Cross-industry remote condition monitoring and data sharing - a templated approach to commercial implementation

I RESEARCH AND DEVELOPMENT

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Interfleet Rail

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Introduction

The cross-industry RCM programme, Phase 2

The use of remote condition monitoring (RCM) can improve asset understanding of asset condition for rolling stock and infrastructure, system reliability and operational management and lead to cost, performance, capacity and safety benefits. In many instances, effective RCM requires co-operation between rail industry partners, with equipment either mounted on trains monitoring the infrastructure or on the infrastructure monitoring trains.

Cross-industry RCM (XIRCM) initiatives are therefore needed if RCM is to be more fully exploited. Such initiatives can involve the infrastructure manager, or maintainer, the train operator, the ROSCO, the train manufacturer and the train maintainer (any of whom could be the promoter) as well as other suppliers to the industry and industry facilitators. This means that business cases to invest in such initiatives may need to be prepared at a rail industry level rather than at the level of a single party.

RSSB therefore established a cross-industry RCM research programme on behalf of the Cross-industry remote condition monitoring Strategy Group, to develop the enablers for further sharing of RCM data across the rail industry in Great Britain (GB). The enablers identified as part of the T986 research project in phase 1 of the research programme are: common information sharing architecture; commercial framework contracts; the necessary standards.

Phase 2 of the research programme was put in place to address these enablers. This ongoing programme is made up of 4 research packages:

- Package 1 covers the preparation of a common information sharing architecture
- Package 2 (the subject of this report) seeks to establish a commercial framework for cross-industry RCM initiatives and has been delivered by Interfleet Transport Advisory in conjunction with Interfleet Technology

(together 'Interfleet') with the support of Stephenson Harwood, legal advisers with extensive experience of the GB railway industry

- Package 3, seeks the preparation of necessary standards for data collection and sharing, following on from Package 1
- Package 4, relates to the creation of updated decision tools

Work package 2 - commercial

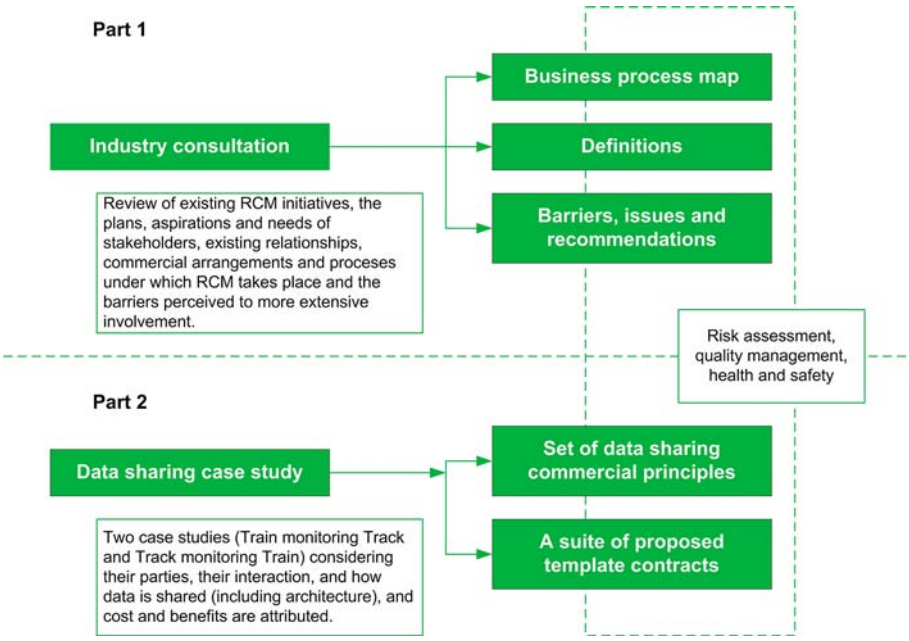
RSSB engaged Interfleet to define the necessary commercial arrangements for RCM data sharing within the GB railway industry, including the preparation of a high level definition of the cross-industry RCM business process using business process mapping techniques and a suite of templates commercial agreements.

The aim has been to provide practical, modular contractual templates that ease the task of setting up cross-industry RCM schemes. In doing so it has been the intention that the templates should facilitate costs, risks and rewards being allocated fairly to benefit all the parties involved in delivering net industry level benefits which in turn flow to users and funders of rail services, both passenger and freight.

Methodology

The step-by-step approach adopted for undertaking the research is set out in Figure 1.

Figure 1 - Method statement for the work package



The research work was divided into 2 main parts. The first part included industry consultation, reviewing RCM initiatives in the current market. It also included a review of the aspirations and needs of stakeholders in the existing relationships and commercial arrangements in the rail industry. This part formed the basis for business process mapping of the current market arrangements and processes under which cross-industry RCM and data sharing take place along with identification of barriers and issues in current or potential cross-industry data sharing.

The second part included evaluating two selected cross-industry RCM data sharing case studies, one covering 'vehicle monitoring infrastructure' and the other for 'infrastructure monitoring vehicle'. These provided a check on the validity of the business process maps and informed, together with the findings from industry consultation, the preparation of a set of commercial principles for data collection and sharing.

These principles were then used as a basis for drafting the suite of contractual templates for cross-industry RCM data collection and sharing.

This report

This introduction is followed by 6 further sections; these are:

- Stakeholder consultation, covering the industry consultation process and findings which informed the remainder of the work
- Cross-industry business process mapping, covering the preparation of the business process maps including their raison d'être and some guidance on their application
- Data sharing case studies, covering the case studies that were used to help validate the business process maps
- Commercial principles, covering the commercial principles which were adopted
- Template commercial agreement, covering the template contract agreements that have been developed
- Conclusions and recommendations for the industry flowing from the work as a whole

Stakeholder consultation

Aims

Stakeholder consultation was undertaken to gain an understanding of existing RCM initiatives, the plans, aspiration and needs of stakeholders, the existing relationships, commercial arrangements and processes under which cross-industry RCM takes place and the barriers perceived to more extensive involvement.

Approach

Questionnaire

Our approach was through the use of a purpose designed questionnaire (see Appendix A) accompanied by interviews (face-to-face or telephone) to elicit views of what representative stakeholders would like to see for themselves, for others and for GB rail as a whole.

Entities consulted

Using our industry knowledge and contacts, and those of the cross-industry RCM work package 2 commercial steering group, in all we engaged with 31 representatives from 27 entities within the industry whom we considered might be expected to have an interest in the commercial framework for monitoring asset condition and sharing data cross-industry. We held interviews or conference calls with, or otherwise obtained responses from, 80 % of them.

The categories of entities we engaged with and their responses are shown in Table 1.

Table 1 - Categories of consultee and response statistics

Entity	No. of Individual Responses	No. of Individual Invitations	Response rate
TOCs, FOCs & ATOC	8	12	67 %
ROSCOs	4	4	100 %
Infrastructure owner/ manager/maintainer (Network Rail)	4	4	100 %
Train manufacturers and maintainers	4	4	100 %
RCM suppliers (hardware, software and services) and RIA	5	7	71 %

The consultees invited to take part were chosen as being representative of their category. In the case of TOCs we aimed to achieve a balance between commuter, regional and Inter-City operators:

- TOCs, FOCs and ATOC
  - Arriva Trains Wales
  - East Coast Main Line Company
  - East Midlands Trains
  - FirstGroup plc
  - Greater Anglia
  - Northern Rail
  - Southern Railway
  - South West Trains
  - West Coast Trains
  - DB Schenker Rail
  - Freightliner Ltd
  - ATOC
- ROSCOs
  - Angel Trains (2 individuals)
  - Eversholt Rail
  - Porterbrook

- Infrastructure owner/maintainer Network Rail (4 individuals - HQ technical, commercial and Route)
- Train manufacturers and maintainers
  - Alstom Transport
  - Bombardier Transportation
  - Hitachi Rail Europe
  - Siemens
- RCM suppliers (hardware, software and services) and RIA
  - Arrowvale Electronics
  - Balfour Beatty Rail
  - Interfleet Technology
  - Nexala
  - Perpetuum
  - Telent
  - Railway Industry Association

We also liaised with the concurrent Work Package 1 Architecture consulting team to ensure our work streams were using consistent terminology and their own experience was taken into account.

