

Consultation

Shaping the 30-year Rail Technical Strategy

2010·2020·2030·2040

“Together, making rail’s technical vision real”

The rail industry’s progress report for the Rail Technical Strategy

TSAG

Foreword

Steve Yianni

Chair, Technical Strategy Advisory Group

“The rail industry needs to act now to secure a sustainable future and long term value for money.”

The railway needs an up-to-date technical strategy to support its business objectives.

This document takes stock of where we are and seeks senior level engagement in forming and developing that technical strategy.



Rail plays an essential role in driving sustainable economic growth, providing access for passengers into and between the major economic centres and fulfilling a vital position in the supply chain to get goods to market. Having the right technology at the right time to meet this role is an essential element of our success and our aim in TSAG is to provide industry leadership by anticipating these needs and securing development and research to enable our industry to achieve these goals.

But the cost of the GB railway system is unsustainable. So we also recognise the immediate need to reduce the £6billion annual 'direct debit' to the 'public purse' and we have a keen eye to technology interventions that reduce our cost base.

At the same time, there is pressure on us as an industry to deliver more. The national rail network is central to the mechanics of the British economy and so crucial to the country's short term recovery and long term competitiveness. We carry 3 million passengers per day, 450,000 of them commuters in the morning peak. Each day, 2 million people either begin or end their journey in London, and 200,000 tonnes of freight are carried. The network as a whole sees over 1.2 billion passengers a year. There's a demand to become more sustainable and a need to handle increasingly stringent environmental constraints. Further, there is an anticipated rise in demand for higher quality and more economic rail travel for passengers and freight use.

The railway desperately needs a systems approach and strategic planning to realise its full potential. Railway assets generally have long payback periods so we can't rely on being able to change things quickly. The railway industry needs to start thinking now about the right technology and value-for-money schemes and associated incentives on a 30 year horizon, and not just the next 5 year control period.

The Technical Strategy Advisory Group (TSAG) has cross-industry representation from infrastructure, passenger and freight operation, rolling stock, RSSB, Transport Scotland – an agency of the Scottish Government, Department for Transport and the Office of Rail Regulation. Together we have illustrated this 30-year value-for-money challenge, of which captains of industry need to be aware.

TSAG's 30 year challenges

Cost: Halve the cost of rail operations

Capacity: Double network capacity

Carbon: Halve the industry's carbon footprint

Customer: Increase customer satisfaction to 99%



Competitiveness:

GB rail as part of the fabric of economic success

TSAG's work complements and supports the work associated with 'Planning Ahead 2010' produced by Network Rail, ATOC and the Rail Freight Operators' Association.

TSAG sees these challenges as opportunities to change, enabling the rail industry to better meet the needs of its customers and society. Technology will help us reduce our cost base. Now is the time to invest energy and resources into understanding how we can achieve this, unblock complex cross industry issues, and bring new insights to the sustainability challenge. Without this, the economy will have the burden of a more expensive railway, which will at the very least hinder its ability to compete and grow. The environment in which we operate is one where sustainable affordability is key.

We have identified **five 'game changers'** which need to be researched and developed now so that decision makers in organisations can collectively identify and draw on the appropriate benefits and take technology decisions in a 30-year time frame.

1) **Enable innovation, not re-invention:**

Systems leadership is key to innovation. Industry needs an incentive and a process to embrace the potential for improvement, without awkward technical, structural or cultural obstacles.

2) **Establish next generation traffic management:**

Centralisation of rail traffic control into a single system or 'guiding mind' to optimise the network's capacity and increase customer satisfaction, reliability and safety. This will require the bringing together of commercially available systems and integrating them. Increases in rail's delivery potential will be reflected in revenue increases, income which might currently be out of reach through capacity constraints, while reducing operations costs through better management of the network, better utilisation and lower energy consumption.

3) Optimise energy strategy:

We must make savings on the railway's annual £500m traction energy bill through better exploitation of new and existing technology. Train regenerative braking is already in use on the network. This and other ideas need to be deployed further to make greater inroads into the collective traction energy bill.

4) Build in whole system reliability:

A business case for a whole system strategic approach to reliability is needed. This would help reduce the £600m annual cost of delays and a host of other related business performance costs in agreeing delay claims. Technology can help deliver better asset management, via deployments such as remote condition monitoring and systems for sharing performance data.

5) Provide smarter data and communications:

We promote a strategy for rail mobile communications which relies on commercially available, off-the-shelf systems to provide enhanced information in line with the needs of both front-line railway operations and customers.

TSAG works with the System Interface Committees and other cross-industry groups in sponsoring research in an RSSB-managed programme. The research covers all these areas to enable industry to make the right call at the right time and enables research institutions to clearly see what the industry needs and have confidence that their work will be applied and deliver benefit. The result of this work will be decisions grounded in evidence on how technology is applied to meet defined future requirements.

We run the risk of substantial unnecessary costs which will be incurred if we don't begin securing the knowledge now, and embedding it into our planning. TSAG has contributed to the production of the 'Planning Ahead 2010' document produced by the rail industry, which acknowledges the role of technology in achieving the plans for rail over the next 25 years. This forms part of the process that will generate the next industry strategic business plan and the Rail Technical Strategy will be developed to support this.

TSAG is supporting basic and applied research and the translation of innovative technical solutions into world-class products. This is part of the essential investment in the science base, engineering and operational capabilities of British industry. It will help drive the future growth of the rail sector and through that, support UK economic growth and exports.

We now need to sense-check these aspirations in a consultation, to inform the next Rail Technical Strategy, due to be published in 2012, which will be owned by the industry. This is your opportunity to help shape future technical directions, and we welcome your views.

Please send your reply by email to: tsagconsultation2010@rssb.co.uk or by post to:

Martin Brennan, RSSB, Block 2 Angel Square, 1 Torrens Street, London, EC1V 1NY by 17 December 2010.

I look forward to hearing from you and your organisations on where we go from here and to tackling the strategy challenge with my colleagues on TSAG.

Steve Yianni

Chair, Technical Strategy Advisory Group



Railway Industry Association



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Executive Summary

This consultation document reports on the initial activities undertaken by the rail industry, supported by the Technical Strategy Advisory Group (TSAG) to progress the Rail Technical Strategy (RTS) and invites you to comment on the proposed priorities for future activity.

We are keen to hear from you.

To help you respond, we have set out six specific questions, and details of how to reply, on page 42.

The Rail Technical Strategy brings together a long term vision of the railway as a system and how technology can contribute to meeting the key challenges it faces. These are:

- Affordability - public funds presently account for half the railway's £12bn annual costs
- Future network capacity - to cope with expected increases in passenger and freight demand
- Carbon reduction - helping to meet transport's contribution to national targets (the initial national target is a 34% reduction by 2020)
- Customers – Develop information systems which match passengers' expectations for real time information for all services

But the technologies required to address challenges of this scale are outside the scope of any single company to pursue. They are typically long-term, and need the involvement and coordination of many bodies – planners, operators, engineers, manufacturers, and equipment suppliers. The rail industry is characterised by having long-term assets, limited opportunities to intervene and a reliance on co-ordinated forward planning. The real prizes will only be gained if whole system approaches are developed.

