issue with ERTMS performance and reliability, it is important to identify all the factors involved so that the best solution may be found.

[1] European involvement regarding legislation can also delay the process for changes to software.
[2] This is a key lesson learned from the introduction of GSM-R voice.

3.5.2 Equipment (hardware & software) faults

a) Random equipment failures
b) Systematic equipment failures
c) Unintended consequence (i.e. equipment functions as designed but not as required)
d) Interface between different parts of the system (e.g. air gap between train and trackside)
e) Integration with legacy systems (an issue for retro-fitted stock)

3.5.3 Process based issues:

a) Process not followed (e.g. train discovered with isolated ETCS equipment when not expected to be isolated)
b) Old processes no longer work when applied to the new system
c) Lack of process (i.e. no process in place to deal with specific situation)

3.5.4 Human factors:

a) Lack of knowledge. (i.e. much more complex system with lots of functionality which may not be used very often)
b) Genuine mistake
c) Deliberate misuse (e.g. DMI damaged, system isolated)
d) Over/under reacting to events
e) Lack of confidence
f) Acclimatisation to new way of working (e.g. Driving to the DMI rather than using route knowledge)
g) Competence only held within a small group of staff

3.5.5 Environmental issues

a) Physical damage caused by the operational environment (e.g. ballast damage)
b) Malfunction due to the operational environment (e.g. odometry error caused by wheel slip)
c) Vandalism (deliberate third party damage, including cyber-attacks)
d) Interference from the operational environment (e.g. weather related interference or interference from external networks).
e) Human factors (e.g. the design needs to consider the DMI brightness and reflectiveness).

3.5.6 Operational issues

a) Timetable delivery (e.g. needing increased time for data entry
b) Management of the service in normal and degraded operations needs to be considered. This does need to include the policy for signage in signals away deployments.
c) Can operators use the system as they want to use it?
d) Increased chance of wrong routing events (drivers no longer have line-side routing information with which to challenge the signaller).

3.6 Collaboration and Industry Partners

3.6.1 There are many different teams involved in ensuring ERTMS is reliable and performs well. These teams do not all work towards the same targets or use the same measures to assess performance. It is important to consider what each individual stakeholder deems to be within their area of responsibility, how they measure performance and how this relates to the performance of the system.

3.6.2 See Appendix B for more detail on stakeholders, the types of issues within their scope and the measures they will typically use to evaluate performance.

3.6.3 Infrastructure Manager (i.e. Network Rail):

a) Project Development Team
b) Route Performance Team
c) Control Staff
d) Signalling Staff
e) Stoke Technical Engineering Centre (TEC) (GSM-R)
f) Depot Maintenance Response Teams
g) Time Table Planning Team

3.6.4 Railway Undertaking (i.e. TOCs and FOCs):

a) Driver & Guard Management Teams
b) Performance Management Teams
c) Control Staff
d) Timetable Planning Team
e) Fleet Management Team

3.6.5 Vehicle Maintenance Teams - N.B. this may or may not be done by the RU depending on the maintenance contract.

3.6.6 ETCS Equipment Suppliers:

a) ETCS on-board
b) ETCS lineside & indoor

3.6.7 Rolling Stock Operating Companies (ROSCOs)

3.6.8 National Performance Improvement Team - (DRACAS) - Various industry partners with a stake in ERTMS system performance

3.6.9 Other Groups: [3]

a) Rail Delivery Group (RDG)
b) Rail Safety and Standards Board (RSSB)
c) Office of Rail and Road (ORR)
d) Department for Transport (DfT)

[3] will not typically be involved in day to day performance management activities, however they do play key roles in specifying and developing the system and ensuring it performs as required.

3.7 Performance Measures

3.7.1 The rail industry uses many different measures to assess performance. It is important to consider how different stakeholder groups measure performance and what they deem to be within their scope. It is also important to understand how these measures can be used to provide an overall view of system performance from the customer's perspective. Different measures can provide contrary views on whether performance is good or not, so it is important to understand how the measures are derived and what they mean. Commonly used measures include:

a) Mean Time Between Service Affecting Failure (MTBSAF).
b) Mean Time Between Mission Failure (MTBMF).
c) Miles per Technical Incident (MTIN).
d) Public Performance Measure (PPM).
e) Right time arrival.
f) Average Minutes of Lateness (AML).
g) Cancellations (including self-caused cancellations).
h) Delay minutes (including self-caused delay minutes and sub-threshold delay).
i) Cancellations and Severe Lateness (CaSL).
j) Number of incidents.
k) Number of faults.
l) Freight Delivery Metric (FDM).
m) Passenger time lost (in hours).

