Technology route-mapping to support the planning for Rail's 30 year vision

October 2009

Executive Summary

Background

This report describes the progress to date on the technology route-mapping programme commissioned by the Technical Strategy Advisory Group (TSAG), an industry group that is concerned with the long term technical development of the national railway system in Great Britain.

The report describes the route-mapping programme, the context for the work including the White Paper "Delivering a Sustainable Railway" (2007) and its four key challenges – the 4Cs (Customer, Cost, Capacity and Carbon), the Rail Technical Strategy (2007) and the role of TSAG.

TSAG recognises that current and planned activity will go someway towards the White Paper's 4C challenges. However, significant further improvement requires a large step change in the levels of performance achieved. For the purposes of the route-mapping work and to ensure that participants were challenged to be radical, TSAG adopted the following 30 year aspirational 'stretch targets':

- Customer – reduction in dissatisfaction by 90%
- Cost – halving the cost of running the railway
- Capacity – doubling the capacity where required
- Carbon – reducing carbon in line with Government policy (50% by 2050 at the time the White Paper and Technical Strategy were published)

The Rail Technical Strategy (RTS) was published alongside, and in support of, the White Paper. It considers eight long term themes for change:

- Optimised track–train interface
- High reliability, high capacity
- Simple, flexible, precise control system
- Optimised traction power and energy
- An integrated view of safety, security and health
- Improved passenger focus
- Rationalisation and standardisation of assets
- Differentiated technical principles and standards

Each theme was the subject of one of a series of route-mapping workshops delivered between October 2008 and January 2009, with a total participation of around 150 senior Rail industry professionals, academics and representatives from other sectors.

Steps in delivery of the programme included: identifying trends and drivers (social, technological, environmental, economic, political and legal analysis); setting down current industry activity and plans; identifying future technical possibilities and insertion points; estimating possible contribution to 4C targets; validating and calibrating the outputs; testing them against the four scenarios from the Sustainable Rail Programme (SRP); prioritising the output and using it to initiate projects in the strategic research programme.

The programme of work identified over 200 applications[1] which could play a part in delivering the White Paper's 30 year vision. After prioritisation, sixty-four of these applications were developed further in the eight themed workshops, and consolidated into 50 which were tested against futures scenarios in a ninth and final workshop. The prioritised outputs are shown in appendix F.

For this work to make a difference, it is critical that the outputs influence the industry's wider strategic planning. The early findings from the programme of research that is being undertaken following the route-mapping will be available in summer 2010. The work will seek to influence the development of the White Paper (to be published in 2012) and the High Level Output Specification (HLOS 2) for Control Period 5.

Findings

The route-mapping work identified the priority areas for further investigation and potential research. The top 15 (see appendix G for brief descriptions) were:

- Traffic Management
- Disruption Management
- Mega-City Suburban (traffic segregation)
- Service Quality
- Station Design & Crowd Management
- Yield Management
- Improved Hubs
- Freight Oriented Railway
- Regional Metro
- ATO and Driverless Trains
- Optimisation of Assets
- Integrated Transport & Ticketing
- High Capacity Trains
- Standards for Carbon
- Modular Trains and Infrastructure

This initial route-mapping project has been undertaken at the direction of TSAG, supported by a steering group. It has proved valuable to TSAG in selecting the priority areas for further investigation and research. It has helped in the identification of linkages and dependencies between long-term goals, applications, technologies and research. It has enabled TSAG to start identifying gaps where further work is needed to deliver the RTS and to evaluate alternative scenarios. It has begun to reveal where new knowledge is required. It will form the basis for an evolving route-map which TSAG will use to guide its work.

TSAG recognise the significant input that many individuals have made to this programme and offers its thanks. Their input has greatly informed the route-mapping work and the ongoing technology debate that TSAG is leading. It has directly influenced the future direction of research and investment.

TSAG endorsed the publication of this document in September 2009.

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[1] "Application" is the generic term applied to those activities/technologies/resources that might play a part in delivering the 30 year vision. They vary greatly in scale and scope, from IT initiatives to major infrastructure works.

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1.0 Introduction

This report describes the route-mapping project commissioned by TSAG. To understand the context for this important piece of work, information on the following can be found in Appendix A:

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2.0 TSAG technology route-mapping

TSAG commissioned a major technology route-mapping study for the industry, undertaken between August 2008 and April 2009. The aim was to develop a cross-industry collective view of rail technology in Great Britain, seeking to answer questions such as:

Where are we now?

Where do we want to get to?

How can we get there?

Why do we need to act?

What should we do?

How should we do it?

By when?

TSAG made a working assumption that there will be a significant gap between the 4C (Customer, Capacity, Cost, Carbon) benefit that current / planned industry activity will deliver on the one hand, and what would be required of the railway in 30 years time. TSAG recognised that current and planned activity will go someway towards the White Paper's 4C challenges but significant further improvement would require a large step change in the levels of performance achieved. In order to 'size the gap' it was considered necessary to enumerate what the values of the 4C's might need to be in 30 years.

Therefore, for the purposes of the route-mapping work, and to ensure that route-mapping participants were challenged to be radical, TSAG adopted the following 30 year aspirational 'stretch targets':

- Customer – reduction in dissatisfaction by 90%
- Cost – halving the cost of running the railway
- Capacity – doubling the capacity where required
- Carbon – reducing carbon in line with Government policy (50% by 2050 at the time)

On the basis that simply doing more of what we already do will not deliver sufficient improvement in the areas of customer focus, cost, capacity, and carbon, the route-mapping process sought to identify technological initiatives and innovation which would contribute to closing this gap.

For this project TSAG enlisted the Institute for Manufacturing (IfM) which is part of Cambridge University and which has specialist expertise in technology route-mapping. There is more information about route-mapping, examples, and details of the IfM approach on their website: http://www.ifm.eng.cam.ac.uk/ctm/trm/

2.1 Purpose of a route-map

Route-mapping (also known as road mapping) is a graphical approach to strategic planning that enables product and business strategies, and technical innovation strategies to be aligned with each other and to be mutually supportive.

Route-mapping approaches are now widely used at company, sector and national levels to align research investments and other strategic actions with wider goals and policy. In our particular case, the route-mapping has identified the key technology areas that will help deliver benefits against the 4Cs. It will assist TSAG to:

- show the linkages and dependencies between policy, programmes, research and technological development;
- influence the wider strategic direction of the industry, identifying the contributions that technology could make to that direction and the goals, as well as the limitations of those technologies;
- identify gaps where further action (including commissioning of research programmes) is needed to deliver the Rail Technical Strategy, and to evaluate alternative scenarios.

2.2 Process

It is recognised that the railway is a complex system and, although by no means exclusively so, the main source of technical expertise resides within the rail industry. In order for the route-mapping to be successful it was essential that the process made use of industry expertise. A workshop-based approach was designed and endorsed by TSAG, with one workshop for each of the eight themes in the Rail Technical Strategy. The Route Mapping Steering Group (RMSG) agreed a four phase approach to the work with IfM as follows (see appendix B for a process flow diagram):

2.2.1 Phase 1

This objective of this phase was to produce the workshop “design” that was used as the basis for the pilot workshop (see Phase 2). The principal supporting deliverable from this phase was an analysis of the external trends and drivers that influence the industry. It set the context for the route-mapping and was used at all the workshops, encouraging participants to maintain a long-term perspective for the route-mapping (20-30 years). This analysis addressed the social, technological, environmental, economic, political and legal trends and drivers (STEEPL analysis, see figure 1).