The Technical Strategy Advisory Group, with cross-industry representation from infrastructure, passenger and freight operation, rolling stock, RSSB, Transport Scotland, Department for Transport and the Office of Rail Regulation, has been established to develop thinking and to lead and champion research in these areas. Thus it is not responsible for implementing or planning rail technology over the short or mid-term, but has a remit to address future technology opportunities over a 30 year horizon. While this timescale gives rise to many uncertainties, TSAG's work, facilitated by RSSB, benefits from informed judgement based on access to leading academic and industry experts.

To promote radical thinking around future technologies, TSAG began by setting some deliberately ambitious values (to the point of being considered unachievable, based on current technology and practice) for the strategic challenges set out in the 2007 White Paper 'Delivering a Sustainable Railway'. These are known as the 4Cs:

- Halving the railway's unit **costs**
- Halving its **carbon** footprint
- Doubling network **capacity**
- Increasing **customer** satisfaction to 99%

These are not explicit targets; they are to establish thinking at a suitably ambitious level, namely step change, not incremental. Nevertheless, through the leadership of TSAG in quantifying them, the 4Cs metrics have become common currency throughout the industry.

A key focus of the early work has been on estimating the size of the prizes available and assessing how much of each of the 4Cs is realistically attainable over various

timescales. For example, the railway consumes energy costing about £500 million, so being able to halve that bill would make a big difference to its overall finances. How far it is possible to get towards that saving is not yet determined, although it is thought to be substantial, but by the time the next version of the RTS is published in 2012 the size of the benefits will be better assessed, and a robust case made for taking forward the relevant technologies. And energy is just one example of many areas where big prizes are foreseen.

In the foreword, TSAG's chairman referred to the challenge and the five 'game changers'. These are explored in a bit more detail here:

Enabling innovation

Delivery of step changes in cost reduction and performance will only come about if the industry is better able to innovate across system boundaries. Four kinds of innovation are needed – technical, structural, process and cultural. The challenges associated with removing the obstacles to innovation have been identified in an initial study, 'Enabling Innovation' and include:

- Lack of a holistic, systems view – eg constraints of franchise conditions
- Weaknesses in organisation, processes, competence and culture – eg problems in monetising benefits of innovation
- Poor implementation risk management – eg acceptance processes are not well understood by suppliers or flexible enough

The principal interventions proposed are:

- Establish a top-level 'sponsor' function to provide the business 'pull' (rather than technology 'push') for innovation and to integrate with industry planning
- Establish a GB rail 'technology leadership' function

The insights gained from this study are not limited to technology issues, but apply to innovation more generally. Understanding them is the key to unlocking progress right across the railway.

The key interventions

From the work done so far, the most promising technological interventions have been identified. These are seen as having the potential for changing the game for the rail industry. These are:

- Introducing next generation traffic management systems
- Optimising energy strategy in a challenging environment addressing reliability in a whole system way
- Supporting these by providing smarter data and communications systems

A programme of research has been established in each of these areas.

- **Next generation traffic management** – This is based on the concept of a central 'guiding mind' controlling rail traffic. It has the potential to change fundamentally the way we operate our railway and to bring about substantial business benefits. In enabling capacity to be maximised, the control would have the effect of sweating existing infrastructure assets, thereby reducing the need for additional capital expenditure to cope with predicted increased demand; by enabling more trains to run reliably to time, it would reduce trainset and human resource requirements, increase customer satisfaction and enhance safety.

The principle is simple: each train reports its status continuously to the guiding mind which then tells it what to do, including optimal speed to minimise energy, avoid conflicts with other trains, maximise capacity and arrive on time. This optimises network operations in normal operating conditions, speeds recovery from disruption and supports the provision of accurate and up to date information to customers.

Modelling work will substantiate benefit estimates, though initial trials indicate that energy savings from early phases of this programme (ie within five years) will be substantial – up to £50m and ultimately capacity worth half a billion annually (based on 8% additional capacity).

Much of this transformation could be delivered independently and well in advance of ERTMS, and bring benefits much earlier. ERTMS once delivered, will in any case need to incorporate a fully optimised traffic management layer to realise its full potential.

- **Energy strategy** – The railway uses 660 million litres of diesel and approximately 3,000 GWh of electricity a year for traction purposes, plus significant non-traction energy for depots, stations and other infrastructure. This results in carbon emissions of around 3.5 million tonnes of CO₂ and an annual energy bill of over £500m. The energy strategy programme is evaluating how large cost savings can be made in this bill and carbon effects minimised, by making best use of existing technology and the development and introduction of new technology.
- **Whole system reliability** – The railway pays a price for unreliability both in terms of service delay for our customers and the provision of recovery time in our timetables, which eats up valuable capacity. The cost of delays alone, if delay minutes compensation payments are treated as a proxy, is of the order of £600m per annum. TSAG is supporting industry research to understand and build a business case for a whole system strategic approach to reliability. This focuses on developing better asset management through sharing asset performance data across the system, enhanced use of remote condition monitoring and predictive asset performance. Also included is the ability to adopt appropriately standardised, high quality, low cost technology that is commercially available from competitive markets.

- **Data and communications** – The telecoms industry delivers advances at an ever increasing rate. Without an integrated, whole system strategy, it is likely the rail industry will miss opportunities or will invest in technologies that may not deliver or have limited life. As rail assets generally have longer life cycles than communications equipment, an important aspect of the strategy is future-proofing. Initial research has confirmed the need for a single, integrated strategy for rail mobile communications, enabling the efficient and effective delivery of both operational and passenger ‘value-added’ communication services. It provides a road map for the technology needed to deliver both fixed and mobile high bandwidth communication services and proposes a coherent programme of activity to deliver future communications and positioning systems.

Exploring more radical interventions

Some ideas are very radical, so the initial focus has been on assessing whether they have sound economic and practical bases before making a decision about whether they should be pursued. For example, a ‘Mega City Suburban’ research project has shown the potential benefits of reserving parts of the network for use by homogenous traffic types. Moving away from the ‘mixed use railway’ concept would have important implications for users, but may be worth exploring if the overall benefits are shown to be substantial. Many radical ideas are being examined but there are areas which have been avoided, for example where technology development is necessarily led from outside the industry – eg battery technology – where TSAG is maintaining a watching brief via RSSB’s ‘technology watch’ service to ensure emerging opportunities are spotted.

But we will only make progress if opportunities are turned into reality. Therefore the implications of the programme in terms of development funding and resource planning have been flagged within the early inputs to the industry planning process – via the developing Network Rail Strategic Business Plan for CP5, so they can be taken account of in the next HLOS and settlement. Emerging outputs will feed into Network and Route Strategies and individual company business plans.

Maintaining ‘business as usual’

As with all change programmes, ‘business as usual’ must be maintained during the development and introduction phases. The programme is in support of the industry and its constituent businesses, and recognises the requirement to support short term business needs while producing long term beneficial solutions to the more strategic problems. An important focus is to de-risk innovations.

Where the programme finds beneficial solutions that are not technological in nature, these will be shared with whoever in the industry is best placed to take them forward.

About this document

You see things; and you say “Why?”

But I dream things that never were; and I say “Why not?”

George Bernard Shaw

This document describes emerging thinking on how technology can help provide solutions to the key strategic problems facing the railway, particularly how to reduce its costs while delivering an improving quality of service to its customers – passengers and freight users – and protecting the environment. It is a consultation document, preparing the way for the second edition of the Rail Technical Strategy in 2012.