3.7.2 See Appendix C for definitions of the performance measures.

3.8 ERTMS sub-systems

3.8.1 Many ERTMS sub-systems collect data as part of their routine function. This data can be downloaded to help investigate incidents, although to do this requires specialist systems and knowledge. Prior to go-live, it is important to know who is responsible for downloading and interrogating the data from these systems, what data is provided, how it may be used and whether it is perishable (i.e. is the relevant data overwritten in continued operation; if so it must be downloaded within that time frame). This should form a key part of the DRACAS process. These sub-systems include:

a) Operations and Maintenance Terminal - Radio Block Centre (RBC).
b) Stoke TEC GSM-R logs.
c) Juridical Recording Unit (JRU).
d) On Train Data Recorder (OTDR).
e) Remote Data Downloads from the on-board.

3.8.2 ERTMS is a shared system and joint investigation of incidents and issues will be required.

3.9 Tools to Aid Performance Management

3.9.1 There are tools which are being developed to assist the proactive performance management of ERTMS, including:

Performance Forecast Calculator

3.9.2 This is an Excel based forecast tool designed to provide a quick assessment of the impact ERTMS will have on performance. It was developed to help TOCs and Network Rail performance teams with the yearly performance forecasting process. It is also suitable for use by scheme development and franchise bid teams and can be found on the RSSB website SPARK Rail.

Defect Recording and Corrective Action System (DRACAS)

3.9.3 The DRACAS process is a critical part of ERTMS reliability and performance management and was a key lesson learned from the implementation of GSM-R voice radio. It enables industry partners to work together to identify, diagnose and correct issues which result in suboptimal performance. It also enables the industry to identify ways in which different ERTMS deployments can learn from each other. There is a risk that industry partners treat DRACAS as little more than an asset management system used solely by fleet engineers. To get the most from the DRACAS process, it requires industry partners to be open to new methods of collaborative working and information sharing. DRACAS will also show information on other operators' systems, for better understanding of systemic issues.

ERTMS Incident Resolution Guide (IRG)

3.9.4 This is a document which is being developed to support the delay attribution process so that teams can quickly attribute and resolve incidents. This was also a lesson learnt from the national implementation of GSM-R voice radio.

ERTMS Failure Modes and Effects Analysis (FMEA)

3.9.5 A generic system FMEA for ERTMS is being developed to provide an understanding of how the system can fail, the symptoms exhibited, the effects of failures and the way in which these failures can be mitigated. This is a critical part of the national DRACAS system as it provides a structure for comparing aspects of different ERTMS deployments regardless of equipment supplier or local deployment decisions.

Remote data download and analysis tools

3.9.6 This functionality needs to be specified as part of fleet fitment and procurement. However, the ability to download and analyse train data in real time allows for much speedier identification of issues (and their correction) and will help to move towards proactive performance management practices.

Part 4 ERTMS Scheme Performance Management Summary

4.1 Introduction

4.1.1 It is critical to understand how train service will be affected by the introduction of ERTMS. The following is an overview of the way in which performance needs to be assessed and the tasks which make up each stage in scheme development and delivery.

4.2 Scheme development

4.2.1 There are clear & measurable targets for ERTMS performance upon delivery. One of the industry business requirements is that performance will not be worse after introducing ERTMS. It is important to be clear about what this really means for each ERTMS scheme in a clear, objective and testable manner.

4.2.2 Quantitative performance assessments have been undertaken. These will provide an indicative view on expected performance impact of the basic scheme remit and any additional initiatives which could enhance benefits.