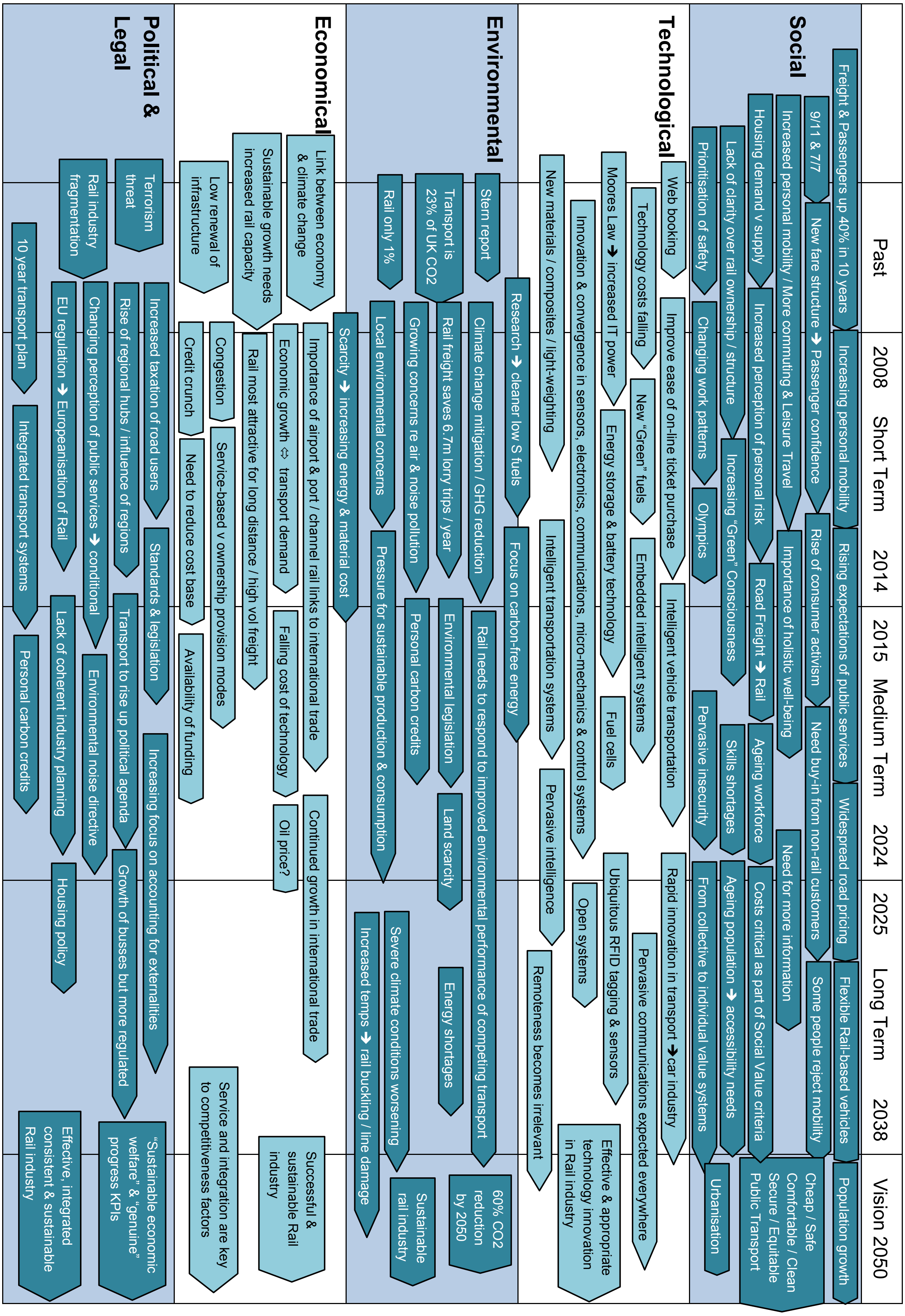

Figure 1. UK Rail industry 30 year trends and drivers (STEEPL analysis)

2.2.2 Phase 2

Phase 2 focussed on the running and evaluation of two pilot workshops (the first two of the eight). For each workshop, and for each of the subsequent ones, an industry champion was nominated from TSAG's membership. IfM undertook initial investigation of relevant material for the workshop theme, and the suitability and completeness of the material was then verified by the industry champion (the industry champions are identified in section 2.3). The output of phase 1 was a pre-read pack for delegates attending each of the first two pilot workshops.

The pilot workshops were held on 14th October 2008. The description that follows is of one of the workshops, although in practice the other workshop followed the same structure.

In the first of three sessions during the day delegates were asked to review and add to a list of proposed applications described in the pre-read material. Once completed, delegates were asked to vote for those applications that they considered to be of greatest importance in the context of the 4C targets. For the purposes of this programme of work, each of the 4C targets was considered to be of equal importance. The eight highest scoring applications from this process were then considered further in the second session.

In the second session, delegates formed small groups in which they considered themselves sufficiently expert to contribute to discussion about the eight highest scoring applications. They were asked to develop their thinking on the scope of the application, describe the contributory technology elements, the resource requirements, and the knowledge gaps that had to be addressed in order for the application to become a reality. The groups were asked to indicate the maturity of the application over time through the allocation of technology readiness levels (TRLs). Where possible, they were also asked to identify any technology insertion points (time-bound opportunities for the technology to be deployed), and any key risks or enablers associated with development and deployment of the application. Finally, the groups were asked to suggest estimates of the contribution that each of the eight applications might make to make towards the achievement of the 4C targets.

In the third and final session of they day, delegates were asked to review the work of the other groups, so providing everybody with the opportunity to critique the outputs for each of the eight applications in the workshop.

This body of work formed the basis of an initial set of route-maps for each of the eight applications within the theme of the workshop.

The two pilot workshops were subsequently the subject of discussion by the RMSG, in order to optimise the process for the subsequent six workshops (which were to address the remaining six themes of the Rail Technical Strategy). The broad conclusion of the RMSG was that the pilots had been successful, and continuation of the programme was agreed.

2.2.3 Phase 3

In Phase 3, workshops addressing the remaining six RTS themes were undertaken. Two workshops took place on 17th November and 8th December 2008, with the last two workshops being held on 21st January 2009.

Overall, more than 200 applications were considered, and as in the pilot, there were eight applications that were developed (as described in Phase 2, above) in each workshop. A total of 64 applications were thus progressed into Phase 4 of the programme.

2.2.4 Phase 4

The primary task in this phase was the convening of a ninth and final workshop. In preparation for the workshop, the RMSG undertook a process of "cleaning" and "levelling" the 64 applications. The process of cleaning involved a review of the applications to remove duplicates and consolidate any that were similar. The levelling process involved a basic review of the estimated 4C contributions for each application, to ensure, so far as possible, that they had been estimated on a consistent basis. At the end of this task 50 applications remained on the list (duplicates having been removed or consolidated).

The final workshop involved TSAG members, other senior industry experts, and representatives of government and academia. The prioritised list of applications was tested for robustness against a set of future scenarios developed as part of the RSSB Sustainable Rail Programme (SRP), described appendix C. The objective of this was to understand whether the applications were relevant to a range of future possible scenarios, or were relevant only to one or two.

Finally the group developed outline implementation plans for some of the applications. The applications selected for this were chosen on the basis of their impact on the 4C targets and their relevance across all/most scenarios. The implementation plans considered any technology or research gaps, as well as constraints associated with implementation. The outputs were to be regarded as initial work only, and it was recognised that further development would be necessary, involving appropriate experts.

Phase 4 concluded with the production of a set of application specifications, one for each of the 50 applications, and a presentation to TSAG of the various analyses of workshop outputs. For example, one such analysis involved the identification of the underpinning technologies and resource requirements of applications. This information presents a fuller picture of those applications and is useful to TSAG in thinking about how applications might be delivered.

2.3 Industry engagement

From the outset it was recognised that the route-mapping programme needed to make use of the wealth of knowledge and experience that exists within the industry. Specific individuals, recognised for their deep understanding of aspects of the rail industry, were consulted and engaged in the programme. Many were at senior (including Director) levels, drawn from train and freight operating companies, infrastructure contractors, manufacturers and suppliers, RoSCos, DfT, ORR, ATOC, RIA, RSSB, Network Rail, London Underground, Transport for Scotland, and with additional input from academia, future thinkers, passenger groups, transport economists, technology promoters/innovators, and experts from other industries. See appendix D for a full list of the organisations that contributed.

Each of the workshops and associated RTS themes was allocated a senior industry champion from within TSAG as follows:

Theme 1: Optimised track–train interface – Andy Doherty (Network Rail)
Theme 2: High reliability, high capacity – Phil Hinde (ATOC)
Theme 3: Simple, flexible, precise control system – Clive Burrows (First Group)
Theme 4: Optimised traction power and energy – Tony Mercado (DfT)
Theme 5: An integrated view of safety, security and health – Steve Bence (ATOC)
Theme 6: Improved passenger focus – Bill Reeve (Transport for Scotland)
Theme 7: Rationalisation and standardisation of assets – Francis How (RIA)

Theme 8: Differentiated technical principles and standards – Andrew McNaughton (Network Rail)

TSAG recognises the significant input that many individuals have made to this programme and offers its thanks. Their input has greatly informed the route-mapping work and the ongoing technology debate that TSAG is leading. It has directly influenced the future direction of research and investment.

2.4 Route-mapping findings

The route-mapping programme generated 50 application specifications, an example of which can be found in appendix E (all 50 application specifications are available in appendix A of the final IfM report, accessible at: http://www.rssb.co.uk/pdf/reports/research/RMS110038826.pdf.