The Technical Strategy Advisory Group (TSAG) is a cross-industry group facilitated by RSSB and remitted to identify and develop technological opportunities for the rail industry over a thirty year timeframe. The scale of the interventions means that they are likely to affect all parts of the rail system - where the big prizes are to be found.

The work we are managing in TSAG and the insights it has already delivered, are described in the following sections. These are based on the four key strategic challenges which TSAG has established, and collectively known as the 4Cs:

- Halve the railway’s unit **costs**
- Halve its **carbon** footprint
- Double network **capacity**
- Increase **customer** satisfaction to 99%

These are not explicit targets the rail industry should adopt; they are to establish our thinking at a suitably ambitious level, namely step change, not incremental.

These challenges are daunting, but present a huge opportunity for the industry if we can harness the technologies that will enable them to be met. As the railway receives £6 billion every year from public funds (half its income), making significant progress in these areas would be good for the economy too.

The Rail Technical Strategy (RTS) published in 2007, sets out the overall approach the industry would adopt in developing technology in support of policy and business objectives. TSAG’s work also supports those objectives, not the pursuit of technical development for its own sake. It contributes to the industry’s long-term planning processes through which key decisions on making and funding change are decided. Consistent with this, we recognise that plans for the implementation of new technology must always take account of the need to continue ‘business as usual’ during the transition.

This document describes and builds on the progress we have made over the first three years to take forward the RTS. High Speed Rail development has been taken forward by the Government’s High Speed 2 company and has not therefore been included within this document.

It asks for your views about where further progress should be focussed. The consultation at the end of the document is a key stage in the development of the second edition of the RTS, due to be published in 2012. That edition will include the results of our further work to quantify the potential impact of technological interventions. Please respond to the consultation by 17 December 2010.

More information on the Rail Technical Strategy and TSAG is available in Appendix 1 and via the TSAG website: www.futurerailway.org

Setting the scene - System capability and the scope for improvement

Key improvement areas

The existing capabilities of the railway system and its technology are used intensively to meet current business requirements. However, those capabilities are finite and the increasing pressures of additional demand and the need to reduce costs will expose their limitations. Therefore more radical approaches must be developed to overcome these limitations, supported and enabled by innovative technology.

We have identified four areas for improvement, where the most impact can be made, and developed them as programmes of research. These programmes are:

- **Next generation traffic management** – how the railway is operated to make the best use of capacity and deliver a reliable, punctual train service at a reasonable cost.
- **Energy strategy** – reducing the financial cost and carbon footprint of the energy used by the railway.
- **Whole system reliability** – managing the assets used by the railway in a way that produces the fewest failures, enabling capacity to be maximised and doing this at the lowest long run costs.
- **Data and communications** – providing complete, accurate and timely information to railway personnel, passengers and freight customers and supporting enhanced processes, for example asset management, while optimising energy usage.

Each of these is explored in subsequent sections, with a description of the proposed interventions.

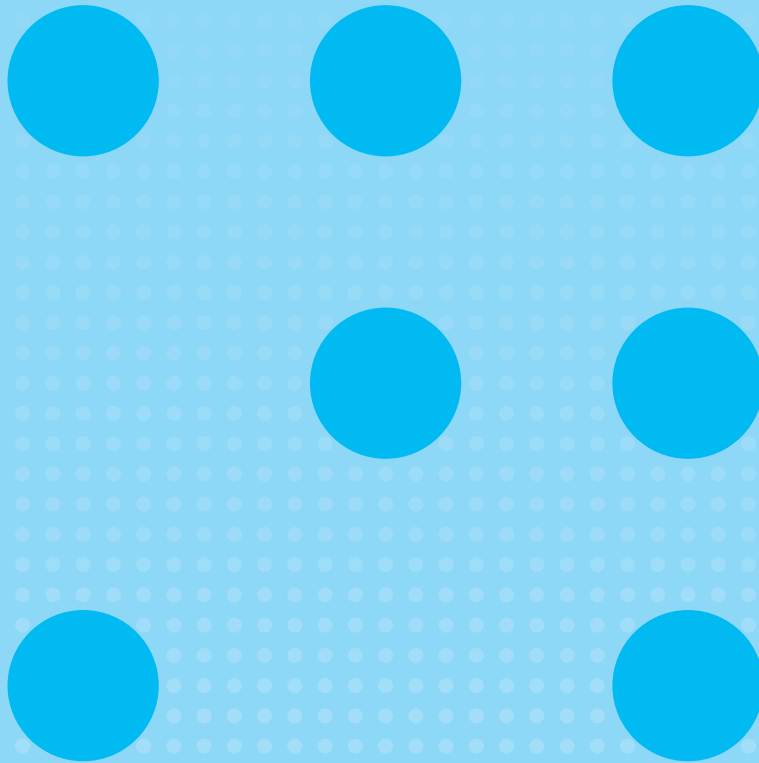
The TSAG-sponsored work which led to the identification of these priorities is described in Appendix 2 and an overview of the 'route-mapping' process, which informed this work, is provided in Appendix 3.

The need for innovation

However, to deliver improvements in any of these areas, the railway first needs to overcome its inhibitions regarding innovation. This fundamental and overarching issue, and the results of the work TSAG commissioned to investigate it, is described in the next section.

Enabling innovation

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Enabling innovation

The problem

Few of the wide-ranging ideas in this document can be implemented unless we can overcome the difficulties of innovating across all the sub-systems that make up the railway.

This implies changes across many aspects of the system, so a mechanism for equitable and aligned apportionment of incentives, costs, benefits and risks is required to overcome potential hurdles to innovation.

Innovation is needed across the whole spectrum of the railway business (and not just in relation to technology) to support the delivery of its objectives. The nature of the innovation will depend on the particular business needs – there is no single approach or standard application. But there are some common factors, as discussed below, which may serve to guide the development of innovative solutions. Business models used by the industry when establishing new ventures, or restructuring, should take account of these to ‘design in’ the capability to innovate.

Discussions we have held with senior industry representatives indicate that introducing innovative products and services into the railway is a real challenge. Four kinds of innovation are needed – technical, structural, process and cultural. Technical, to allow the application of the latest knowledge, materials and techniques; structural, to ensure incentives are aligned and technical innovation is welcomed; process, to make it easier to implement change in practice; and cultural, to create a can-do and want-to-do approach typical of best practice innovation industries.

The vision

A vision of the railway of the future would include a description of its ability to innovate:

‘By 2030 the sector is widely recognised as one of the most dynamic of the transport sub-sectors, with a thriving mix of organisations working together both within the GB and in international markets, and attracting the best talent’.

Amplifying this vision:

- **Commercially attractive:** Venture funding is available for the many attractive opportunities, while long-term investors are able to derive stable and attractive returns from a robust infrastructure sector. The industry is a magnet for talent and resources.
- **Technologically dynamic:** The industry is recognised as forward-looking, with a flourishing research base and a cross-section of companies committed to innovation, able to adopt new technologies and philosophies and bring them to commercialisation quickly and effectively. There is collaborative management of intellectual property, standards and systems. Innovation is facilitated by technology.
- **Innovation-driven results:** By 2030 the industry has made great strides in meeting the 4C challenges with innovation as a key driver and enabler for achieving results.
- **International reputation:** Companies active in the GB industry supply chain are internationally competitive and have an enviable reputation for innovation.
- **Industry research:** Informed research communities working with us to capture, explore, prove and apply innovative solutions which grow their reputation and deliver our goals.