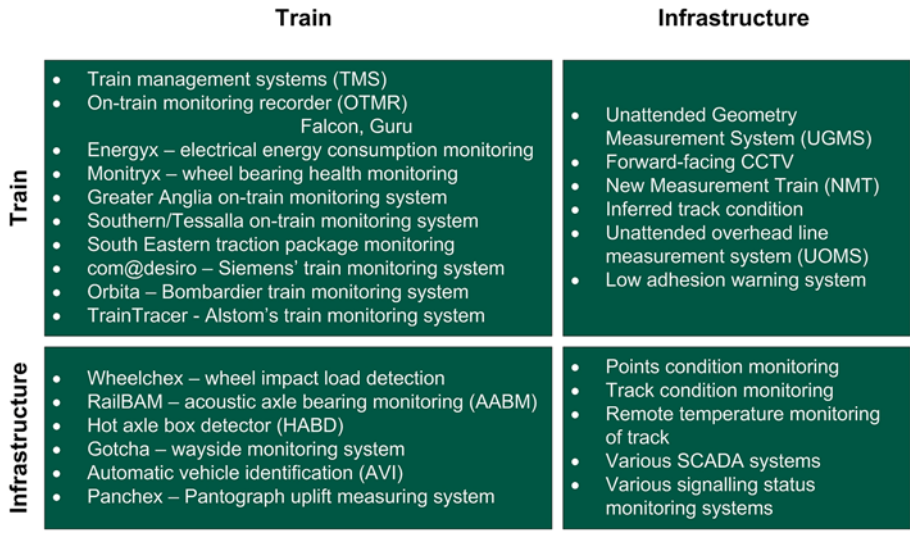
Findings

Our full findings were reported in the presentation *Findings from industry consultation*. This is contained as Appendix B. Below we present a summary of current initiatives as well as findings by stakeholder category.

Current RCM activity by quadrant

Figure 2 shows the schemes that were identified, mapped by 'quadrant'. By far the biggest number of initiatives was in the train on train category with train on infrastructure and infrastructure on train. In the course of discussions with stakeholders these initiatives were referenced as illustrations and 3 were used as case studies: RailBAM (Acoustic Axle Bearing Monitoring); Trackside Acoustic Detection System (TADS) and Unattended Overhead Line Measurement System (UOMS). Information on the case studies and lessons learned are contained later in this report.

Figure 2 - Quadrant diagram of current initiatives



Some projects might fall in more than one industry quadrant but for ease of presentation overlaps are not shown here.

Responses by TOCs, FOCs and ATOC

Twelve individuals were contacted for stakeholder consultation among TOCs, FOCs and ATOC, out of which 8 responses were received. In terms of RCM industry quadrants:

- 7 out of 8 in this category who responded were involved in 'Train monitoring Train' activities
- 6 out of 8 were involved in 'Infrastructure monitoring Train'
- 5 out of 8 in 'Train monitoring Infrastructure'
- There were no respondents involved in 'Infrastructure monitoring Infrastructure'

Despite most TOCs and FOCs being involved in XIRCM activities, formal agreements for data sharing were not commonly reported by respondents. Older initiatives are covered by existing industry agreements or regulations whereas some newer initiatives are still at a relatively early stage of development.

Level of interest in sharing RCM data cross-industry

A wide range of responses were received regarding the level of interest in sharing RCM data cross-industry. The FOCs and Regional TOCs were found to have a great difficulty in making business cases or obtaining funding for XIRCM due to operating low intensity services, although some nevertheless expressing strong interest in the opportunities, this contrasts to several highly committed and heavily involved London Commuter and Intercity TOCs who were well able to make business cases and obtain funding for XIRCM given the high intensity of their operations.

Aspirations and needs for RCM information

TOCs and FOCs showed significant interest in using XIRCM for issues such as performance improvement, infrastructure (track and OLE) and train reliability growth, train maintenance cost reduction, capacity management, safety and security, and post incident investigation. Some TOCs are working to get their entire fleets fitted with the necessary Ethernet spine and antennae so that multiple initiatives can then be added. For many TOCs and FOCs automatic vehicle identification (AVI) is a critical ingredient to making XIRCM data from Network Rail worthwhile.

Perceived issues and barriers to wider RCM adoption

There were a number of perceived issues and barriers identified during stakeholder consultation with TOCs, FOCs and ATOC:

- Getting costs low enough to provide a business case for funding
- NR are seen to over-specify, promote top-down solutions, and only use large and costly suppliers
- Complexity of industry, multiplicity of systems, distrust between NR and TOCs creates barriers, as TOCs and FOCs think that Network Rail might use RCM data in delay attribution disputes
- Lack of open access to data and asymmetry with NR benefiting more
- Lack of recognition that TOCs generally will need agreement of ROSCOs, TSPs, and maintainers

Potential solutions to overcome barriers

TOCs and FOCs suggested some potential solutions that might help overcome the identified barriers:

- There is a need for 'clarity' on what data is shared, with whom it is shared, how the data will be used and who can see it
- Funding support from Network Rail for demonstration projects and real life systems
- Distinguish between development initiatives and operational projects
- Cost effective bottom-up initiatives with small and medium level suppliers who have customised, well suited solutions needs to be promoted
- Adopt national strategy such as on ETCS
- New rolling stock should have a common list of mandatory RCM channels

Existing commercial arrangements

Many industry relationships are already contractual; for example, through franchise agreements, track access agreements, rolling stock lease agreements, and alliance agreements. It was observed that at the development stage there are often joint funding agreements for capital works but sometimes work is done without formalities other than the industry agreements referred to above. Less often there are also agreements covering operation, maintenance and data sharing - agreements that this study is intent on addressing.

Specific commercial protections sought

- What data is shared, with whom it is shared, how the data will be used, who can see the data (non disclosure, restrictions on use), ready availability of data, data quality, integrity and security including Service Level Agreements
- Clarity on responsibility for renewal, maintenance and operation of kit and for data ownership, who pays for data
- Time for rectification of relevant faults should be mentioned
- End of franchise handover terms to be agreed with DfT; refranchising 'purdah'
- Common formats and interfaces and open source for business continuity planning

Responses by ROSCOs

All 3 ROSCOs interviewed are involved in RCM in connection with their trains 'Trains monitoring Trains'. Two of the 3 ROSCOs are also involved in their rolling stock being used to monitor the infrastructure, such as 'Trains monitoring Infrastructure'. No ROSCOs reported involvement in 'Infrastructure monitoring Trains' although the TOCs to which they lease their rolling stock are involved in it, presumably this is because they do not have to authorise modifications to their trains in this case. Moreover, the ROSCOs do not deal directly with the infrastructure provider, Network Rail.

Level of interest in sharing RCM data cross-industry

Given that the ROSCOs' primary relationships are contractual ones with the TOCs and the train manufacturers rather than the rest of the industry, the interest in XIRCM (going beyond those parties to the wider industry) is not generally strong.

Aspirations and needs for RCM information

ROSCOs are highly interested in RCM with respect to improving their fleets' attractiveness to the industry - in particular reliability improvement.

Perceived issues and barriers to wider RCM adoption

- According to ROSCOs, the value placed on 'data' is inappropriate; only processed and cleansed data ("information") upon which action can be taken is of value
- Identifying the right data, reliability of the data and access to data (current systems working in isolation)
- Competition between TOCs at franchise re-letting means that they are wary of sharing information on the underlying drivers of their performance
- Risk of issues with Competition Commission if a ROSCO is seen as acting cooperatively with other ROSCOs

Potential solutions to overcome barriers

- Ensuring that industry agreements such as track access agreements (TAA) include definitions of 'data' and 'information' so that data is unrestricted and IPR only applies in the value added by the post processing of data that leads to the distillation of actionable information

- Suitable partnership agreements, commercial agreements, non-disclosure agreements - there are already some commercial agreements in place for the sharing of data amongst cross-industry, fleet-specific user groups

Responses by infrastructure owner, manager, maintainer (Network Rail)

Network Rail reported involvement in all 3 parts of the RCM quadrant relating to infrastructure and as might be expected it reported no activity in 'Train monitoring Train'.