Further information can be provided by application to research@rssb.co.uk), together with a much larger volume of supporting information relating to enabling technologies and resources. The applications to which the 50 specifications apply have been ranked in two ways:

- likely contribution to the 4C targets over 30 years
- relevance across the 4 scenarios described in Appendix C

Comparing the rankings from the two methods showed there to be a significant degree of consistency. By combining those rankings to give one overall ranked list (see appendix F), the following 15 applications emerged as those having the highest priority:

- Traffic Management
- Disruption Management
- Mega-City Suburban
- Service Quality
- Station Design & Crowd Management
- Yield Management
- Improved Hubs
- Freight Oriented Railway
- Regional Metro
- ATO & Driverless Trains
- Optimisation of Assets
- Integrated Transport & Ticketing
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- Standards for Carbon
- Modular Trains and Infrastructure

The first column of appendix F shows the applications by overall ranking. Columns 2-5 show how far each application might contribute toward the TSAG 30 year ‘stretch targets’, for example “Traffic Management” is expected to take us 3.5% of the way toward doubling capacity. This was determined through expert judgement of the possible 4Cs benefit as suggested in the workshop, and takes into account the possible level of deployment by 2038 as well as the breadth of application across the network. For each application, an average is taken across the 4Cs and that average is categorised as very high, high . low, as seen in column 6. Columns 8-11 indicate the ranking that each application was given for each of the four future scenarios. Again, the average was taken across the four scenarios, and categorised as very high, high . low, as shown in column 7.

When the two ranking methods are combined, the top 15 applications are all very high, or high and that convergence between the two lists gives TSAG confidence that those applications towards the top are worthy of further investigation. Appendix F is seen as an illustration of a decision support tool. It is the evidence that supports TSAG’s decision to turn its attention to certain technology-based applications that can reasonably be expected to deliver 4C benefits.

3.0 TSAG taking the route-mapping findings forward in the context of TSAG deployment maps

The applications to emerge from the route-mapping vary in scale and scope, from those that are seen as enabling applications with the potential to provide a platform for other (possibly several) activities, to those that would involve massive capital investment for major changes to infrastructure and/or rolling stock. There are supporting or alternative relationships across applications, some of which are mutually exclusive, while others are complimentary. The route-mapping also identified many specific technologies as well as resources that need to be considered. TSAG is addressing these and other issues in taking a programme-wide view of next steps.

As part of this programme-wide view, TSAG is now extending the route-mapping work to develop deployment maps to show how the route-mapping applications mesh into existing industry technical and planning activities. These deployment maps have been informed by IfM's route-mapping work (see figure 2 below) and their themes are an expansion of the eight themes of the RTS. The deployment maps consider: ongoing and planned industry activities, how research can input to industry strategic planning (future RTSs, White Papers and HLOS[2]), how the route-mapping applications might fit in, where industry take-up might be facilitated and where the technology insertion points might be. A draft example of a deployment map and a graphic of the notation used can be found at appendix H. It is planned to complete the draft deployment maps in early 2010 at which point they will be published on TSAGs website. They will also form an important part of a Rail Technical Strategy Progress Report which will be published in Summer 2010. It is the intention to maintain and update the route-mapping work, including the deployment maps, as a tool for TSAG to monitor and communicate its work.

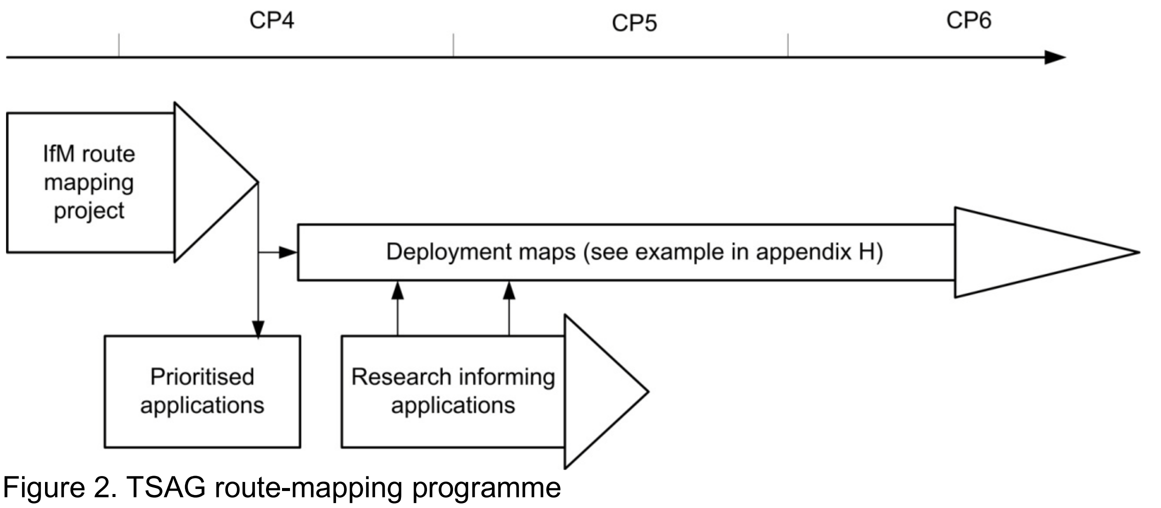


Figure 2. TSAG route-mapping programme

[2] The Railways Act 2005 requires the Secretary of State for Transport (for England and Wales) and Scottish Ministers (for Scotland) to present to the Office of Rail Regulation in each periodic review, a specification of the high level outputs (HLOS) they want the railway to provide, and a statement of funds available (SoFA). ORR must then determine the outputs that Network Rail must deliver to achieve the HLOS, the cost of delivering them in the most efficient way, and the implications for the charges payable by train operators to Network Rail for using the railway network.

Initially, TSAG has taken the outputs of the route-mapping work and is focussing its attention on those areas that presented themselves as being of strategic importance in relation to the 4Cs. Starting at the top of the prioritised list of applications (appendix F), TSAG is developing remits for further work, initially concentrating on scoping studies and studies to better understand the “size of the prize”. A key element of this initial work is to understand where activity is already underway within the industry so that effort is not duplicated and outputs from this work integrate into industry planning.

Given the variety of applications, the work streams that follow will require different procurement strategies. Some pieces of research that can be well defined will be able to be procured through conventional competitive tendering, while others may be more novel, leading to research calls, possibly requiring consortia of academia, scientific institutions, and industry.

A first tranche of projects are progressing under the overall governance of TSAG and calls for a second tranche are planned.

You can keep informed of progress in this area and of other TSAG activities, as well as view the TSAG business plan at the website:

http://www.futurerailway.org/

You can also register there for the newsletter or register your interest as a supplier to the programme.

4.0 Integrating the route-mapping outputs into industry strategic planning

The industry has a defined timetable for planning TSAG will be contributing as follows:

- Rail Technical Strategy Progress Report in 2010
- Initial input to the Government’s High Level Output Statement (HLOS 2) in 2010
- Publication of the second edition of the Rail Technical Strategy (RTS2) in 2012 to align with the publication of HLOS2

The Rail Technical Strategy will continue to have a 30 year time horizon. However in order to progress initiatives which, in part due to the long life of railway assets, may take several decades to implement, it is important for TSAG to influence planning for the next control period (CP5 2014-2019).

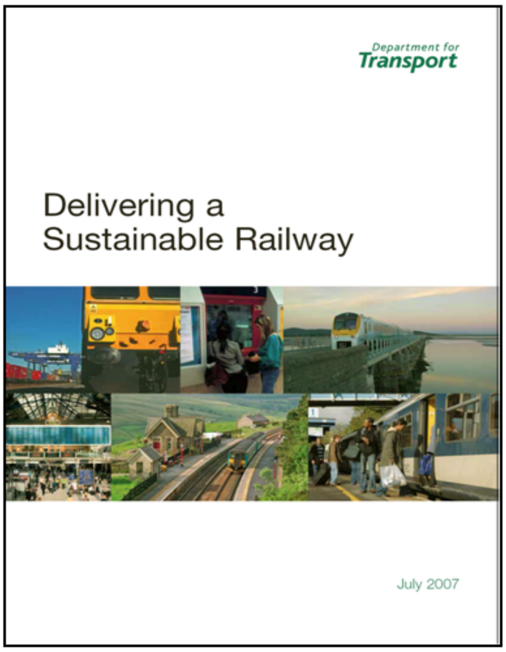
The research and deployment maps that it feeds into will inform the development of RTS 2 and HLOS2. The programme of research provides insights into the feasibility, development timetable, size of prize, costs and benefits of potential applications. This enables informed decisions on the desirability of applications to be made whether they should be incorporated, or not, into policy documents that map out the future.