Progress and initial insights

We commissioned research into the challenges of enabling innovation on the railway and have received an initial report: *Enabling technical innovation in the GB rail*

industry-barriers and solutions. This reveals that barriers exist at three levels - industry, organisation and tools/ techniques. It identifies seven key success factors:

- **A unified system-wide perspective:** A common understanding and capability to assess the system-wide opportunities of technology decisions
- **Clear and stable policies and incentives:** which
 - Balance social, economic and sustainability demands and trade offs
 - Reflect the full life of assets
 - Provide commercially-motivated demand for innovation
- **Longer term technology planning:** More sophisticated technology strategies, including platform engineering (which involves engineering new products in such a way that it is possible to reuse product components and apply variability with decreased costs and time) and radical innovation concepts, to allow faster technology lifecycles
- **A capability resource base for innovation:** Active and strong knowledge networks and programmes of research, leading to significant demonstrators of radical systems opportunities
- **Harmonised standards:** Progress in harmonising philosophies, standards and technologies across international boundaries so innovations can flow more easily between markets
- **A collaborative supply chain:** A community of suppliers collaborating to form responsive supply chains contributing to the GB economy and serving global markets – based on the right incentives coming through the style of contractual engagement
- **Better risk management at technology introduction:** Better ways of working to manage and reduce the risk of introducing innovation to the railway system (developed before implementation)

The research identified a range of enablers to facilitate innovation, regardless of the context - ie they apply at any level of the business and whatever scope or issue is involved. They do not imply any structural change or

necessitate the creation of new groups. The outputs from the Enabling Innovation project form a toolkit for technologically based innovation in the rail industry.

- **Establish a top-level ‘business leadership’ function** - to provide the business support and to secure funding to develop/apply new technologies and integration with industry planning
- **Establish a ‘technology leadership’ function** - to identify and make the case for innovative solutions. This leadership role would be positioned appropriately for the business circumstances. In the context of the thirty year roadmap and for the most complex and challenging innovations, TSAG will provide the leadership function for the industry
- **Create tiered templates for contract conditions** to align industry incentives, drawing on lessons from recent cross-industry projects
- **Design and develop more effective mechanisms** to translate ideas into demonstrable, de-risked, system-level, radical innovation projects
- **Build upon existing materials and disseminate models of good practice** (drawing on experience from other industries)
- **Promote Open Innovation** (sharing ideas and benefits across the supply chain and beyond) for the early phases of the innovation process
- **Build on and reinforce existing support and coaching resources** for acceptance processes/ standards
- **Build on the ERA’s work on cross-acceptance of rolling stock**, to extend this into other rail environments
- **Take steps to ensure good access to appropriate test facilities**
- **Build on existing and find new mechanisms** to help the industry manage the commercial risk of testing on the operating railway

Next steps

The enablers are seen as fundamental to transforming the industry through technical and other business process innovations. The focus so far has been on developing the first two, but the key to success is in take-up by the industry and its supply chain. As these ideas become embedded in the way it works, the industry and its supply chain should gain greater confidence that innovation in the rail sector is a strategy that delivers real benefit and become enthusiastic participants in delivering and profiting from new opportunities.

Work to develop the capability to innovate across the industry is at an early stage and is involving all rail stakeholders, including DfT and ORR. Proposals for establishing business and technology leadership functions are being tested with key stakeholders. The way these functions would work is set out in the diagram on page 17 (A Framework for Technology Innovation). This shows an idea progressing from its inception through to incorporation in company business plans, with the leadership function taking forward feasibility, research and trials and the sponsorship function making the key commercial 'go / no go' decisions at each stage.

Links to key documents

The report on this project (T934 Enabling technical innovation in the GB rail industry - barriers and solutions) can be found on the RSSB website www.rssb.co.uk

Innovation in aerospace – a model for the rail industry?

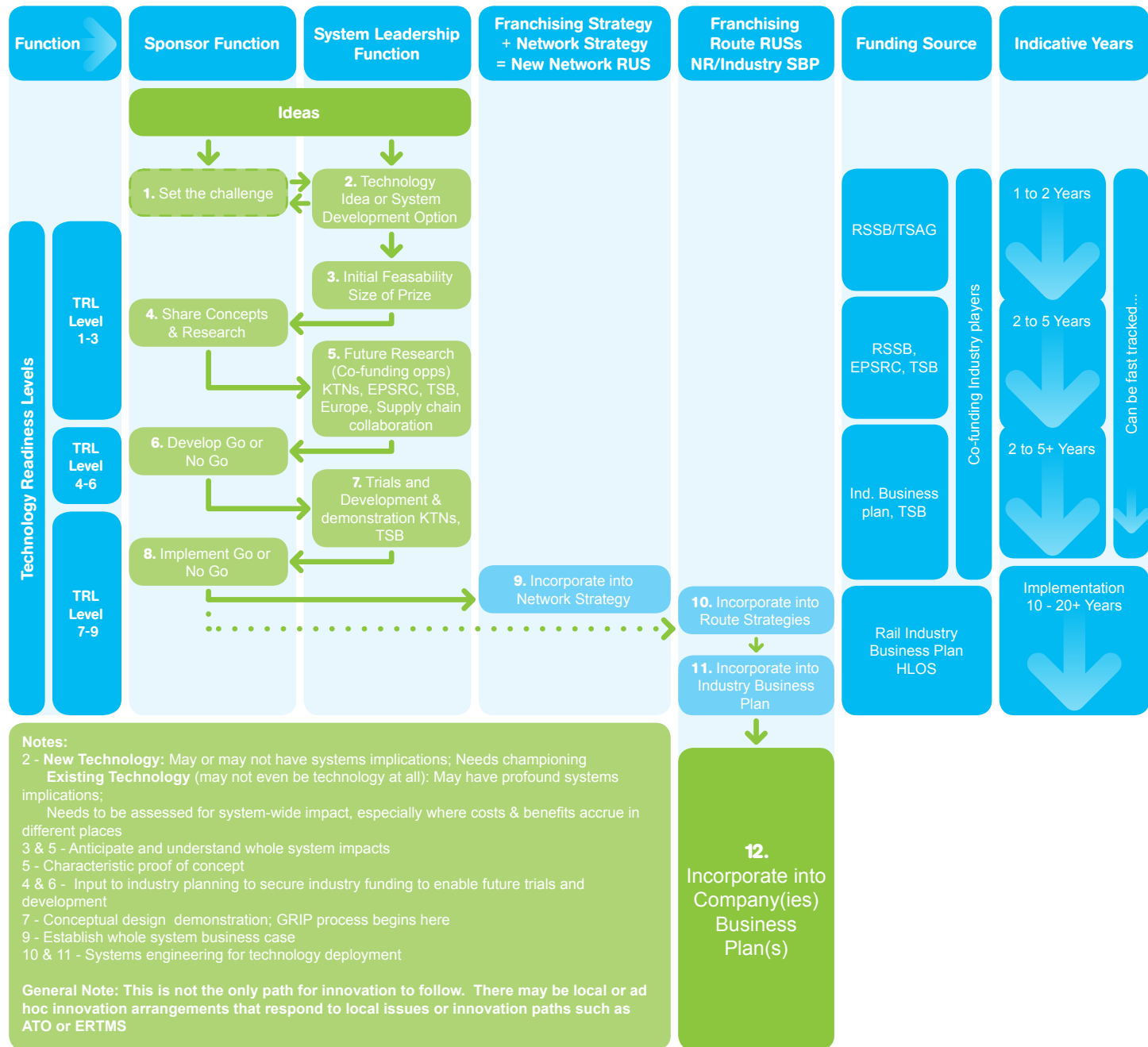
In 2002, the Aerospace Innovation and Growth Team (AeIGT) was established to plan and guide the strategy for the UK aerospace industry.