Level of interest in sharing RCM data cross-industry

Those involved in RCM at Network Rail showed a keen interest.

Aspirations and needs for RCM information

Network Rail believes that RCM data can be used for reliability growth, safety, maintenance and long term asset management; Network Rail representatives were happy for data to be shared across the industry to promote this. However some caveats around sensitive data (such CCTV streaming which needs careful control) would be required.

Perceived issues and barriers to wider RCM adoption

- There is little commonality or spread in terms of 'Technology and its use': bespoke v. generic; sourced within rail v. elsewhere; train side v. infrastructure side
- Lots of service providers are doing it their own way which causes issues related to data compatibility and standardisation
- Network Rail desire for pan-industry RCM v. those who don't want to wait for that have different views on how RCM should be adopted
- The 'time to market - time to application', as industry process are convoluted and slow
- Business cases not being cross-industry
- There is a disagreement in industry about "Who pays and who gets benefits' for RCM?
- Responsibility for maintenance and upkeep of kit once installed

Potential solutions to overcome barriers

- Division of data into: (1) raw data which can be shared easily and (2) analysed data which can be part shared with the industry and part kept to own use
- At 3rd level to the above bring in automated tools for decision making in due course (used more commonly in military and air industry)
- Better to have kit maintenance and upkeep as a part of franchise, track access, or train service agreements
- Open standards which can be used by all
- Getting a business case for a whole industry

Existing commercial arrangements

Network Rail reports that they have a number of agreements in place such as for the first RailBAM® installation (all such installations will have similar agreements). These are generally funding and commercial agreements involving the supplier, Network Rail and the TOC. Network Rail has shared a number of example agreements (redacted/ anonymised) with the study team which show what terms have been accepted by the industry in recent initiatives

Specific commercial protections sought

Key topics referred to by representatives of Network Rail included:

- Service level agreement
- What data and what format?
- Level of accuracy
- Frequency of data (daily, weekly…)
- How to decommission during works (allowing in SLA for out of service)
- Name and contacts
- Time to turn around, or complete data processing
- Communications and reliability for data transfer (and backup method if main communication method fails)
- Consistent with industry contractual and regulatory environment, such as TAAs and FAs

Responses by train manufacturers and maintainers

Train manufacturers and maintainers reported involvement in all parts of the RCM quadrant. ‘Train monitoring Train’ is the strongest area with the

involvement of all firms which responded to the consultation. Three out of 4 respondents were involved in 'Train monitoring Infrastructure' and 'Infrastructure monitoring Train'. One firm from this category also reported involvement with 'Infrastructure monitoring Infrastructure'.

Level of interest in sharing RCM data cross-industry

This category of respondent has been slowest to respond, possibly because of their size and commercial sensitivities. Understandably in the competitive train supply market it's safe to say all actions taken in this category on RCM are driven by commercial advantage and not all respondents saw XIRCM as beneficial. The study team noted the same commercial driver motivated all categories (except Network Rail) but tempered elsewhere by reference to 'the right industry thing to do'.

Aspirations and needs for RCM information

Manufacturers are highly active in the field of 'Train monitoring Train' typically with a view to:

- Reducing the whole life asset management (WLAM) costs
- Maintenance optimisation - pushing out frequencies and interventions
- Automatic advisory generation
- Validation, mitigation and management decision taking
- Most manufacturers are also responsive to commercial opportunities in monitoring train/infrastructure interaction

Perceived issues and barriers to wider RCM adoption

- Commercial sensitivity deterring involvement
- Benefit residing with parties other than the value generator
- Cost based approach killing value generation
- IP issues
- Lack of understanding in the industry of:
  - How to partner successfully, stifling innovation and leading to above issues
  - What condition-based maintenance (CBM) means and how it can be informed by condition monitoring, whether remote or not

Potential solutions to overcome barriers

- Industry needs to evolve and recognise value and partnership
- Industry needs to learn CBM and WLAM

Existing commercial arrangements

Commercial arrangements are already in place with ROSCOs and TOCs in terms of asset purchase, support and maintenance and these include use of RCM for the collection of data about the condition of their trains. Key issues are IP, confidentiality and limits of use of data which is shared with ROSCOs and TOCs.

Responses by RCM suppliers (hardware, software and services) and RIA

One of the 5 responses in this category was from the RIA which assisted by providing relevant contacts in RCM industry contributors. Of the 4 suppliers who have responded, only 2 reported involvement in all parts of the RCM quadrant. Train monitoring Train is the strongest area with the involvement of all firms which responded to the consultation.

Perceived issues and barriers to wider RCM adoption

- Confidentiality of data
- Lack of understanding by Network Rail of motivations of supply base
- IPR issues including retaining IPR on innovations
- Business cost-gain split
- Cultural challenges to making use of the data/information derived

Existing commercial arrangements

Suppliers have commercial agreements for the supply of equipment, software and services including data collection, analysis and hosting, and the distribution of processed information to clients in accordance with their requirements.

Key features of agreements include:

- Ownership retained by client
- Security of data
- Refresh rates
- Accuracy and validation

Further observations

The principal parties in cross-industry RCM are TOCs and Network Rail Routes (backed by HQ) operating where capacity is at its limits and poor performance has major consequences. The most successful initiatives are developed from the grass roots up working with the RCM supply chain (and ROSCOs and manufacturers).This leads to innovation and diverse systems, delivers real benefits and, for TOCs, competitive differentiation (the McNulty[1] agenda live

1 The Rail Value for Money Study, http://orr.gov.uk/publications/reports/rail-value-for-money-study

and well in the industry). It also leads to lack of commonality or spread of best practice - against the grain of Network Rail's instincts.

However, top down systems have not proceeded to implementation (such as LiveTrain) and can risk running counter to the McNulty agenda. Mandating use of particular systems across-industry is therefore likely to be counterproductive. This is very different from moving over time towards commonality of system architecture without stalling current initiative. This is also despite RCM industry suppliers being frustrated by the benefits of their systems not being fully recognised or exploited even where they are installed.

Template commercial agreements need to enable the technical, whatever it is, not dictate to it. They need to:

- Avoid the trap of allowing IPR to rest in data rather than in its processing into value added information
- Embrace uncertainty and experimentation with data to find significant information, be brave over data quality and waive SLAs at the development stage

A memorandum of understanding may be appropriate when parties come together for the development phase of initiatives. The extent to which each party will benefit may be unclear initially, but real costs will be incurred meanwhile. Having commercial principles for the implementation phase in place early on should encourage participation in the development phase.

This would be followed by a full agreement to cover investment, ongoing operation and maintenance costs and SLAs (very possibly 2-way, detailing for example who does what, the level of reliance, what happens when systems are degraded) along with governance arrangements and rules on 3rd party involvement, data sharing, IPR on value add information.

It was concluded that the template contractual arrangements need to be appropriate for deals between consenting parties (first step first) rather than the more complex issues associated with the 'cloud of data' concept (a future ambition).