In many of the fields addressed by the applications, the industry is already active and has established plans for the near and medium term. TSAG will ensure its longer term proposals integrate with these plans and the means of achieving this is shown in appendix H, which is an example of the deployment maps that TSAG is developing.

Appendix A – Setting the context for TSAG route-mapping

A.1 The White Paper "Delivering a Sustainable Railway"

The White Paper 'Delivering a Sustainable Railway', published in July 2007 fulfils the remit the Government set itself in 2005 to provide strategic direction for the rail industry.



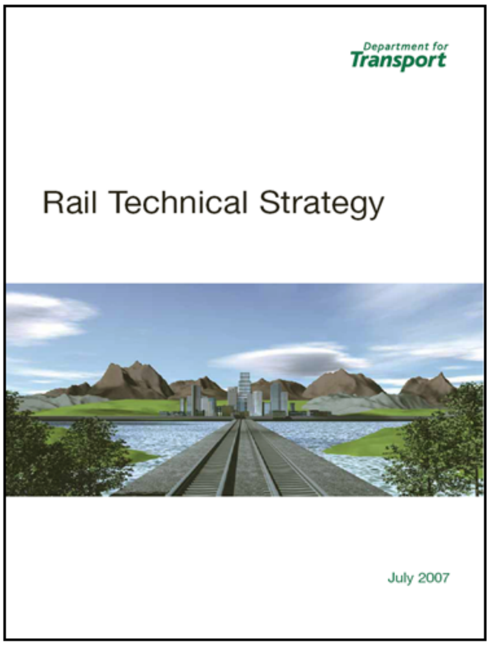
The Railways Act 2005 places a statutory duty on the Government to set out every five years how much public expenditure it wishes to devote to rail and specify what it wants the railway to deliver, notably in relation to safety, reliability and capacity. The formal statement, including the High Level Output Specification and Statement of funds available, is contained within the White Paper. It covers the period 1 April 2009 to 31 March 2014.

The White Paper looks at the potential future challenges for the railway over a 30 year horizon. It identifies four long-term agendas for Government and the rail industry working in partnership: increasing the capacity of the railway, delivering a quality service for passengers, reducing the cost of running the railway and fulfilling rail's environmental potential. (See "A.4 The White Paper's 4 C challenges")

For more information, visit:

http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/

A.2 The Rail Technical Strategy



The RTS was published with, and in support of the 2007 Rail White Paper. The RTS demonstrates how future demands and key drivers may be addressed though a combination of existing and future technology. These technologies will meet changing passenger expectations by improving the attractiveness of the rail mode compared with less environmentally-friendly competition.

For more information visit:

http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/railwhitepapertechnicalstrategy/

A.3 The eight RTS themes

The RTS identifies the following long-term themes for change.

1. **Optimised track–train interface:** Light but strong rolling stock running on precisely-engineered, accurately-maintained track, reducing energy demand, track maintenance cost and noise.

2. **High reliability, high capacity:** World-class reliability of both infrastructure and rolling stock. Infrastructure designed on lean principles with minimal trackside equipment. Intelligent infrastructure and intelligent rolling stock, each able to monitor the other and predict incipient failure.

3. **Simple, flexible, precise control system:** Communication-based cab signalling to reduce infrastructure complexity and cost, as well as improve flexibility, combined with an intelligent management layer to offer precise control of train movement through the network, allowing energy efficiency to be improved and full potential capacity to be realised.

4. **Optimised traction power and energy:** Regenerative braking on all trains, whether on the electric network or through onboard energy storage. Better use of existing electrification and selective extension where justified by business need. Bi-mode trains capable of running on or off wire, based on energy storage and with on-board power only where needed.

5. **An integrated view of safety, security and health:** Improved detection of obstruction, intrusion and abnormal behaviour at all boundaries of the system, combined with better management of response to both safety and security threats and, in the long term, recognition of the need to reflect public health concerns in the rolling-stock surface materials and air conditioning.

6. Improved passenger focus: Exploitation of ticketing, passenger flow, train movement and train load data to give high-quality information to passengers throughout their journey. Use of the same data to optimise controller response to abnormal traffic or passenger-flow conditions.

7. **Rationalisation and standardisation of assets:** A rationalised approach to asset specification, with greater use of modular and ‘commercial off-the-shelf’ (COTS) equipment, covering industry-specific assets such as rolling stock based on a whole-life, whole-system cost approach across all industry partners.

8. **Differentiated technical principles and standards:** Application of differentiated technical principles and standards to railway routes based on predicted traffic type and usage, allowing cost efficiency to be optimised whilst maintaining interoperability for passenger trains and access for commercial freight to all areas of the network where there is a reasonable expectation of need.

A.4 The White Paper's 4 C challenges

The white paper identifies several long term agendas for Government and the rail industry working in partnership. These are underpinned by the 4C challenges:

- CAPACITY: increasing the capacity of the railway whilst further improving safety and performance
- CUSTOMERS: delivering a quality service to meet the rising expectations of passengers
- COST: improving the overall cost effectiveness of the railway
- CARBON: improving rail's environmental performance

Wishing to encourage step changes in these areas, TSAG has assumed, for the purposes of route-mapping the 'stretch targets' of doubling the capacity on the network where required, reducing customer dissatisfaction by 90%, halving the cost of running the railway and reducing the carbon emissions of the industry in line with broader Government policy (50% by 2050 at the beginning of route-mapping, now 80% by 2050). The ambition is to achieve a significant improvement in each of these four areas and for this reason; TSAG adopted these 'stretch targets' for the route-mapping work.

A.5 Meeting the challenges of the Rail Technical Strategy

In responding to the Rail Technical Strategy (RTS) (and "Delivering a Sustainable Railway") the Department for Transport identified a number of key enabling actions, three of which are:

- Establish a client group for strategic research (described in A.5 to A.7 below)
- Initiate a strategic research programme (described in A.8 below)
- Develop route-maps (the subject of this report)

In 2007, TSAG was established to support the development, challenge, communication and delivery of the RTS. TSAG is the industry client group for strategic research, as established in its remit agreed in October 2007.

The establishment of a client group with a budget of £15M for strategic research signals that this area is considered a high priority. TSAG will commission strategic research focussing in particular on a thirty-year timeframe to support the development and implementation of the RTS.

A.6 TSAG's remit

TSAG is a senior cross-industry expert group drawn from the organisations directly responsible for funding, specifying and operating th1e railway, whose purpose is to:

a) Advise members' organisations (with respect to their particular functions in the railway system) on the optimal approach to the long term technical development of the railway system in Great Britain

b) Be a focus for the rail industry response to the Railway Technical Strategy, including making proposals for its further development and implementation

c) Monitor delivery of the Railway Technical Strategy, identifying opportunities and barriers and recommending actions needed to achieve an optimum outcome.

d) Overview strategic research, in particular that to be carried out by RSSB, ensuring that any work undertaken is understood to be in support of the Technical Strategy or of a challenge to it

e) Overview as appropriate the work of the System Interface Committees (SIC), industry activities and other cross industry groups, ensuring their agendas (including research) are consistent with long term needs, and encouraging efficiency in the means by which these are developed.

In delivering this purpose, the scope of the TSAG's activities is to:

a) Lead the revision of the Technical Strategy, ensuring consistency with members' own strategic plans and providing a challenge function

b) Lead the communication and dissemination of the Technical Strategy and support such communication and dissemination in their own organisations

c) Provide a point of reference for coordination of SIC activities, identifying and resolving overlaps and interactions in relation to SIC activity and between SIC activities and other cross-industry programmes and processes

d) Maintain a strategic viewpoint covering RSSB and SIC-related research, identifying the need for research into strategic issues

e) Direct strategic issues to existing cross-industry groups, wherever possible, for them to solve

f) Maintain an overview of the effectiveness of planned research to support the delivery of the technical strategy

g) Act as a client for strategic research, where this cannot appropriately be undertaken by an existing industry group.

A.7 Composition of TSAG

TSAG is made up of senior industry members drawn from all categories of RSSB membership (Network Rail, Passenger and Freight Operators, RIA, Maintenance Contractors, ROSCOs and Suppliers) RSSB, DfT, ORR, Transport Scotland, Rail Research UK, and the System Interface Committees (SICs).