The Aerospace Technology Steering Group (ATSG) provides technical leadership and the National Aerospace Strategy is becoming the de facto UK strategy for the sector.

The ATSG established subsidiary task forces to i) undertake detailed co-ordination of the delivery of the projects under the strategy and ii) create common collaboration agreements for partner organisations.



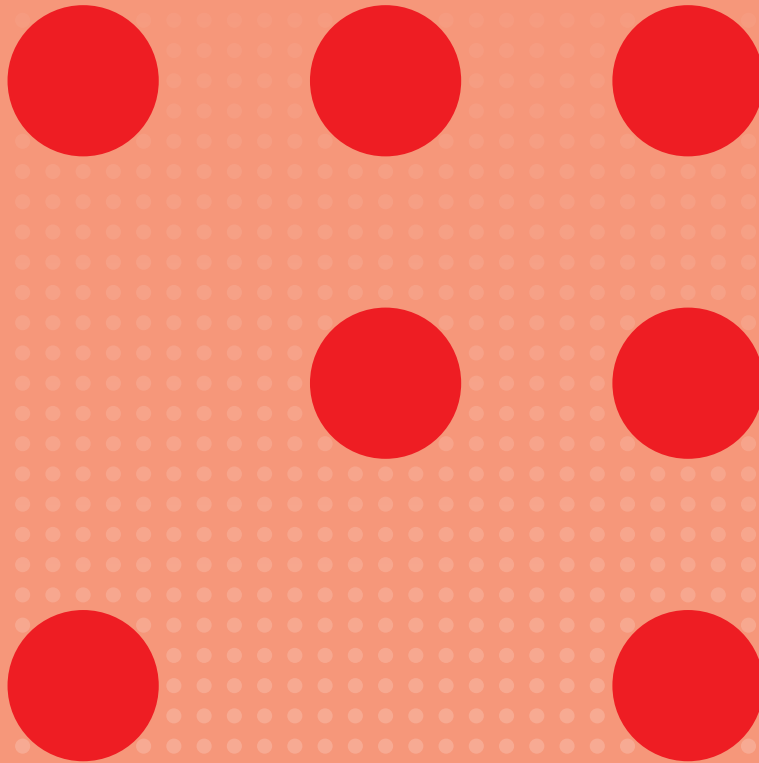
A Framework for Technical Innovation - from idea to implementation





Next generation traffic management

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Next generation traffic management

The problem

Movement optimisation across the network is not possible using traditional methods, particularly as traffic density increases – and small shifts in modal patterns could cause large shifts in rail demand.

This requires a ‘guiding mind’ able to take account of, and respond to:

- Different policies (eg energy saving, capacity or reliability maximisation, recovery from perturbation) in force at different times and locations
- Changes in these policies in real time, in response to changing operational conditions

The fundamental concept is simple: the train says ‘this is where I am’, and the ‘guiding mind’ says ‘this is what you do’ (eg drive at this speed, coast etc). It also makes available complete, accurate and timely information in support of operators and to benefit customers. In advanced form, it enables the automation of traffic regulation on the network.

This approach to traffic management in turn requires a long-term view, currently underdeveloped, about how the railway will be used and operated for different markets and locations.

The benefits of automated network regulation apply under normal operational conditions and where there is abnormal, degraded or emergency working. For normal conditions, it can optimise traffic flow, energy use and power demand, regulating trains ahead of conflicts, using information gained from intelligent trains and infrastructure and advanced position monitoring systems. Where other conditions apply, the decision support capability can optimise for a different policy and help return the network to normal operation. Customer information systems will feed off traffic management systems, providing reliable and up to date information to passengers and freight users.

Much of this transformation could be delivered independently and well in advance of ERTMS, and bring benefits much earlier. ERTMS once delivered, will in any case need to incorporate a fully optimised traffic management layer to realise its full potential. For instance, system capacity will be greatly enhanced on routes where bi-directional operation can become the norm, with timetable rules written to accommodate the new capability.

An array of technologies will be required to support this approach to traffic management, including accurate reporting of position and orientation of rolling stock, consistent geographic referencing systems, driver advisory systems, operational communications systems and real time braking information, in addition to the modelling to underpin the ‘guiding mind’ software.

Progress and early insights

To take these ideas forward, the ‘Next generation traffic management’ (NGTM) programme, as a first step, is building the economic case for the provision of whole system traffic management, including as a ‘traffic management layer’ for ERTMS, using a systems modelling approach. The case will be based primarily on energy and capacity benefits.

The programme is developing the principles that would apply for traffic management to support policies in place at varying locations and times and principles to support making information available for operational decisions and customer advice.

Supporting activity is investigating:

- Driver advisory systems (DAS) to assist train drivers with guidance on optimal speed and driving techniques to maximise system capacity. First Group

is working with Network Rail to trial this technology and early indications are that substantial fuel savings can be made.

- Enhanced train location and identification technologies, and their integration with data transmission initiatives.
- Reliable position tracking of trains.
- Better understanding of braking (adhesion) capability in real time.
- The circumstances where automatic train operation (ATO) might provide safety and punctuality benefits.
- ATP cab-signalling without on-track detection and sensor technology that works in bad weather.

Underpinning traffic management development is the requirement for a set of premises about the way the railway is to be used in the long term by its customers. A range of scenarios is being developed against which to evaluate different technical 'operational concepts' and test them for robustness. Technology issues being considered in this context include crashworthiness, optimisation of both capacity and power supply, standards changes and system trade-offs.

Work to develop driver advisory systems is being progressed for the industry by First Group. Initial tasks are defining data interfaces, understanding the human factors implications (effects on the driver), development of 'real time' timetables and modelling the commercial implications for all stakeholders (eg performance regime adjustment should overall network performance decisions cause trains to be delayed for the greater good).

It is clear that many of these ideas, while having a significant impact on cost and carbon for the future railway, are many years from implementation. In the shorter term, it would be possible to develop optimisation algorithms to identify the most favourable timetables, eg in terms of energy and carbon costs and overall reliability.

Traffic management is critically dependent on developments in data and communications and closely associated with a whole system approach to asset

management. In turn it is a key contributor to delivering the challenges of the energy programme, both directly and as an enabler. (see 'energy strategy' section on page 23)

Next steps

The next stages in the NGTM project are:

- Completion of the business cases for whole system traffic management and for specific components such as enhanced train location and identification tools.
- Development of algorithms to optimise capacity, speed and energy use for given locations and times.
- Development of prototype DAS, train location/identification and ATO technology – then testing and field trials.