4.2.3 Performance modelling has been undertaken to provide a view on service delivery during:

a) normal operations
b) perturbation
c) degraded operations
d) emergency operations

4.2.4 An assessment has been made as to the scheme's capability of delivering forecasted growth.

4.3 Pre Go-Live

4.3.1 The following activities have been assessed for the risk they pose to service delivery. Mitigating actions have been identified and put in place to minimise any risk from:

a) First in Class fitment and Fleet fitment (including confidence building runs at a test track)
b) Infrastructure fitment
c) Testing and commissioning
d) Driver handling and route learning
e) Technician knowledge
f) Operational staff knowledge
g) Real time fault and incident management
h) Incident and fault investigation

4.4 Go-Live System Infancy

4.4.1 Additional resources have been identified to support service delivery.

4.4.2 It is clear how this resource will work with route teams by bolstering existing teams and creating a temporary ERTMS Infancy management team

4.4.3 The national DRACAS is a key feature to managing the reliability and performance of the system and there are clear associated roles and responsibilities.

4.4.4 There are Key Performance Indicators (KPIs) in place to support performance management during System Infancy:

- Identification of emergent issues, trends, repeat failures, or problem locations
- Monitoring use of attribution bins & No Fault Found (NFF) or unknown diagnoses
- Speed of resolution

4.5 Business as Usual

4.5.1 There is clarity with regards to identifying when operations are deemed to have reached steady state, meaning that the System Infancy period has ended.

4.5.2 There is a plan to manage the transition from infancy period to steady state (i.e. planned withdrawal of additional resource to ensure BAU processes can sustained).

4.5.3 Performance reporting and KPIs have been reviewed to ensure they are appropriate for steady state performance.

Appendix A – Summary: Performance Risks & How They Change Over Time

<table>
<tr><th></th><th colspan="2">Pre Go-Live</th><th>Go-Live System Infancy</th><th>Go-Live Business as Usual</th></tr>
<tr><td rowspan="2">Route Infrastructure Manager</td><td>Infrastructure Fitment

The length of this period will depend on:
▪ The size of the route to be fitted
▪ The complexity of the fitment
▪ The number of possessions required

The risks to performance are similar to other infrastructure fitment projects. The critical issues are:
▪ Possession over-runs
▪ Mistakes made during possessions which cause the railway to be handed back in a sub-optimal condition (e.g. handing back with points still clipped)
▪ Need for additional possessions (over and above initial plan) to complete required work</td><td>Test & Commission

The length of this period is expected to be short when compared to the other periods. Its length will depend on the amount of testing that is required to commission the system (including integration testing with the rolling stock).

FiC and RIDC confidence testing and integration trials.</td><td rowspan="3">The infancy period is expected to last between 12 and 20 months (based on the experience of introducing ERTMS on the Cambrian).

Performance issues at the start of this period are expected to spike as unforeseen faults become apparent. The number of incidents should reduce as the underlying causes are designed out or overcome through procedural changes.

The risks to performance during this period are:
▪ Unforeseen technical issues becoming apparent (e.g. software glitches or unintended functionality).
▪ Unforeseen environmental issues (e.g. interference).
▪ Unforeseen operational issues (e.g. operational procedures not working with ETCS fitted trains).
▪ Human factors (e.g. problems arising from a lack of confidence in applying new rules and procedures).

If there isn't enough capacity to properly investigate incidents and faults, it increases the likelihood of having lots of unexplained or no fault found diagnoses which are more likely to be dealt with through commercial agreements or delay bins rather than by fixing the underlying problem.
To keep the impact and duration of the infancy period to a minimum, it is important that incidents and faults are investigated thoroughly and in a timely manner.</td><td rowspan="3">The Business as Usual period is reached when performance has reached consistent and predictable levels. Most issues should be random failures rather than systematic issues.

Operational issues will predominantly be managed by NR Route or TOC/FOC teams with minimal or no involvement from the project deployment team.</td></tr>
<tr><td rowspan="2">Train / Freight Operator / RoSCO</td><td>FiC & Fleet Fitment

This assumes that retro-fitted fleet will be used as part of the ERTMS deployment.

The length of this period and level of impact on performance will depend on:
▪ The size of the fleet to be fitted
▪ The complexity of the fitment
▪ The availability of fleet
▪ Availability of cover stock

Performance could be affected by the following issues:
▪ The performance of the newly fitted ETCS equipment
▪ The underlying reliability of the fleet and how fitting ETCS equipment affects this
▪ Fleet availability

As more trains are fitted with ETCS there is an increased likelihood of the service being affected, however the performance impact during this time is expected to be minimal.</td><td>Shadow Running, Driver Familiarisation & Integration Testing

NJRP have specified a 12-month shadow running period where retro-fitted ETCS trains can accumulate operational hours for their reliability figures.