At the time of publication, the composition of TSAG was:

- Alan Bennett Freight Operators (Rail Freight Group)
- Clive Burrows (First Group and Chair of VTC&C SIC)
- Derek Chapman (DfT)
- David Clarke (DfT)
- Andrew Coombes (Network Rail)
- Andy Doherty (Network Rail and Chair V/T SIC)
- Jerry England (Network Rail)
- Tim Gilbert ROSCOs (Porterbrook and Chair V/S SIC)
- Roger Goodall (RRUK)
- John Hawkins (First Group, new Chair V/V SIC)
- Francis How (RIA)
- John Larkinson (ORR)
- Martin McKinlay (Transport Scotland)
- Tony Mercado (DfT Chair, V/E SIC and TSAG)
- Len Porter (RSSB)

- Louise Shaw Passenger Train Operators (ATOC)
- James Hardy (RSSB)

A.8 The Rail Industry Strategic Research Programme

DfT have identified the need to focus on strategic research targeted at the priorities of the Rail Technical Strategy and White Paper. In response, the Rail Industry Strategic Research Programme (RISRP) was established. RISRP is funded principally by DfT, and managed on behalf of the industry by RSSB.

Strategic research is necessary to realise the long-term direction as set out in the Rail Technical Strategy, and can be characterised as:

Concentrating on defined but broad-ranging subjects where it is possible to identify a need for improvement, but not necessarily the specific solutions

Addressing complex, multi-facetted problems

Focussing on solutions that may be many years ahead

Requiring innovative approaches

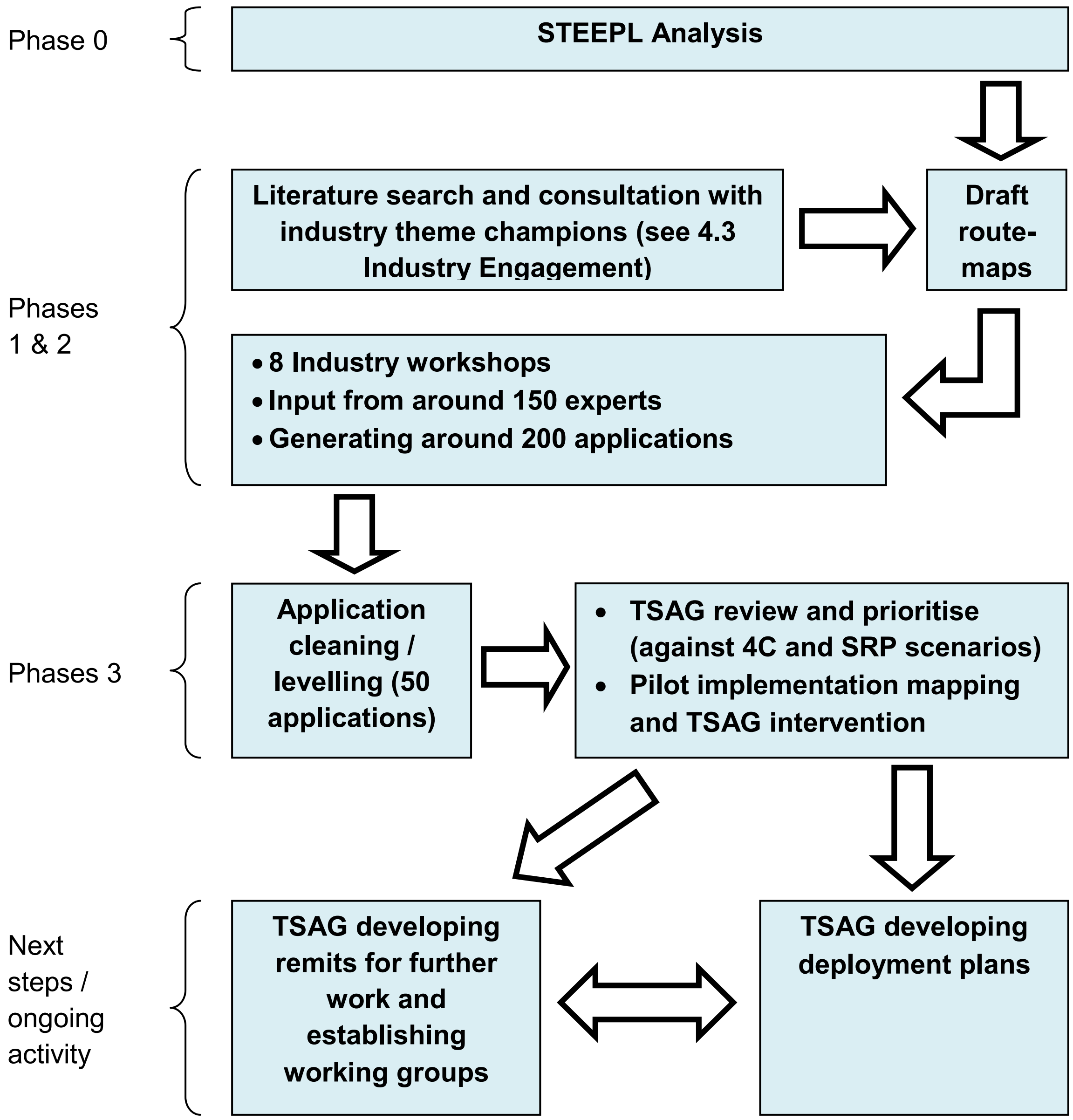
Likely to involve complex modelling and/or proof of concept

Requiring strong industry and academic collaboration.

Research will be targeted at innovative initiatives aiming to make step changes and respond to the characteristics of the future railway as identified in the Rail Technical Strategy. Projects that would be suitable for funding under RISRP are likely to:

- Have the potential to influence the delivery of more than one of the RTS themes
- Affect several elements of the railway (e.g. rolling stock, track, signalling) and therefore have significant interface issues to be addressed
- Require cross-industry collaboration to address these interface issues and develop a whole-system solution
- Address major and complex issues requiring significant levels of resource and time to develop potential solutions.

Appendix B – Route-mapping process flow diagram



Appendix C - Sustainable Rail Programme (SRP) futures scenarios

The futures scenarios that were applied to the route-maps in Phase 3 were a product of the RSSB SRP.

This foresight research was commissioned to inform long-term thinking and provide tools and techniques to assist the rail industry to determine and test potential strategies to meet the sustainable development challenges it now faces. During 2007, research was undertaken through a series of interviews and workshops on a similar scale to TSAGs route-mapping programme involving senior industry members with the ability to influence the strategy for sustainable development in rail.

The research explored the key social, technological, economic, environmental, political and organisational drivers of change impacting upon the rail industry. Analysis of these drivers of change provided the foundation for stakeholders to develop four possible 'scenarios of the future' in which the rail industry may operate. In turn, these future contexts provided the basis for stakeholder discussion on how the industry will need or want to develop over the next thirty years to ensure it is sustainable in the long-term.

The four scenarios that were developed are titled Cloud Zero, Homeward Bound, Gold Stars and Grand Projects. These scenarios can be expressed graphically over the axes of “level of co-ordination of the transport sector” (policy led - market led) vs “amount of travel” as in figure 3 below. The scenarios are described on the pages that follow.