Links to key documents

Documents on the following research projects provide greater detail on some of the technology developments covered in this section.

- Driver advisory information for energy management and regulation (T724)
- Obtaining data to assess the dependability of GNSS information and accuracy of odometry (T510)

Traffic management was the 'top scoring' contributor to the 4C challenge identified through the initial route mapping exercise, in which a large number of industry experts participated.



Next Generation Traffic Management

Why do this?

Intelligent management of train movements across the network can optimise capacity utilisation, save energy and resource costs and by reducing delays improve passenger satisfaction.

Context

- Inefficiencies in traffic management waste energy and capacity, cause delays and passenger frustration, and increase system asset costs
 - Lack of linkages between data sourced from infrastructure and trains
- Early phase of ERTMS being introduced to GB but without traffic management element

Non-technical issues

- Human factors aspects of traffic management systems such as DAS/ATO
- Financial effects of traffic optimisation - via industry contractual matrix and franchise agreements

Progress and Plans

Progress 2007 - 2010

- NGTM project initiated to create the economic case for traffic management optimisation
 - Whole system business case for train location and identification technology - initial studies and concept development
- DAS concept development and trials being undertaken by First Group
- Operational concept scenario development, based on sector analysis
 - Infrastructure programme projects: Mega City Suburban and Freight Oriented Network, which have begun, will inform this work

Plans 2010 - 2014

- Network Rail to sponsor the initial Traffic Management strategy
 - Finalise NGTM business case
 - Human factors analysis of migration to DAS/ATO operation
 - Completion of DAS trials; rollout
- Train location/identification technology: business case completion, feasibility studies, trials/deployment
- Principles for movement optimisation based on 'controlling mind' concept: algorithm development

ATO - Automatic Train Operation DAS - Driver Advisory System ERTMS - European Rail Traffic Management System
NGTM - Next Generation Traffic Management

Energy strategy

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Energy strategy

The problem

Rail currently consumes around 670 million litres of diesel (gas oil) and approximately 3,000 GWh of electricity a year for traction purposes. This results in emissions of around 3.4 million tonnes of CO₂ and an annual expenditure of over £500m for traction energy alone.

We expect energy costs to rise year on year and as we meet the demand for additional service that our consumption will also rise. Our challenge is to reduce our fuel needs to improve on our carbon emissions and control costs. We aim to do this through more efficient use of our assets (full trains are very carbon efficient), appropriate use of alternative energy sources and development of lower cost solutions for electrification of the network.

The industry faces some strategic energy-related challenges. There is considerable concern about the long-term availability of diesel fuel and, in its absence, suitable alternatives such as sustainable biofuels. However, electrifying significantly more of the rail network may not be viable unless electrification costs can be reduced. However, if technology allows such cost reduction, and creates the economic conditions to electrify most of the network, rail will be in a better position than other modes to play a major role in reducing transport's carbon footprint, particularly if there is progress with green generation sources. Carbon output is determined not only by the level of energy consumption, but also by factors outside the direct control of the industry, such as GB electricity generating policy (and mix of sources). TSAG is not concerning itself with UK energy policy, as this is generally a matter where government is in the lead.

Evidence has emerged from carbon footprinting research for TSAG that there are significant carbon emissions associated with non-traction activities, notably operating stations and depots and maintaining/renewing infrastructure. Wider industry work by RSSB for the Sustainable Rail Programme is exploring how such

infrastructure can be made more carbon efficient, both at the design stage and in operations.

In key areas of technological developments affecting energy use, the GB rail industry is a relatively small player and is more likely to use or adapt technology as it becomes available rather than to lead or influence development. This applies, for instance, to engine developments and alternative fuels. Therefore TSAG is not sponsoring active research in these areas; rather, we are monitoring developments to spot any opportunities they may provide for rail industry application.

Progress and early insights

The development of a long-term energy strategy for the railway, based on having the information to make the right choices and the development of innovative technical solutions, is the principal target of the work already in hand. The 4Cs challenges of halving the railway's costs and halving its carbon footprint can only be achieved if there is a strong contribution from energy efficiency. Additionally there is the opportunity to optimise power demand; this reduces energy consumption and related provision of infrastructure. These are being addressed initially through a series of TSAG supported feasibility studies investigating energy technology relating to infrastructure, trains and operations. These studies are being augmented by the active monitoring of energy technologies being developed elsewhere, such as alternative fuels and energy storage.

Infrastructure

Near-term work has focused on using technology to reduce the cost of conventional electrification, for instance by addressing the technical challenges of

introducing discontinuous electrification, which would allow difficult locations (eg small tunnels) to remain unwired. This would permit lower cost electrification schemes, particularly where the business case for the extension of a conventional electrified network would otherwise be weak. The application of this technology would therefore have the potential to extend the size of the network for which electrification is economically viable.

Related research has investigated energy storage devices such as flywheels and supercapacitors and resolved issues associated with raising and lowering train pantographs in motion. Proposed research will bring these elements together to understand the business case for discontinuous electrification and the case for running a demonstration project. Work is also underway to establish the business case and feasibility for the conversion of relatively energy inefficient third rail DC routes to AC operation.

Research being undertaken by the Sustainable Rail Programme is examining the benefits of using 100% recycled steel for rail production, substituting cementitious material in concrete and extending the lifespan of track components.

Trains

There are opportunities to reduce energy consumption in both new and existing trains, for example through the use of more efficient traction systems, further use of regenerative braking and lighter materials. There may be opportunities to incorporate energy efficient technologies during routine overhauls, including improved traction packages, lighter bogies and more efficient engine management systems. A recent study shows the whole life value of 1 tonne of train mass is between £7k and £40k (depending on the train service type). An early project, co-funded with EPSRC, will examine the use of new materials for railway application. Other areas of transport show this to be a fruitful avenue to explore eg the use of light yet very strong carbon composites designed for the racing car industry which have also been deployed in the Royal Navy's new Class 45 destroyers.

Operations

Timetables, traffic management systems and driving techniques that minimise conflicts with other trains and encourage a constant speed can offer significant energy benefits. The operational and economic feasibility of 'adaptive train lengthening', to provide a better match of capacity to demand and reduce the cost of unnecessary haulage, is being investigated. Energy savings from the employment of differentiated technical standards (for routes with different traffic types) are also being assessed. A key research theme going forward is to understand the full benefits of such approaches and how to implement the best of them.

Alternative fuels and energy storage technologies

The technology watch programme managed by RSSB is monitoring developments in energy storage technologies, alternative fuels and power sources including hydrogen cell technology and biofuels.

Next steps

By 2012 the initial work will have identified the most promising technologies worth developing, trialling or implementing in CP5. Opportunities to introduce the new technology will include new electrification schemes, new stations and depots, new or life-extended rolling stock and franchise lettings (with incentives aligned to encourage whole system gains).

Links to key documents

Documents on the following research projects provide greater detail on some of the technology developments covered in this section.