During this period, there will be some driver familiarisation activity and integration testing.

The impact on performance during this period is expected to remain low, only seeing an increase in incidents and delays as driver familiarisation and integration testing activities take place.</td></tr>
<tr><td colspan="2">Introduction of New (ETCS fitted) Fleet

For operators operating with new trains, the risks to performance during this period are comparable those which arise from the introduction of a new fleet. There is an additional risk to performance as integration testing takes place in readiness for Go-Live.</td></tr>
</table>

Appendix B – Stakeholders and their Performance Measures

Stakeholder	Area of Interest	Measure of Performance
Infrastructure Manager		
Project Deployment Team.	Scheme design, performance modelling to support scheme development.	MTBSAF, MTBF.
Route Performance Team (including delay attribution).	Overall performance delivery. Forecasting performance, identifying performance improvement initiatives. Attributing delay.	Delay Minutes, Cancellations.
Control Staff	Real time incident management & service recovery. VSTP schedules. Fault logging and investigation. Delay incident logging and investigation.	Delay Minutes, Cancellations, CaSL
Signalling Staff (including Box Technical Officers).	Routing trains. Applying / removing TSRs. Applying / removing line blocks. Speaking to drivers to do initial incident investigation.	Delay Minutes, Cancellations.
Stoke TEC (GSM-R)	GSM-R related issues.	# Incidents, Delay Minutes
Depot Maintenance Response Teams.	Managing equipment failures, response, fault repair, diagnosis & logging.	MTBF, # Faults, associated delay minutes (to some extent).
Time Table Planning Team.	Delays and cancellations due to scheduling errors. Delays and cancellations caused by errors with train planning rules. Validating time tables and train paths.	Delay Minutes, Cancellations.
Rail Undertaking		
Driver & Guard Management Teams.	Human factors how drivers use the system correctly, applying processes correctly, driving style. Changes to dispatch arrangements and management of station dwell.	
Performance Management Teams (including delay attribution).	Overall performance delivery. Forecasting performance, identifying performance improvement initiatives. Attributing delay.	Delay Minutes, Cancellations, Self-Caused Cancellations, TOC- on-Self, TOC on other, PPM, right time running.
Control Staff.	Real time incident management & service recovery. Fault logging and investigation. Delay incident logging and investigation.	Delay Minutes, Cancellations, PPM
Time Table Planning Team	Delays and cancellations due to scheduling errors.	Delay Minutes, Cancellations
Vehicle Maintenance Teams *(may be different from RU depending on contracts in place).*	Availability. Trains undertake routing examinations. Ensuring that there are enough trans available to run the planned service. MTBSAF, MTBMF, Cancellations, MTIN	MTBSAF. MTBMF, MTIN, Cancellations, Delay Minutes.
Supplier		
On-board	Technical failures of the on-board equipment.	MTBSAF, MTBMF
Line-side	Technical failures of the line-side equipment.	MTBSAF, MTBMF
National DRACAS Team		
Industry Partners	Whole system performance and reliability.	MTBSAF. MTBMF, Faults, Incidents, SAFs, Delay Minutes.
RoSCO		
On-board	Technical failures of the on-board equipment.	MTBSAF, MTBMF