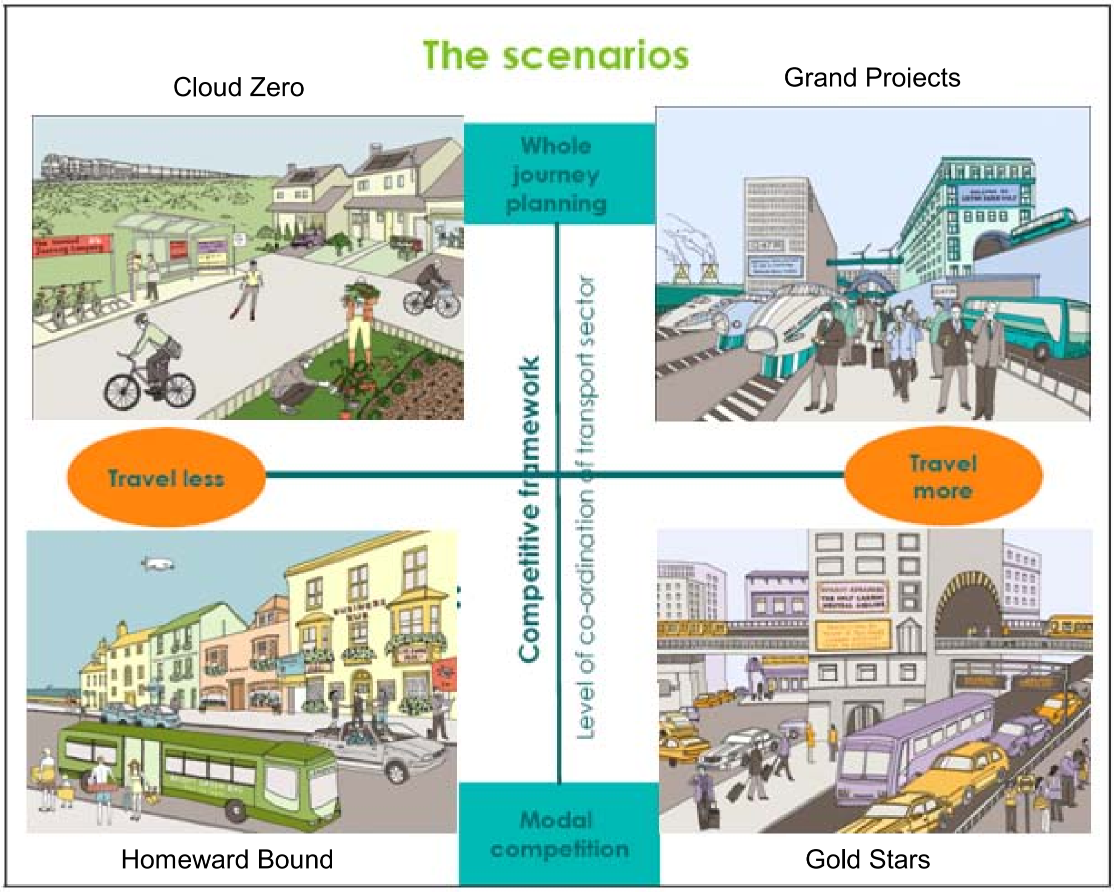


Figure 3. The 4 SRP futures scenarios.

C.1 Grand Projects

Grand Projects represents a world in which the government – nationally and regionally – decide to support the rhetoric of integrated transport planning with integrated investment. It is a world in which technology advances – and competition policy – have made a reality of through ticketing and live information which also connects rail and bus to the rental car business.

One significant shift is towards rail as the backbone of the long-haul business within the UK, taking share from both aviation and long-distance motorway travel. This is a world in which access to effective transport is increasingly more important than ownership, which is to the benefit of public transport providers, since it means that the marginal costs of each journey to consumers tend to reflect more fully its actual cost.

C.2 Gold Stars

Gold Stars portrays a world in which transport investment decisions are framed by the ability of competing sectors to deliver improved outcomes in terms of reducing carbon emissions while ensuring that economic activity is supported. In a world where road transport (car and bus) have made huge strides to reduce their emissions, rail's significant advantage is in addressing congestion in urban travel-to-work areas. This has become increasingly significant across the UK.

In this world, carbon and resource metrics are important but disputed. In this world, the key to success is aggressive reduction of the cost base, because rewards come to those who deliver the most public and social value, sustainably, in return for public investment funding.

C.3 Homeward Bound

Looking at the scenarios in which there is reduced travel, Homeward Bound characterises a world in which the government seeks to influence behaviour by imposing taxes on transport choices which have higher carbon emissions. Cars are more heavily affected than buses and trains; the impact on aviation is most severe. Generally, the effect is to reduce transport use by increasing its relative price. However, within the scenario, communications technology replaces travel to a significant extent and economic growth is maintained provided the tax signals have shifted production decisively towards lower resource costs (e.g. through closed loop production).[3]

In this world, the biggest relative change is an increase in the use of rail for leisure, both within the UK and Europe, because tax increases have caused a significant fall in aviation demand. In this world, rewards come to those who have addressed energy management, since a combination of increasing resource costs and a tax policy designed to reflect external costs creates significant social change. Although overall UK travel falls, it is likely that modal share of rail will increase, certainly proportionately and potentially also in absolute numbers of kilometres travelled.

C.4 Cloud Zero

In Cloud Zero, which combines reduced travel with policy-driven transport, this is achieved through personal carbon rationing. Technology creates an environment is which goods and services have both a financial price and a carbon price. This leads to a more local world in

[3] 'Closed loop production' describes a production system in which all by-products and waste products generated are either returned to the earth safely as biological nutrients' or are re-used as raw materials in a complementary production process ('technological nutrients').

which long-distance travel is – to a significant extent – substituted by telecommunications. Rail's big gains are in the freight sector, because of the high carbon impact of road-based heavy goods vehicles. Economic growth will have declined in this world, but it is likely that indices of social well-being and sustainable economic welfare will have increased, depending on the circumstances leading up to the introduction of carbon rationing. Rail's modal share will increase, but absolute levels of passenger demand are likely to fall.

Success in Cloud Zero goes to those who have clear metrics supported by effective and credible measuring systems.

The output of this work provides a valuable input to the rail industry long-term thinking. The scenarios themselves will allow the rail industry to test initiatives and plans as they develop to ensure they support the agenda of sustainable development in the railway. A detailed toolkit has also been produced which will ensure the industry gains maximum benefit from this research. Providing step by step guidance and resources for facilitating a scenarios workshop, this toolkit can be used effectively without training which will enable the cost effective implementation of the benefits of this research.

This work can be accessed at:

http://www.rssb.co.uk/Proj_popup.asp?TNumber=713&Parent=884&Ord=

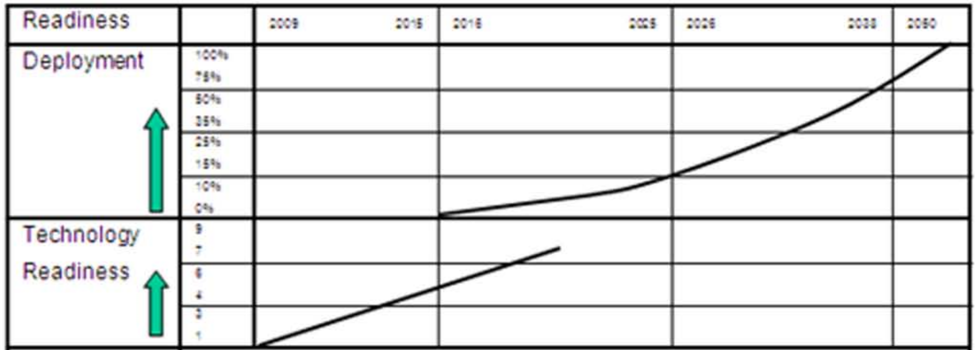
Appendix D – Industry representation at workshops

	Theme 1: Optimised track–train interface	Theme 2: High reliability, high capacity	Theme 3: Simple, flexible, precise control system	Theme 4: Optimised traction power and energy	Theme 5: An integrated view of safety, security and health	Theme 6: Improved passenger focus	Theme 7: Rationalisation and standardisation of assets	Theme 8: Differentiated technical principles and standards	Implementation and scenario testing workshop
ABB				1					
Alstom		1		1					
Amey	2							1	
Angel Trains							1		
Arup							1		
ATOC		1	2	1	2	1			2
Atkins			2						
Balfour Beatty	1								
Bombardier		1		1			1		1
Chiltern Railways						1			
Corus Rail	1							1	
Delta Rail			1						
Department for Transport	2	3	2	5	2	2	3	4	4
EDF		1		1					
Eurostar					1				
First Group			2						1
First Great Western									1
First ScotRail		1							
GE			1						
Grantrail								1	
Halcrow	1								
Henley Centre Headlight Vision									1
HSBC	1			1				1	
Industry consultants	3					1			
Lloyds							1		
London Travelwatch					1				
London Underground		1		2					
National Express Group						1			
National Express East Anglia					1				
National Physical Laboratory							1		1
Network Rail	4	4	6	2	2	4	4	7	3
Northern Rail					1				
ORR		2							1
Passenger Focus						1			
Porterbrook		1						1	1
Rail Freight Group								1	1
Rail Industry Association		1	1			1	1	1	2
Rail Research UK (RRUK)									
Birmingham University		1		1			1		
Nottingham University					1				
Southampton University	1	1			1	1			
Lancaster University				1					
Loughborough									1
RSSB	1	2	3	3	3	2	2	2	6
Siemens	1						1		
South Eastern					1				
Southern						1			
Technology Strategy Board			1				1		1
Transport for Scotland						2			1
Transport Research Laboratory							1		
Virgin Trains		1	1		1				
Westinghouse		1							

Appendix E - Example of route-mapping output, application specification "Traffic Management"

Scope: Efficient management of trains through the network The method for communication between infrastructure & train to optimise movements through the network Includes: Signalling systems; Driver advisory information; Optimisation algorithms (Timetable & Disruption); Reliability (no single point of failure) Excludes: ATO (dealt with elsewhere)	

Application:	Traffic Management				J
Products:	LD	Region	LSE	Rural	Freight
	H	H	H	H	H