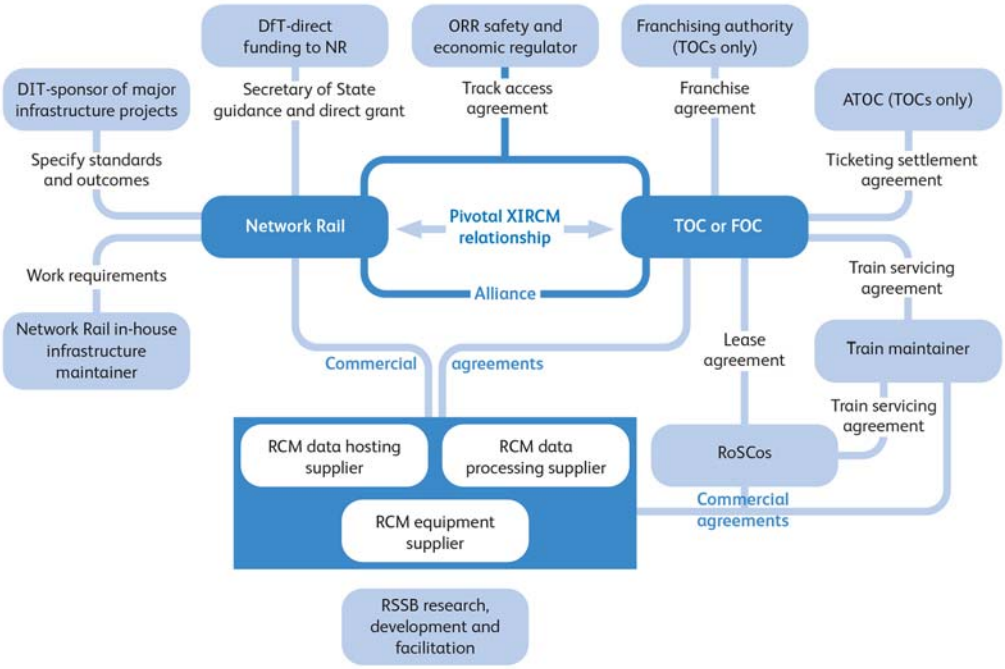
Cross-industry business process mapping

Parties and relationships

To provide an exemplar of best practice in cross-industry RCM and to inform the commercial principles, business process mapping was developed, building on the findings of the industry consultation.

The process mapping includes a diagram setting out the parties involved, their relationships and the links between them.

Figure 3 - Cross-industry RCM parties and relationships



Features include:

- The key cross-industry RCM relationship is identified as existing between Network Rail (Routes) and the relevant TOCs and FOCs - although they are not necessarily always the promoters of an RCM scheme
- The RCM supplier industry is linked to Network Rail, TOCs, FOCs and multiple other industry parties including ROSCOs and train maintainers
- Network Rail and TOCs, FOCs are also backed by multiple formal industry agreements, regulatory and funding relationships

Ideal process flow charts

The process mapping also includes a set of idealised process flow charts that indicate the steps through which data collecting and sharing schemes can ideally be set up, defined, agreed and implemented. Indications are given in the charts of the documentation required adequately to define a scheme and how it should work - details that will be needed to prepare a business case and for reaching agreement on appropriate contractual arrangements between the parties.

The idealised flow of activities shown in Figure 4 (and in Appendix C) follows a 7-step process with 4 key decision points.

Appendix C also includes the following 6 separately detailed sub-activity flow charts:

- Sub-activities to support activity A: Identify scheme and outline business case
- Sub-activities to support activity B: Consider preliminary heads of terms
- Sub-activities to support activity C: Define RCM lifecycle (major step leading to full business case)
- Sub-activities to support activity D: Conclude agreement between parties (using the template contractual agreement developed as part of this work package and included at Appendix E as a starting point)
- Sub-activities to support activity E: Install, test, commission
- Sub-activities to support activity F: Go live

In this idealised activity flow process the scheme definition is at activity C; this is the critical enabler that, if successful, leads to inter-party contractual agreement at activity D. Activity C includes preparing an information framework - one of the 4 frameworks that help define the overall RCM

lifecycle. The information framework needs to include an information lifecycle for the scheme and the final chart in Appendix C, labelled as activity G gives an example of such an information lifecycle (see Figure 5).

Figure 4 - Idealised 7-step RCM activity flow chart

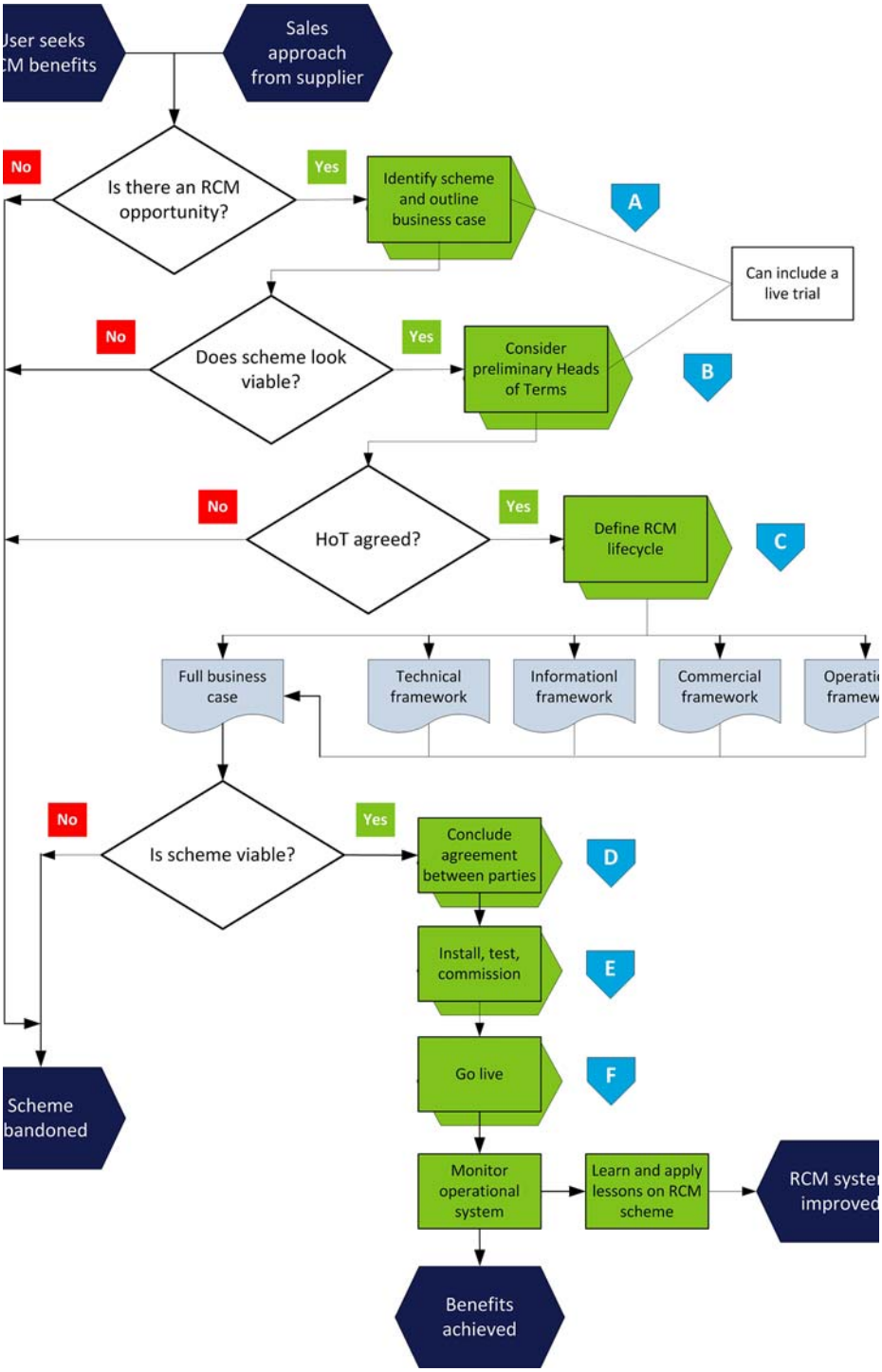
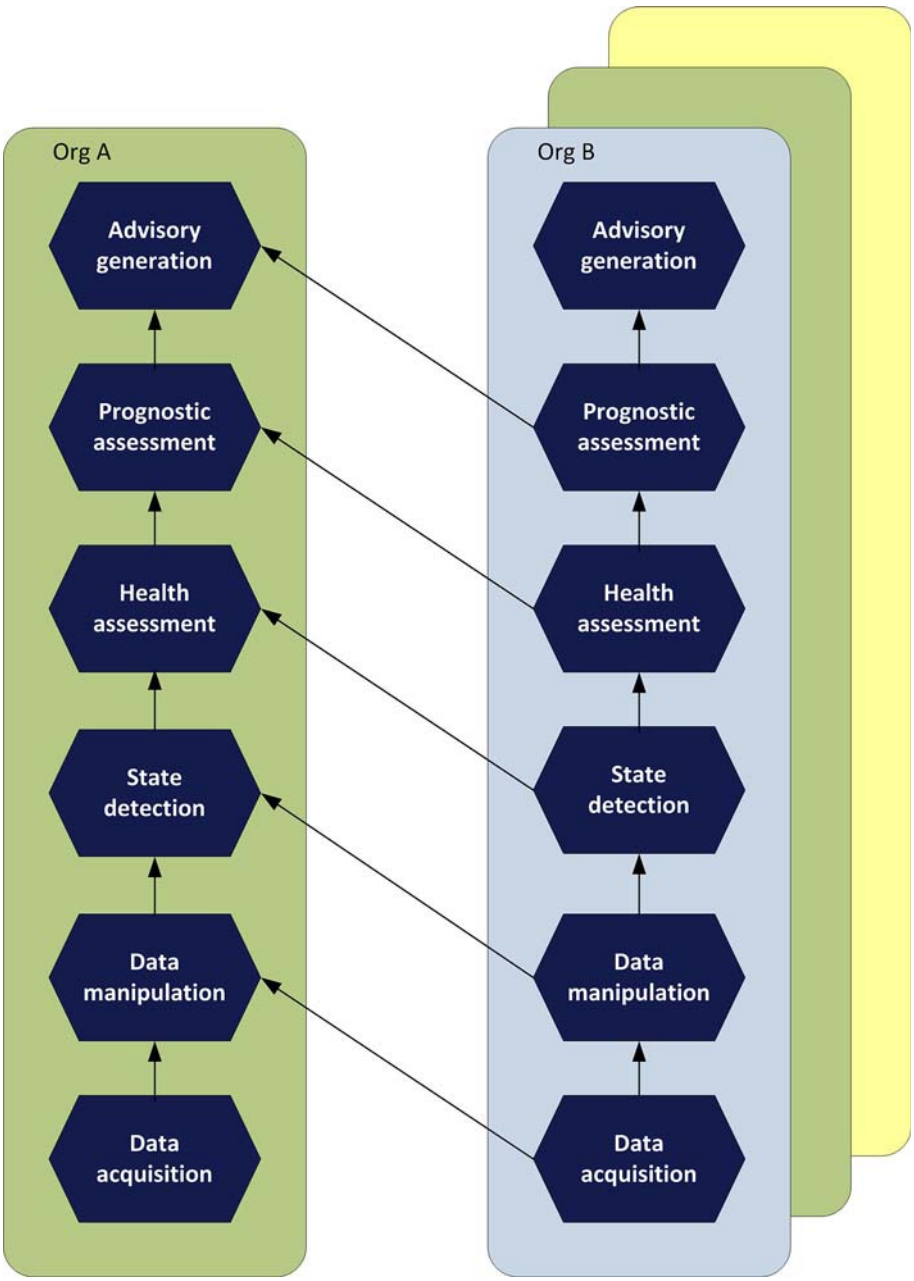