Appendix C – Definitions of Performance Measures

Measure	Definition	Additional detail
Mean Time Between Service Affecting Failure (MTBSAF).	Cumulative ETCS operational hours divided by the number of Category 2 & 4 events	Operational hours: The time that the on-board ETCS equipment is turned on (for passenger services) or the time while the locomotive engine is running or the pantograph is connected to the catenary and the cab is active/live (controller away from OFF position) (for freight services). Category 2 event: an in-service failure which causes delay. Category 4 event: a failure during train preparation which causes delay. Category 3 event: an in-service failure which causes a cancellation or necessitates a unit/loco swap to run the service. Category 5 event: a failure during train preparation which causes a cancellation or necessitates a unit/loco swap to run the service.
Mean Time Between Mission Failure (MTBMF).	Cumulative ETCS operational hours divided by the number of Category 3 & 5 events	
Miles per Technical Incident (MTIN).	'A measure of the engineering reliability of trains expressed as the average mileage between incidents and reported for individual fleets."	For further information refer to The Twenty Point Plan.
Public Performance Measure (PPM).	'The percentage of trains which arrive at their terminating station on time. It combines figures for punctuality and reliability into a single performance measure. '	PPM measures the performance of individual trains advertised as passenger services against their planned timetable as agreed between the operator and Network Rail at 22:00 the night before. A train is defined as on time if it arrives at the destination within five minutes (i.e. 4 minutes 59 seconds or less) of the planned arrival time for London and South East or regional services, or 10 minutes (i.e. 9 minutes 59 seconds or less) for long distance services. Where a train fails to run its entire planned route calling at all timetabled stations, it will count as a PPM failure.
Cancellations (including self-caused cancellations).	Where a train service in the timetable cannot be run.	This can also include part cancellations where the train terminates short (known as a Pine) or starts before its first station stop (known as a Calvin)
Delay minutes (including self-caused delay minutes and sub-threshold delay)	When a train loses 3 (or more) minutes in a predefined section of track known as a TRUST section. Sub threshold delays are When a train loses time which is less than 3 minutes in a predefined section of track known as a TRUST section	Network Rail caused delays: as well as infrastructure faults this figure includes external factors such as weather, trespass, vandalism, cable theft and fatalities which account for approximately 33% of the delays attributed to TOCs and 20% of all national delays. Self-caused delays: delays to a passenger train operating company's services that are caused by that company. Caused by other train operators: delays to a passenger train operators services that are caused by another train company.
Cancellation and Significant Lateness (CaSL).	A train is considered a CASL failure if: ▪ It is cancelled at origin. ▪ It is cancelled on route. ▪ The originating station is changed. ▪ It fails to make a scheduled stop at a station. It is significantly late (i.e. it arrives at its terminating station 30 minutes or more late).	
Right time arrival	'The percentage of all planned station stops that occur early or within 1 minute of the booked time stated in the public timetable. This will be measured at all station stops covered by TRUST with each station call having equal weighting.'	
Incidents	When a train loses 3 (or more) minutes in a predefined section of track known as a TRUST section or where a train is cancelled or terminated short	
Faults	Equipment failure	
Service Affecting Failure	Failure of the equipment where the train service is delayed by at least 3 minutes.	

Glossary of Acronyms

The following acronyms appear in this guidance note:

ARS	Automatic Route Setting
AWS	Automatic Warning System
BAU	Business as Usual
CaSL	Cancellations and Severe Lateness
CCS	Command Control and Signalling
CR	Change Request
DfT	Department for Transport
DMI	Driver Machine Interface
DRACAS	Defect Recording and Corrective Action System
ERTMS	European Traffic Management System
ETCS	European
EVC	European Vital Computer
FiC	First in Class
FMEA	Failure Modes and Effects Analysis
FOC	Freight Operating Company
GB	Great Britain
GPRS	General Packet Radio Service
GSM-R	Global System for Mobile Communications - Railway
IM	Infrastructure Manager
IRG	Incident Resolution Guide
JRU	Juridical Recording Unit
KPI	Key Performance Indicator
MA	Movement Authority
MTBF	Mean Time Between Faults
MTBMF	Mean Time Between Mission Failure
MTBSAF	Meantime Between Service Affecting Failure
MTIN	Miles between Technical Incident
NFF	No Fault Found
NR	Network Rail
ORR	Office of Rail and Road
OTDR	On Train Data Recorded
PPM	Public Performance Measure
RBC	Radio Block Centre
RDG	Rail Delivery Group
RIDC	Rail Industry Development Centre (test track)
ROSCO	Rolling Stock Operating Company
RSSB	Rail Safety and Standards Board
RU	Railway Undertaking
SAF	Service Affecting Failure
SPaD	Signal Passed at Danger
TM	Traffic Management
TO	Technical Officer (Role within Signal Box)
TOC	Train Operating Company (TOC)
TPR	Train Planning Rules
TPWS	Train Protection and Warning System
TSR	Temporary Speed Restriction
VSTP	Very Short Term Plan or Path