Technology pacing items:	Development of ECTS or equivalent ETCS L2 → L3 (& successor technologies)
Commercial pacing items:	Business case for ECTS
Technology needs:	ECTS (or equivalent) / Control algorithms → optimised scheduling Communication technology (coverage / bandwidth / integrity) Real-Time information management. Integration with ATO Traffic management & movement authority in degraded modes
Resource needs:	Capital / Skills / Asset knowledge Tech transfer (& adaption?) from other country rail systems Migration from legacy systems
Capital cost:	£bns

Capacity				Optimis'n & efficiency Unlocks capacity	
	-%	0% 0.5% 1%	2% 4% 7%	10% 20% 40%	70% 100%
Carbon				Optimal driving → 0% energy saving Less stop/start	
	-%	0% 0.3% 0.5%	1% 2% 3.5%	5% 10% 20%	35% 50%
Customer				Improved reliability & Disruption mgmt.	
	-%	0% .05% 0.1%	.2% .4% .7%	1% 2% 4%	7% 10%
Cost			More efficient use of asset base Less disruption & mitigating action		
	-%	0% 0.3% 0.5%	1% 2% 3.5%	5% 10% 20%	35% 50%

Original Application:	2.1 (part), 2.2, 3.1, 3.7
Interfaces:	2.4, 2.6, 2.8, 4.2, 5.4, 5.5, 5.8, 6.3, 6.7, 3.2, 3.3, 3.4, 8.1, 8.3, .4, 8.5, 8.6, 8.7, 8.8 Integration with ATO.
Knowledge gaps:	

Appendix F – Application ranking by 4C contribution and relevance to the SRP scenarios

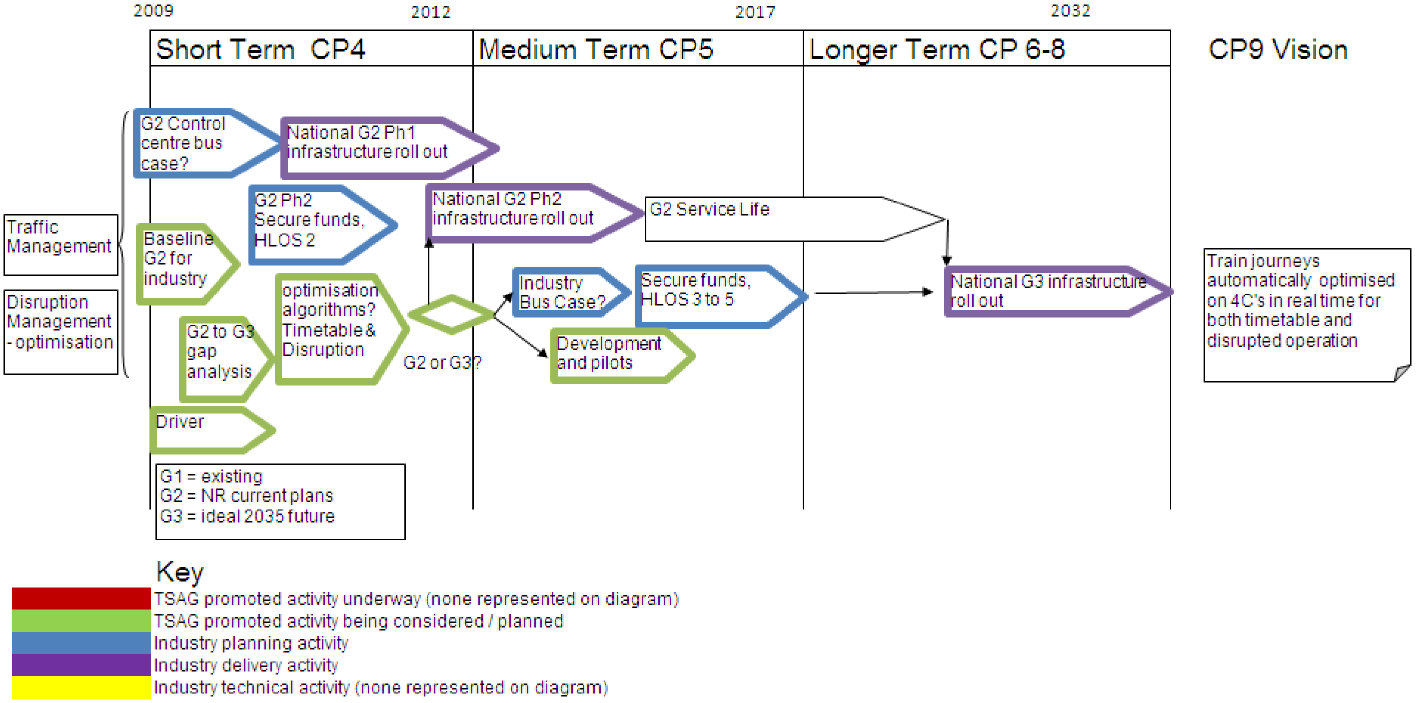
Application	2038 Impact				4C Impact	Scenario Importance	Scenario Applicability			
	Capacity	Carbon	Customer	Cost			CZ	GP	HB	GS
Traffic Management	3.5%	9.7%	6.0%	0.8%	Very High	Very High	9%	12%	5%	7%
Disruption Management	2.0%	0.0%	9.9%	0.5%	Very High	Very High	4%	5%	0%	9%
Mega-City Suburban	9.1%	0.3%	12.2%	6.1%	Very High	High	0%	3%	0%	7%
Service Quality	1.0%	0.1%	12.4%	1.5%	Very High	Very High	9%	3%	0%	0%
Station design & Crowd Management	2.0%	0.3%	15.6%	0.7%	Very High	High	0%	3%	0%	7%
Yield Management	4.3%	0.0%	4.9%	0.0%	High	Very High	5%	5%	0%	7%
Improved Hubs	3.0%	0.0%	3.7%	0.0%	High	Very High	13%	8%	8%	4%
Freight Oriented Railway	2.1%	0.1%	2.2%	2.6%	High	Very High	5%	10%	5%	5%
Regional Metro	6.9%	1.4%	2.8%	4.2%	Very High	High	0%	3%	6%	0%
ATO & Driverless Trains	4.6%	6.6%	1.3%	0.7%	Very High	High	0%	3%	3%	4%
Optimisation of Assets	0.7%	1.7%	3.5%	8.7%	Very High	High	0%	8%	0%	0%
Integrated Transport & ticketing	1.0%	0.0%	6.8%	-0.2%	High	High	5%	7%	0%	0%
High Capacity Trains - Existing	4.1%	1.5%	0.8%	0.1%	High	Very High	9%	2%	0%	5%
Standards for Carbon	0.0%	6.5%	0.0%	0.2%	High	Very High	0%	0%	13%	0%
Modular Trains & Infrastructure	0.4%	1.5%	5.2%	3.7%	Very High	High	4%	0%	5%	0%
Improved Electrification Systems	0.1%	4.9%	0.0%	0.3%	Moderate	Very High	9%	7%	8%	5%
Low Mass Trains	0.0%	5.7%	0.0%	1.1%	High	High	4%	0%	8%	0%
Regenerative Braking	0.0%	8.3%	0.0%	0.6%	High	High	0%	0%	8%	0%
Economics of Optimisation including VTSIM	1.0%	0.0%	0.0%	17.9%	Very High	Low	0%	0%	0%	0%
Personal Journey Assistant	0.2%	0.1%	10.7%	0.0%	Very High	Moderate	5%	0%	0%	0%
24 / 7 Railway	2.0%	-2.0%	2.9%	-0.3%	Moderate	Very High	11%	7%	0%	4%
Market-Led Lighter Regulation	0.0%	0.0%	0.0%	14.9%	Very High	Low	0%	0%	0%	0%
Capturing, Managing & Sharing Asset Knowl	0.0%	0.0%	0.0%	2.0%	Moderate	Very High	0%	0%	0%	13%
Leveraging Technology from Outside Rail	0.2%	0.3%	0.3%	4.9%	High	High	0%	0%	8%	0%
Adapting to Extreme Climate	1.1%	-0.3%	0.5%	0.5%	Low	Very High	0%	3%	10%	0%
High Capacity Trains - New	1.8%	0.6%	0.2%	0.2%	Moderate	High	0%	5%	0%	5%
Intelligent Monitoring	0.5%	4.0%	2.0%	4.0%	High	Low	0%	0%	0%	0%
Good track quality retention	1.3%	1.7%	1.7%	3.5%	High	Low	0%	0%	0%	0%
Economics of Line Differentiation Optimisat	2.2%	0.4%	0.7%	0.0%	Moderate	Moderate	0%	0%	8%	0%
Rolling Stock optimised for Track:Train Inter	0.4%	4.5%	0.4%	1.5%	High	Moderate	0%	0%	1%	0%
Multi-Purpose Core & New Intercity Routes	5.1%	0.0%	0.3%	0.1%	Moderate	Moderate	0%	0%	0%	5%
Capacity Modelling	1.0%	0.0%	0.0%	2.0%	Moderate	Moderate	0%	5%	0%	2%
Infrastructure Validation Facility	1.7%	0.3%	2.6%	1.7%	High	Low	0%	0%	0%	0%
Trans Shipment for Freight	0.6%	0.2%	1.2%	0.9%	Moderate	Moderate	4%	0%	0%	0%
Rolling Stock Interior Design	0.3%	0.0%	5.6%	-0.2%	Moderate	Low	0%	0%	0%	0%
Systems Engineering Approach	2.0%	0.1%	0.0%	0.3%	Moderate	Moderate	4%	0%	0%	0%
Condition Monitoring	0.2%	0.1%	4.7%	0.3%	Moderate	Low	0%	0%	0%	0%
Improved Track:Train Interface Knowledge	0.0%	0.0%	0.0%	0.4%	Low	Moderate	0%	0%	0%	7%
Micro Generation	0.0%	0.0%	0.0%	0.0%	Low	Moderate	0%	0%	4%	0%
Approval & Business Case Modelling	0.0%	0.0%	0.0%	2.0%	Moderate	Low	0%	0%	0%	0%
Future Standards Processes	0.0%	0.0%	0.0%	2.0%	Low	Low	0%	0%	0%	0%
Personalised Rapid Transport & Mkt-driven	0.0%	0.0%	0.0%	0.0%	Low	Moderate	0%	0%	0%	2%
Standards & Safety	0.5%	0.0%	0.0%	1.5%	Low	Low	0%	0%	0%	0%
Elimination of Single Point Of Failure - Point	0.2%	0.2%	0.2%	0.2%	Low	Low	0%	0%	0%	0%
Monitoring System	0.2%	0.0%	0.9%	-0.3%	Low	Low	0%	0%	0%	0%
Discontinuous Electrification	0.0%	0.5%	0.0%	0.0%	Low	Low	0%	0%	0%	0%
Lean Thinking to Optimise Rail	0.0%	0.0%	0.0%	0.4%	Low	Low	0%	0%	0%	0%
Methods Of Working	0.0%	0.0%	0.0%	0.4%	Low	Low	0%	0%	0%	0%
Elimintae Risk @ Level Crossings	0.1%	0.0%	0.1%	0.0%	Low	Low	0%	0%	0%	0%
Ubiquitous Data Network	0.0%	0.0%	0.0%	0.0%	Low	Low	0%	0%	0%	0%