User seeks RCM benefits
Sales approach from supplier
No
Is there an RCM opportunity?
Yes
Identify scheme and outline business case
A
Can include a live trial
No
Does scheme look viable?
Yes
Consider preliminary Heads of Terms
B
No
HoT agreed?
Yes
Define RCM lifecycle
C
Full business case
Technical framework
Informationl framework
Commercial framework
Operati framew
No
Is scheme viable?
Yes
Conclude agreement between parties
D
Install, test, commission
E
Go live
F
Scheme bandoned
Monitor operational system
Learn and apply lessons on RCM scheme
RCM syste improved
Benefits achieved

Figure 5 - Information cycle



These detailed prescriptions for a successful cross-industry RCM scheme are recommended to the rail industry as a valuable aide memoire. The actual

process followed in particular cases may or not follow this precisely, depending upon the scale of the project, its nature and the ease with which a business case can be demonstrated, the maturity of the technology, the number and nature of the parties and the experience of the team involved.

It is recommended, however, that these flow charts and the activities and documentation suggested by them are reviewed at the outset of any cross-industry RCM project and a scheme-specific activity flow chart derived that meets the requirements of the sponsoring parties and the level of governance formality required to achieve gateway approvals.

Data sharing case studies

The data sharing case studies considered, to understand the existing data sharing in the industry, were examples from both Infrastructure monitoring Train and Train monitoring Infrastructure.

- First case study (Infrastructure monitoring Train) is carried out by selecting 2 projects from this RCM industry quadrant. The projects selected were:
  - RailBAM (an acoustic axle bearing monitoring system)
  - TADS (Trackside Acoustic Detection System)
- Second case study (Train monitoring Infrastructure) used an example of Unattended OLE Monitoring System (UOMS)

Each case study was conducted through consultation meetings or interviews with concerned stakeholder from respective organisations. The case study findings were shared with RSSB during second stakeholder meetings held in November 2013.

A brief description of each data sharing case study and lessons learnt is listed below:

RailBAM case study

The objective of this RailBAM® case study was to review an existing infrastructure based system monitoring the train project and to test and validate the process maps that have been developed by ITA in support of the T1010-02 commercial assignment.

RailBAM® is an acoustic monitoring system that detects damage to the axle journal bearings on trains at an early stage of degradation. This solution was developed by Trackside Intelligence Ltd Pty of Australia and Siemens plc has an exclusive international agency agreement to sell the product. Siemens claim that RailBAM® improves the reliability of rail transport and reduces maintenance costs. The system records the acoustic emissions of axle journal bearings on trains that are in motion. Since November 2009 RailBAM® has been monitored over 10.2m axle bearings passing the site at a trackside installation at Swaythling, Southampton. A site at Mortlake has monitored an additional 5.9m axle bearings since October 2010. Normally, the wheelsets

would be replaced at around 900,000 miles (1.4m km) due to the perceived half- life (life being L10) of the axle journal bearing. RailBAM® can detect axle journal bearing defects long before an actual failure occurs. Technicians can now replace wheelsets whenever the measurement data shows early indications of damage. As a result, it has been possible to extend the maintenance intervals for powered and non-powered wheelsets by between 10 % and 50 % respectively, with further extensions anticipated as the fleet mileage is accumulated.

RailBAM® now makes it possible to regularly monitor the axle journal bearings of trains in service. The system is based on an acoustic sensor that is mounted adjacent to the mainline, either in the cess or 6-foot and continuously records the acoustic emissions of all trains. RailBAM® also records the vehicle numbers via Siemens supplied RFID tags fitted to the trains and associates it with the acoustic files. The data is processed on-site with only the processed data being transferred via secure VPN connection to a web server for real-time access. The system analyses the acoustic data for known distress frequencies. These very small amplitude sounds can be identified giving the train maintainer up to 9 months (100,000 miles) notice of a failure. Such defects would be otherwise undetectable. In the event that an axle journal bearing is flagged as carrying a defect, then corrective maintenance for the unit can be scheduled for the next exam. No reactive response is required, thus not impacting on unit availability or train safety or reliability. Conversely, an axle journal bearing can be allowed to remain in service beyond its maintenance interval, as long as the monitoring data does not show any problems that require attention.

At the moment, RailBAM® can be used to monitor trains travelling at speeds up to a maximum of 160 kilometres per hour. However, due to the high level of interest from various rail operators, there are plans to develop the system so that it can also operate with high-speed trains. There is also a project running to develop the system to monitor inboard bearings, such as inboard axle journal bearings, bearings within the gearbox, traction motor or suspension tube.

Process gone through to reach agreement

In 2007, a cross-industry group (ATOC, Southern Railways and Network Rail) sponsored a trial system which operated for 3 months at Three Bridges. The purpose of the pilot was to validate the concept on the UK infrastructure. Trial data was reviewed and analysed to establish whether there were ‘suspect’

axle bearings and this proved to be the case. However, neither Southern Railways nor Network Rail was prepared to proceed with the project.

In 2009, Siemens evaluated the global data as well as the 2007 pilot and opted to proceed with a full installation in Swaythling, Southampton. This was the first site in Europe and the first dedicated to monitoring passenger rolling stock.