- Research into trains with lower mass in Britain (T712)
- Energy storage systems for railway applications (T779)
- PantoTRAIN – Pantographs: total regulatory acceptance for the interoperable network (T849)
- Understanding the effect of 'gaps' in electrical continuity of the traction contact system (T777)
- Feasibility of raising and lowering pantographs while trains are in motion (T778)

How carbon is distributed in the rail industry

| Component | Subcomponent | Total emissions (000 tCO ₂ e) | Percentage of total |
|-----------------------|-----------------------|---|------------------------|
| Traction | Diesel | 1,780 | 33% |
| | Electricity | 1,600 | 29% |
| Staffing and services | Staff and offices | 81 | 1% |
| | Services | 93 | 2% |
| Subsystems | Track | 490 | 9% |
| | Rolling stock | 165 | 3% |
| | Stations | 223 | 4% |
| | Depots | 539 | 10% |
| | Structures | 229 | 4% |
| | Electrification | 44 | 1% |
| | Train control systems | 233 | 4% |
| Total | | 5,470 | 100% |

Further electrification, the use of cleaner fuels and further energy efficiency improvement could reduce rail's carbon footprint by 50% in the longer term. If we can make discontinuous electrification viable, it would create a 'ripple effect' allowing more of the network to be electrified economically.



Energy strategy

Why do this?

Large cost savings are available by optimising rail energy use. Rail's contribution to carbon emission targets can also be facilitated.

Context

- The cost to the railway of energy consumption (in 2010) is more than £500 m
 - Future electricity supply uncertainties
 - Future of diesel uncertainties
- Increasing demand for rail services - passenger and freight
 - Carbon reduction targets

Non-technical issues

- Aligning incentives
- Sourcing low carbon electricity

Progress and Plans

Progress 2007 - 2010

- Energy efficient operations
Developments in fuel metering and driver advisory systems
- Lower energy demand vehicles
Opportunities for / value of mass reduction
 - Regenerative braking
Exploration of energy storage technologies
- Energy efficient infrastructure
Developments in micro generation
- 'Pantotrain' EU electrification projects
 - Discontinuous electrification
Understanding 'gaps'
Energy storage applications
 - Alternative fuels
Technology watch on biofuels and hydrogen cell

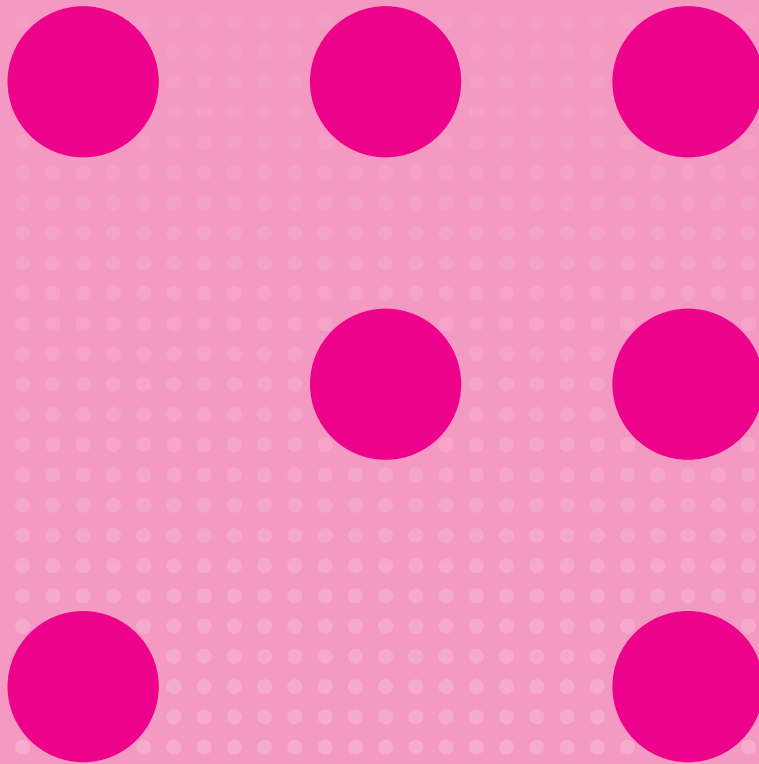
Plans 2010 - 2014

- Energy efficient operations
Design of Next Generation Traffic Management system to deliver energy efficiency
Freight traffic efficiencies
- Lower energy demand vehicles
Opportunities to reduce auxiliary energy use
Co-funded research call on new materials
 - Regenerative braking
2nd Generation regenerative braking technologies
- Energy efficient infrastructure
Exploration of efficiency opportunities within DC networks
Developments in micro generation
- Discontinuous electrification
Whole system business case
- Low cost electrification system
Business cases



Whole system reliability

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Whole system reliability

The problem

The railway pays a significant price for unreliability, driven to a large extent by asset failure, although there are other causes - about half of all delay minutes are technical in origin, the rest being mainly attributable to operations and external factors ie weather, vandalism, trespass etc.

On this problem, TSAG's focus is primarily on solutions relating to technical causes, and areas where technology can help operational decisions and processes to be more reliably delivered.

This price, which increases as spare capacity is used up, includes delay compensation payments, lost revenue from reduced demand, additional resources procured and maintained (eg for spare cover) and the people and administration associated with all of these. As an indication of scale for the first of these, payments within the industry for delay (calibrated to reflect its commercial value) are £600 million pa. Significant sums are associated with the reliability of structural assets in the face of climate change – eg our estimate of the combined business interruption and material damage costs due to flooding, unless adaptive action is taken, is in the range £1-3 billion over the next thirty years.

The railway has in recent years made significant improvements in PPM (its measure of train punctuality) to a current average of around 93%. However, maintaining that level, or improving it, are challenged by increases in demand and traffic density. Nevertheless, by fully embracing a whole system approach to asset management, there is an opportunity for significant further improvement. Therefore our research needs to answer questions such as 'how reliable would the railway need to be, were capacity doubled?'

At present, much railway technology is bespoke and therefore expensive. A key driver to significant performance improvement and cost reduction is developing the ability to adopt appropriately standardised, high quality, low cost technology that is commercially available from competitive markets.

There are large potential benefits from a whole system approach to reliability. Better understanding of how assets perform leads to better design (with lower maintenance costs). Improved understanding of interactions between sub-systems (eg track/train), allows optimisation of track and train specifications, reduced maintenance and better performance. Inventory costs can be reduced by simplification in the range of assets. Productivity improvements come from reduced complexity, greater staff familiarity with the use and maintenance of equipment, the use of effective asset control/information systems and flexibility in operations.

However, delivering these benefits is hampered by asset information being stored in systems which are often difficult to access and use in an integrated way. There is no common model or approach that seeks to serve the whole industry. Updating the information can be laborious and expensive. The whole system approach seeks to overcome these kinds of problems.

Progress and initial insights

TSAG has focused on developing a whole-industry approach to asset management, although this is still at an early stage. We have initiated work towards delivering whole system reliability and the use of commercial off-the-shelf (COTS) assets.

Knowledge of asset condition is key to reliability management. Therefore initial work focused on remote condition monitoring (RCM) which allows prediction of asset failure and timely intervention (and informs decisions on intervention strategies). It concluded that a straightforward RCM system could reduce train delays by up to 12%. But to transform the data into information that could be used by maintainers would require the adoption of train locator/identification systems, a future-proof, low cost data transmission capacity and common information and data storage standards.