See **2.4 Route-mapping findings** (pg 10) for an explanation on the construction of this table

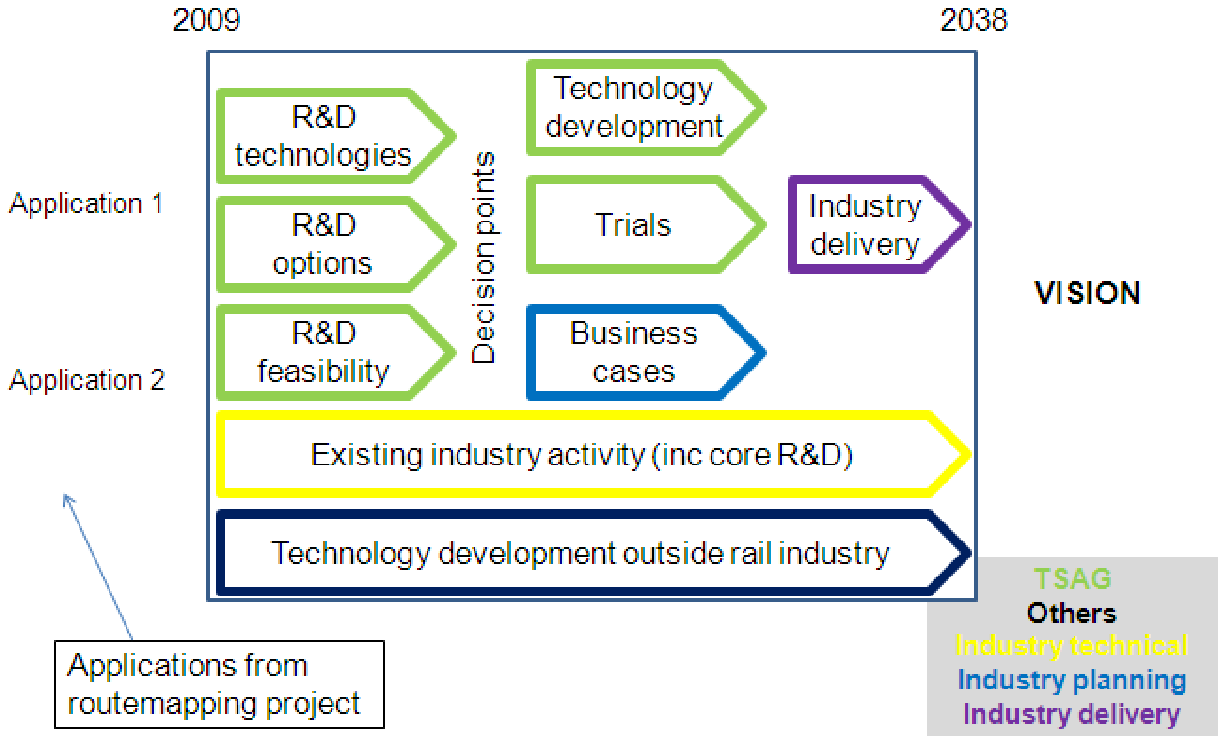
Appendix G – Descriptions of the top 15 applications

Traffic Management	Radical "signalling" (without signals?) and movement optimisation.
Disruption Management	Optimisation of disruption management and telling the customer what's going on.
Mega-City Suburban	Testing the hypothesis that changing part of the existing network to create segregated suburban railway delivers cost efficiencies and capacity benefits.
Service Quality	Technological innovation that could contribute to the overall travel experience (eg cleanliness, environment, toilet facilities & general up-keep etc.). Also to cover the non-physical aspects of passenger experience (eg availability of seating, passenger journey information etc.).
Station Design and Crowd Management	How existing stations could deal with increased capacity in the future by utilising technology to provide a safe seamless and secure transition for customers without major re-building work.
Yield Management	Improving utilisation of existing capacity by persuading customers to adapt travel behaviour to available capacity – mechanisms might include pricing, real-time journey information, improved safety / attractiveness of services.
Improved Hubs	Getting more trains through a hub (bottleneck) and the establishment of a service case for doing so.
Freight Oriented Railway	A network that is designed for freight that passenger trains can use as well
Regional Metro	Shared use of the network but with differentiated standards on the tram-train model, ie. Rolling stock which is lighter / lower-cost, able to run on streets and with line-of-sight signalling (& hence track brakes). It is segregated from other traffic by signalling systems that allow lower crashworthiness standards (may have capacity dis-benefit). As street running is possible congestion at hubs can be relieved and lower cost & tensions at "country end".
ATO & Driverless Trains	Develop the evolution of automation towards "Driverless Trains": 1. Driver Advisory Speed Systems, 2. Automatic Train operation (Driver still present), 3. Driverless Trains
Optimisation of Assets	Data collection, analysis and use in order to improve the reliability (real time and future) and whole system whole life cost of assets.
Integrated Transport & Ticketing	Improvement in the integration of rail with other transport systems (buses, air, underground, tram systems, taxi's, bikes, walking, boats and private cars) (car parks) including: integrating ticketing, integrated passenger information (personal navigation systems, journey planning), stations integrated with other transport modes, integrated timetables, ensuring availability of buses/taxis/bikes/etc when required. Integrated transport is also an issue for freight.
High Capacity Trains	Making the best of the vehicle envelope dictated by fixed infrastructure. Issues include 1) tolerances, vehicle control and localised infrastructure constraints, 2) useable space (box size, furnish-able space).
Standards for Carbon	The railway is regulated by a wide range of standards that were developed in an era that predated concepts of sustainability. This application seeks to re-examine these standards and, where appropriate, adjust them to reduce the carbon footprint of the railway.
Modular Trains and Infrastructure	Developing system functionality maps to highlight those areas that are able to be modularised. Encompasses; plug and play Common Of The Shelf (COTS); lean principles; obsolescence management; minimisation of whole life costs and reduction of risk (eg supply chain).

Appendix H – Example TSAG deployment map



Deployment map nomenclature



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