The commercial and technical process for introducing RailBAM® included factors such as:

- Supply, installation and commissioning
- Basic asset protection agreement (BAPA)
- Access arrangements to data
- Provision of a web portal
- Provision of communication from the wayside to the shore-based servers
- Commercial payments for the data/information
- Agreement of warranty and servicing of the RailBAM® equipment
- Safety assessments and mitigation

Type of agreement in place

Siemens stated that they have commercial agreements in place with Network Rail covered by the BAPA. This defines the role of Siemens and Network Rail and the respective responsibilities and helps to ensure that the RailBAM® equipment is not inadvertently damaged by track maintenance.

There are commercial agreements in place for the data with interested parties such as Network Rail, TOCs, FOCs, and other train manufacturers and maintainers. Under these commercial contracts, Siemens provides customers limited access to only their data therefore respecting the confidentiality of other users. Data on untagged trains is provided to Network Rail and is covered under a different agreement.

How issues relating to warranties, third parties, data management were handled

Siemens has taken a lead role and taken responsibility in the management of warranty, 3rd party access and data management. Broadly speaking the organisation that procures the RailBAM® equipment owns the data and

hence agreement with that organisation is sought in terms of data distribution.

Obstacles to reaching agreement

The main barrier that Siemens needed to overcome was who pays. The RailBAM® business case compiled by Network Rail demonstrates a clear positive return but this was at an industry level. However the procuring party may not be the one who ultimately receives the maximum benefit.

With 3 fully operational RailBAM® sites in service, the base commercial and technical obstacles have been overcome for these local installations. However for a national rollout Siemens consider there are some major hurdles to overcome. These include:

- Considering RailBAM® as a 'national system' and not a local project, and hence having wider and more appropriate governance
- Network Rail procurement terms and conditions broadly inhibits innovation and creativity by wishing to own all the IPR, whilst not being prepared to accept any liabilities
- Procurement policy within Network Rail is preventing a single supplier of a major system such as RailBAM®

Lessons learned

Siemens consider the introduction of RailBAM® nationally would contribute to McNulty?s recommendation of reducing the overall cost of the railway. A national rollout of approximately 35-40 strategic sites would provide blanket coverage for all train movements and all train types. This rollout would facilitate the removal of hot axle box detection (HABD) equipment from over 100 sites.

Potential future benefits

This acoustic technology could also be extended to look for technical problems with inboard bearings, and components such as traction motors, gearboxes, final drives, suspension tube drives and cardan shafts. A pilot of this is anticipated in Q2/2014.

Conclusion: impact on commercial principles and commercial contract template

The review of the flow charts concluded that the process was logical and correct. Siemens' main concern was that the pivotal relationship between Network Rail and the train operator does not necessarily reflect who pays for a cross-industry RCM project and who receives the main benefit.

RCM of rolling stock will principally benefit the maintainer of the rolling stock by way of underpinning reliability, which in turn stabilises availability and will ultimately reduced whole life cost. However, apportioning the Capex and Opex associated with a national rollout of RailBAM® with a fragmented industry split between the silos of Network Rail Routes, ROSCOs, maintainers, operators and consultancies, will in turn make the business model unclear.

TADS case study

The objective of this Trackside Acoustic Detection System (TADS®) case study was to review a further existing infrastructure based system monitoring the train (in addition to RailBAM®) and to test/validate the draft business process maps that have been developed by ITA in support of the T1010 - 02 commercial assignment.

Initial discussions took place with Network Rail (Dan Grover, who consulted his senior manager) and East Coast (Tony Brown). However, it was apparent that what was supposed to be a three month trial had not yet got properly underway for technical reasons and Network Rail felt it would be unhelpful to use TADS® as a commercial workstream case study given the lack of positive progress.

According to website information, Trackside Acoustic Detection System TADS® is designed to monitor roller bearings and identify internal defects prior to overheating, costly train stops, and ultimately failure. This technology, a product developed by TTCI (a subsidiary of the Association of American Railroads), is intended to enhance equipment performance and prolong infrastructure life.

It had been intended that we speak with Dave Bishop of TTCI's UK agent, Lloyd's Register Rail (LR Rail), but that was not proceeded with given the circumstances. This note therefore picks up on what information we have gathered meanwhile. The objective of third-party review of the draft business process maps has not been accomplished but some inferences can still be drawn.

Process gone through to reach agreement

Network Rail is understood to be seeking demonstration of alternatives to RailBAM® for acoustic axle bearing monitoring in order to have commercial flexibility prior to expanding the application of this type of monitoring more widely across the network.

Type of agreement in place

It is understood that a 3-month trial of TADS® was planned and that Network Rail entered into a form of interim, or loan, agreement with LR Rail to supply equipment for the purposes of the trial - with a view to full agreement being entered into amongst the relevant parties at the appropriate point. Currently there is no formal agreement in place between Network Rail and East Coast Main Line Company but an informal understanding covers the fitting of RFID tags to the TOC's HST fleet.

How issues relating to warranties, third parties, data management were handled

As this is only a trial installation these issues have not yet been addressed.

Lessons learned

- Only limited agreement is in place between Network Rail and Lloyd's Register for the trial installation
- Early stage trials and demonstration projects need to be allowed for in planning commercial contract templates

Potential future benefits

These will become clearer once the trial moves forward.

Conclusion: impact on commercial principles and commercial contract template

The aim of gaining insights from this case study has not been achieved. However, it has become clear that early stage experimental/demonstration applications are a key part of the development of wider use of cross-industry RCM and this needs to be recognised in the business process maps and in the template commercial agreements.

UOMS case study

The objective of this Unattended Overhead Line Measurement System (UOMS) case study was to review an existing train based system that monitors

the infrastructure (in this case the overhead line) and to test/validate the business process maps presented in the section Cross-industry business processing model.

In 2009, the reliability of pantograph current collection heads on the CL390 West Coast Pendolinos had reached a low of 5,000 miles mean distance between failure. The service impact on passengers was becoming significant with a corresponding high level of delay impact minutes for both Network Rail and Virgin Trains.

It was believed that irregularities with the overhead wire were causing the carbon blocks on the pantograph to be damaged and in some cases ripping out the whole pantograph [head] but the exact locations of these irregularities was difficult to pin down.

A scheme was proposed to measure the longitudinal force on the pantograph whilst in service, the idea being that when a pre-determined threshold was exceeded an alert could be triggered and recorded. The system would record the force value, date and time and most importantly the latitude and longitude co-ordinates of the train at the time of the exceedance via a GPS signal.

A proposal was made by Virgin Trains to install the UOMS equipment on the CL390 train at a nominal cost of £100,000. Network Rail found the funds to pay for the equipment and installation costs on 2 Pendolino units based on a one-off purchase order, whilst Virgin Trains facilitated installation and operational aspects. The UOMS equipment was supplied by Serco.

The resulting data was made available to both parties.

There are 2 aspects to the data. If a major force exceedance is detected then this will cause a relay contact to close and trigger a flag within the Train Management System. This will result in an email being sent from the train to the shore in the form of an alert stating the time and location of the exceedance or incident.

The second aspect of the data is more granular in detail and this requires the data to be manually downloaded off the train and sent for further manual analysis on the shore by Network Rail.

A degree of filtering and interpretation of the data has to be undertaken as 95 % of alarms are caused by electrical interference and not mechanical problems with the overhead wire or the pantograph.

Installed some 3 years ago, UOMS achieved early success averting an incipient failure, saving some four times the start-up costs and immediately confirming the business case for the investment. The reliability of the current collection system on the West Coast and Pendolinos has now increased to approximately 48,000 miles mean distance between failure, a significant and near 10-fold improvement.

Process gone through to reach agreement

The process to reach an agreement between Virgin Trains and Network Rail for the installation of the UOMS equipment was relatively rapid as speed was of the essence in terms on implementing a solution. It was also relatively informal. Once funding for the supply and installation of the system was approved and provided by Network Rail, it was up to Virgin Trains to organise the installation and corresponding engineering change documentation.

Type of agreement in place

Presently there is no formal agreement in place between Network Rail and Virgin Trains. No one is contractually obliged to perform any aspect of the data collection, analysis or equipment maintenance although a 'minuted gentlemen's agreement' has been put in place retrospectively to cover upkeep of the equipment as a result of the system degrading over time with no upkeep (battery replacement) - this covers Network Rail, Virgin Trains and Alstom responsibilities. There is currently no service level agreement with Serco regarding the equipment supplied by them but a second purchase order from Network Rail is being discussed for upgraded equipment. The lack of a formal agreement between Network Rail and Virgin Trains means there is ambiguity as to who actually owns the data other than both parties (mutually and jointly).

How issues relating to warranties, third parties, data management were handled

The overall system has no warranty management system in place either for the hardware or data collection aspect.

Virgin Trains pay Lloyds Register Rail to manually collect the raw data off the trains and then email it to both Network Rail and Virgin Trains.

Network Rail undertakes data handling and analysis which incurs costs yet has no allocated operational budget for that - which leaves a level of uncertainty.

Nevertheless, Network Rail is working on the possible expansion of the system across the electrified fleet nationally with potentially 100 units. For that to be implemented a solution to the data handling workload would be required.

Obstacles to reaching agreement

Both Virgin Trains and Network Rail stated that there were no obstacles in reaching an agreement on the initial capital purchase and installation, as the UOMS technology was going to be beneficial to both parties. Once the funding was approved, the design and implementation was quite rapid.

Lessons learned

A key lesson that should be learnt from the UOMS project is that whole life aspects to ensure long term sustainability of the project needs to be considered from the first instance. This would have included agreeing a long term service contract with the equipment supplier Serco. This does not exist at the moment and hence there is no incentive on Serco's part to develop the UOMS technology further. It would also have included agreement on who would do what more generally, the format of the data and arrangements for access to the vehicles for maintenance. Asked whether there was any desire to automate the collection of the raw UOMS data from the train - the answer was no.

Similarly there are no plans to automate the analysis of the raw data at Network Rail. Regarding long-term sustainability, the view was expressed that there is currently no guarantee that the project would survive a franchise change. A suggestion was made that responsibility might be moved into the train service agreement so that the arrangement for the equipment would at least be reflected in the franchise competition data room.

Potential future benefits

The UOMS technology could be enhanced and developed to provide a better understanding and detection of electrical interference type issues.

Conclusion: impact on commercial principles and commercial contract template

The general view from both Virgin Trains and Network Rail was that the proposed business process maps are generally fine and that having that process and the planned template contract terms in place would have benefited the UOMS project. It was felt they might have acted as a prompt for

a longer term view being taken and a service or SLA type contract being established with Serco.

Commercial principles

As a result of the industry consultation a set of commercial principals was developed; these were used to inform the development of the template contract by Stephenson Harwood.

A draft of the commercial principals was presented at a workshop on 15/11/13 with the T1010 project steering group (see Appendix D) and a final version, set out below, was then developed.

The 'strawman' commercial principles had not been subject to legal review but covered many of the key issues to be included in the templates, indicating where specific provisions were required. It was pointed out to the steering group that:

- The templates were not intended to be fully developed agreements but would include modules covering a range of alternative approaches that can be chosen by the parties to suit different types of RCM activity and different cross-industry relationships
- The templates were planned to target agreements between parties interested in common endeavour (and thus appropriate for immediate application to current initiatives) and not the 'cloud of data' concept where other parties can 'reach in' (a future ambition)
- An overall scheme may involve multiple parties with a single agreement or, more likely, multiple agreements some of which will be bilateral supply or service agreements. The templates are intended to have multiple uses
- Where purely commercial supply or service agreements are based on existing company terms of supply then certain of the template modules may still be used in schedules to ensure obligations still flow back-to-back between the parties
- At an early stage preliminary Heads of Terms might be agreed pending full development of the concept and the business case (which could themselves require considerable inputs)

The final version of the commercial principles included these 13 clauses:

1 Organisation and parties

For a data collection and sharing scheme to be successful there needs to be clarity on who is the promoter, who is supporting that and the roles and responsibilities of the different parties.

Roles identified include:

- Scheme Lead or Joint Scheme Leads (scheme promoter(s), who can be expected also to have other roles listed below)
- Suppliers:
- Equipment and software suppliers/installers/maintainers o Data collectors/ hosters/processors/analysts/distributors o Data receivers/users/ beneficiaries
- Scheme facilitators

The organisations fulfilling these roles can include NR, other infrastructure owners such as HS1, TOCs, FOCs, ROSCOs, train manufacturers, train maintainers, monitoring equipment manufacturers, software houses, data hosting firms and technical consultants.

Scheme facilitators can also include governmental, regulatory and industry bodies with contractual of regulatory relationships with any of the above.

Figure 3, showing interested parties within the industry and their relationships, illustrates this item.

2 Objectives

A preamble is needed setting out the overall aims of the scheme. There may be multiple aims for different parts of the industry which need to be referred to, whether achieving maintenance efficiency gains, better performance or other improvements. The intention to achieve these aims by common endeavour of the parties to the agreement needs to be expressed. If there is to be an 'alliance' relationship with a risk/reward sharing mechanism this should also be mentioned.

3 Governance

Where there are Joint Scheme Leads, provision may be needed for establishing a governance forum (management group) for scheme oversight including details of how decisions are to be taken. If an alliance is involved this forum would have oversight of the operation of the risk/reward mechanism.

4 [Business Case]

[Where a scheme business case has not been completed prior to an agreement (or more likely a Heads of Terms agreement) being reached between the parties, the agreement may need to include reference to responsibilities of the parties for its completion. This may be at industry level and parallel business cases at the level of the individual parties involved (allocating contributions and benefits to them) will be an enabler for agreement to be reached.]

5 Initial investment, renewals

Details are required of:

- The investments required (initial investments and potentially future renewals depending upon the intended life of the scheme)
- Which parties are responsible for delivering them and overseeing commissioning, including communications links
- Which parties are paying for the investments, how much and when, including allocation of cost and other implementation risks to the parties best placed to mitigate and manage those risks

Where equipment is being placed on the lineside, a Basic Asset Protection Agreement (BAPA) will be required with Network Rail and responsibilities for arranging this need to be defined.

Similarly, with on-train equipment, the necessary clearances from owners, maintainers and operators will be required and responsibilities for arranging those agreements need to be defined.

Other agreements with 3rd parties, such as the Franchising Authority (usually DFT, TfL, TfS, etc.) or ORR, may possibly be required and responsibilities for arranging those agreements need to be defined.

6 System operation, maintenance

Details are required of:

- The tasks required to accept the system, undertake system safety assessments, put the system into operation and keep the system operational (day to day system management and maintenance, including managing equipment servicing and warranties)
- Which parties are responsible for undertaking the O&M tasks

- Which parties pay for the O&M tasks, how much and when, including allocation of operating cost and other O&M risks to the parties best placed to mitigate and manage those risks

7 Data collection, processing, hosting, transmission

Details are needed of:

- The data required:
  - Metadata for data to be collected
  - Information lifecycle (including initial processing, cleansing, normalising and transmission)
  - Frequency of collection and provision
  - Time to turn around processing
  - Levels of precision and accuracy
- Any specific requirements regarding the data and its processing - including its format following processing, and whether it is required to be processed with open source software
- The tasks required for data handling (collection, processing, hosting and transmission)
- Which parties are responsible for undertaking each of the data handling tasks
- Which parties pay for each of the data handling tasks, how much and when, including allocation of data handling cost/other data handling risks

8 Data ownership (IPR), sharing, usage and confidentiality (NDAs)

Details are required of the intended ownership of data and of value added information made available post-processing.

The principles proposed to be put in place for this are:

- Raw data:
  - Should remain the intellectual property of the party for whom it is collected (that is normally the organisation responsible for the assets being monitored, whether it is a TOC, FOC, manufacturer, maintainer or infrastructure owner), even though it is considered that raw data should generally be shared freely within the industry given appropriate licensing conditions (see below)
  - May not be ascribed value other than the allocated cost of collecting it

- Processed information:
  - Should become the intellectual property of the party for whom the data is processed (in whom IPR should rest)
  - May be ascribed value in addition to the allocated cost of processing where it enables demonstrable net savings or value added, so leading to net industry costs being reduced

Details are required of the data that it is intended to share, with whom and for what purpose, whether ownership is transferred.

The principle proposed is that data ownership is not transferred but that the sharing is by means of a licence to receive and use the data for specified purposes (to be described) and subject to non-disclosure agreement (NDA) terms to be set by the owner.

Any further processing by a party with whom the data has been shared, and any subsequent sharing with further parties, should then be subject to the same conditions and limitations.

9 Service level agreements

Details are required of the levels of service agreed between the service providers and the users or beneficiaries. These are likely to relate principally to data or processing. For example:

- Availability
- Timeliness (or frequency)
- Quality (integrity, precision, accuracy)
- Transfer dependability
- Security

10Warranties, [Insurances], [Liability Caps]

As a principle it is not generally accepted that data that is shared by an owner with another party should carry any level of warranty. This is particularly the case with raw data. It is believed that the only duty on the owner is to be open with the receiving party about the source of the data and methods used to collect it. The view is taken that parties with responsibilities in the rail industry are sufficiently knowledgeable to assess the data and the risks around it and to take responsibility for any use to which they put it.

[We have no information on insurances being employed specific to XIRCM schemes but provision could be made for clauses adaptable to any perceived needs.]

[We have no information on limitations on liability being applied in XIRCM schemes but these are expected to be in place on many commercial contracts and provision can be made for suitable clauses to be made available.]

11Alliance risk and reward arrangements

While in usual rail industry business, commercial agreements will set out the services being supplied and costs and risk allocations, there are good reasons for more collaborative commercial arrangements to be entered into in certain circumstances. Examples include the Wessex alliance, bringing SWT and NR Wessex Route together in a shared risk and reward model intended to drive up such things as efficiencies and performance.

In such arrangements, the targets are set out, as are how to share the risks and rewards of achieving, exceeding or underperforming those targets. XIRCM schemes, with clear aims for outcome improvement could also be incentivised in this way. Provision can be made in the template agreements for clauses that would enable alliance arrangements (unspecified) to be covered.

12Term of agreement, franchise-end provisions

Depending on the nature of the scheme and its intended longevity, it may be desirable to identify with the franchise authority arrangements to allow carry-over of a scheme into the next franchise. It has been suggested that this might be overcome by having the equipment provision added to the requirements of the track access agreement or train service agreement - this making it feature in the data room when a franchise competition occurs.

13Disputes, termination, decommissioning

Suitable arrangements for resolving disputes and for termination, consistent with industry norms, will be needed along with specific provisions for decommissioning equipment.

Template commercial agreement

Stephenson Harwood have undertaken the legal drafting of a single, flexible template commercial agreement that can be applied in multiple ways as described in an accompanying guidance note. The template has been based on the final version of the commercial principals (set out in the *Commercial principles* section) prepared to reflect the T1010 project steering group comments. Stephenson Harwood have also drawn on the earlier work and in particular the business process mapping described in the *Cross-industry business process mapping* section.

A draft of the template agreement was made available to the members of the steering group for their comments. All comments received were discussed in a meeting of the steering group held in February 2014 after which agreed changes were made to the template.

The final template commercial agreement and its associated guidance note can be found in Appendix E and Appendix F respectively. It is also available separately via RSSB.

Key feature of the commercial template agreement

The documentation comes in 2 parts:

1 The template for the RCM agreement to be used as the basis for developing tailored agreements for signature by parties implementing cross-industry data sharing initiatives.

2 Guidance Note on 'How to use this agreement', for reference by parties developing initiatives and wanting to put them on a formal footing.

The RCM data sharing agreement is not a straitjacket and it is unlikely that it could be entered into in its current form. Instead, it provides a legal framework for the parties to arrive at an agreement, as well as pointers and aide memoires of the sorts of issues that will need to be resolved. It is noted that the parties are not required to use this document and may choose, for example, not to use the format where a party is collecting data as part of its usual course of business. Nonetheless, the template agreement can be

versatile and used, potentially, multiple times in any one project - if appropriate, for example, by acceding new parties seeking to join an existing RCM scheme.

This RCM agreement document can be conceptually divided into two sections. The first section of the agreement defines and structures the general commercial principles as agreed with the steering group. The second section is a group of eight schedules to the agreement which define project specific requirement and agreement among parties involved:

Schedule 1 Contract Specific Provisions: This schedule defines the contract specific provisions for the commercial principle in first section of the RCM agreement. This includes party name, dates, and definitions for a particular project.

Schedule 2 Specification: This schedule details out the specifications for equipment, data collection, processing, hosting transmission and terms for data sharing.

Schedule 3 Programme: This schedule details out the dates of the programme for supply and installation of the Equipment, for the delivery, transmission etc of any Data or any other dates that the Parties need to agree upfront.

Schedule 4 Data Ownership and Intellectual Property: The schedule deals with data ownership and its usage. It also includes Intellectual Property Right (IPR) of the data and licensing of IPR.

Schedule 5 Payments: The schedule deals with payments against various milestone like supply and installation of the equipment, and its maintenance.

Schedule 6 Service Level Agreement: The schedule deals project specific service level agreements.

Schedule 7 Insurance: The schedule deals with insurance like Product liability insurance, Third party liability insurance, and Employers' liability insurance.

Schedule 8 Joint Management Group: The schedule deals any clause in case a joint management group is formed as part of arrangements.

The guidance note includes the details on when this document should be used and who should use this document. It also includes some further notes to assist the user.

Conclusions and recommendations

The main objective of this study was to derive a set of template commercial agreements as tools to facilitate the adoption of RCM within the industry. This RSSB's cross-industry RCM programme which has been established to help realise rail industry objectives to improve reliability, capacity and value for money by encouraging cross-industry condition monitoring and data sharing. One of the main issues which has been holding this back is a lack of a commonly accepted commercial framework for this cross-industry activity.

As a part of this study, stakeholder consultations were carried out across-industry to understand the views of industry stakeholders with an interest in the commercial framework for cross-industry RCM data sharing. As a part of this industry consultation, review of existing RCM initiatives was undertaken to understand about the plans, aspiration and needs of stakeholders. The next stage of the study involved undertaking 2 case studies: Train monitoring Infrastructure and Infrastructure monitoring Trains, to gain a deeper understanding of the RCM data flow and processes in the industry. The existing relationships, commercial arrangements and processes under which cross-industry RCM takes place in the industry and the barriers perceived to more extensive involvement were observed to assist in creating the business process map included in this report. This understanding was shared with the RSSB steering group and other stakeholders prior to drafting the commercial principles and template commercial documentation.

There was consensus that the agreement should not be fully defined but rather present a flexible template offering a range of alternatives to suit individual initiatives as necessary. The template will act as a starting point or enabler so that industry parties can set up the specific commercial arrangements required for a XIRCM application relatively quickly and easily.

The work to derive the template commercial agreement has been subject to an extensive process of consultation and reviews from industry experts and stakeholders and the completed template, presented in Appendix E, has been endorsed by the T1010 project steering group for use throughout the GB rail industry.

To realise the benefits that the increased use of cross-industry RCM data sharing offers, both to the industry itself and, importantly, to its customer and taxpayer funders, it is recommended that:

- The industry follows the processes as set out in the business process mapping included in this report when initiating and developing cross-industry RCM data sharing activities
- The industry adopts the template commercial agreement as endorsed by the steering group and makes use of the associated guidance notes in formalising the commercial relationships required in developing cross-industry RCM data sharing activities

Appendices

The appendices are published as separate documents.

Appendix A: RCM questionnaire

Appendix B: Presentation of findings from industry consultation

Appendix C: RCM business process mapping

Appendix D: Presentation of business process mapping, case studies and commercial principles

Appendix E: RCM agreement - template

Appendix F: RCM agreement - user guide

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