TSAG's Reliability Steering Group has launched two projects to make the business case for a whole system approach to reliability and to understand better the underlying relationships:

- **Building the evidence for a whole system, strategic approach to reliability**

This work will provide an evidence based case for the development of:

- A joined-up, system-wide approach to reliability in the medium/long-term
- An operations reliability work stream
- A reliability programme over several years in order to embed continuous reliability improvement into the industry in a similar way to safety

- **Reliability modelling**

This work seeks to understand the relationships between reliability, cost and capacity. It will run scenarios and consider trade-offs, to answer such questions as:

- If system capacity doubles over the next 30 years, what level of reliability will be required?
- What will the cost of unreliability be in the future?
- What does a 99.9% reliable system look like?

A TSAG sponsored project, co-funded by RSSB and Network Rail is examining how the railway can adapt to climate change. Led by Network Rail, it will provide information, on a route basis, of the likely effects of climate on asset performance and safety. It will help predict asset and system behaviour for the next 50 years and the formulation of a plan for an affordable and cost-effective weatherproofing programme over a 20-year period.

There have been other industry initiatives to capture, manage and share asset knowledge to improve reliability management– eg the cross-functional Fleet Challenge, which seeks to raise PPM by 1% in CP5 (2014-19) through train fleet performance improvements, and the Network Rail led Intelligent Infrastructure project. Network Rail has proposed the development of a formal, co-ordinated asset management planning activity for the rail industry, linked to industry planning processes and regulatory control timescales. The scope would extend to shipper systems as well as traffic management, infrastructure and vehicle systems. The cross-industry integrated approach would provide a structure to baseline and generate proposals to improve processes through stakeholder engagement/ contribution – creating consensus where this is currently often lacking.

Asset management prizes are often greatest at system interfaces, as shown by the cost reductions and better informed procurement stemming from the application of VTISM (Vehicle Track Interaction Strategic Model). In co-operation with the industry's System Interface Committees, we will evaluate the potential for other such optimisation tools and the development of the next generation VTISM.

Next steps

TSAG will evaluate the technology and systems that will contribute to the new approach:

- A data transfer backbone
- Algorithms that predict, rather than report, asset failure, to inform optimal maintenance
- Sharing data across sub-system boundaries
- Data fusion to convert data to information and integration to whole system business processes
- Modelling to establish how reliable the system needs to be to cope with future capacity requirements and to cope with climate change impacts

We will also examine the scale of potential benefits and the challenges associated with a modular approach to trains and infrastructure. This approach would support the implementation of 'open systems' architectures, lean systems, smaller on-board equipment, shorter product development lead-times, lower costs and higher reliability.

An outcome of the whole system reliability programme may be the need for changes to standards.

We expect the initial work, making the case for a whole system reliability improvement programme, to be complete by 2012. This will be followed by the phased, co-ordinated delivery of the technology and plans to implement it over the medium term. With Network Rail and others, we will support the development of a system-wide asset management strategy. This could start within the next two years (for use in CP5 planning) and develop as the willingness and ability of industry parties to integrate permits.

Links to key documents

Documents on the following research projects provide greater detail on some of the technology developments covered in this section.

- Developing a railway system reliability framework and mapping current remote condition monitoring activities to it (T844)
- Remote condition monitoring IT survey (T853)
- Making the case for a whole system strategic approach to reliability improvement (T935)
- Stage 2 development of the Vehicle Track Interaction Strategic Model (T792)

Half of unreliability is due to technical causes. The rest are from operations, weather etc. Simple remote condition monitoring could reduce overall delays by up to 12%.



Whole System Reliability

Why do this?

Whole system reliability maximises rail asset use and minimises whole - life costs

Context

- Lack of any system wide approach to asset management
- Weak supply market - expensive, bespoke, 'railway-only' technology
- High cost of unreliability - compensation, lost revenue, additional resources
- Increasing customer expectations - reliability is a top-three customer priority
- Increasing traffic volume demands on the network; towards 24/7 operation

Non-technical issues

- Aligning industry incentives to promote asset management collaboration
 - Resourcing change management
 - Cultural dimension

Progress and Plans

Progress 2007 - 2010

- Uninterrupted Journey Group report on remote condition monitoring
- Reliability Steering Group report - evidence to support business case development for a reliability programme; modelling unreliability
 - Fleet Challenge initiative
 - Intelligent Infrastructure initiative
 - Success of Vehicle Track Interaction Strategic Model (VTISM)
- Initial scoping studies to understand the 'size of the prize'
 - Network Rail proposal for co-ordinated Asset Management planning
 - TSAG proposals for technology to support integrated asset management

Plans 2010 - 2014

- Develop approaches to delivering whole system, whole life reliability
 - New system interface models
 - Complete scoping studies
 - Identify transferable technology
- Evaluate value of specific and collective opportunities - business case development
 - Develop whole system whole life approach to asset management
- Implement first phase systems as defined and agreed



Data and communications

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Data and communications

The problem

Delivering a reliable railway, managing traffic to maximise capacity use, and providing the range and quality of information (and entertainment) expected by rail customers, all require the industry to have up-to-date data and communications capability.

The telecoms industry delivers advances at an ever increasing rate. Without an integrated, whole system strategy, it is likely the rail industry will miss opportunities, hence lose revenue, or invest in sub-optimal technologies which fail to deliver or duplicate solutions resulting in increased industry costs. Rail assets generally have longer life cycles than communications equipment, so an important aspect of the strategy is future-proofing.

The growth in data transmission carries a cost to the rail industry in terms of user charges and related equipment. The existing industry network has a finite capacity. A fundamental issue for the strategy is what rationale there could be for the rail industry to have its own data transmission capability rather than procure from the open market.

The increasing availability of inexpensive and reliable remote condition monitoring sensors, coupled with whole system integrated asset management approaches and CCTV applications, demand a capability to transmit increasing quantities of data around the rail network to make it available to rail stakeholders.

Progress and initial insights

Initial research has confirmed the need for a single, integrated strategy for rail mobile communications, which will enable the efficient and effective delivery of operational communications and support passengers' mobile devices. A ubiquitous data network would cater for data sharing, handling, fusion, transmission and storage. Higher quality, speed and ease of use of common data would bring benefits across the system. The value of using commercial off-the-shelf (COTS) communication services and products, avoiding wherever possible the implementation of bespoke, railway specific solutions, has also been highlighted; past experience shows the latter to be slow to market, costly and less reliable than COTS equivalents.

Quantification of demand growth for both fixed and mobile communications has been undertaken. This included identification of the passenger and operational applications with the greatest impact on bandwidth demand. The analysis considered three different projected scenarios and the impacts and requirements of each on the railway. This resulted in further work aimed at taking forward the mobile communications strategy and developing guidance on how to frame standards to reduce whole life costs and ensure maximum connectivity between applications.

The Department for Business, Innovation and Skills (BIS) has been carrying out a study to identify the technology solutions for the delivery of rail passenger mobile broadband services. The study is expected to identify options for rollout and delivery of services and TSAG will be investigating options for integrating with this work.

There is a strong relationship with the traffic management programme - data and communications between infrastructure, trains and maintenance providers will be primary beneficiaries of the new capability. The traffic management aspirations set out in the RTS are dependent on the development and implementation of this capability.

Bandwidth to support high data-rate applications, such as video streaming, would also be facilitated.

The optimisation of whole life asset management, the related step-changes in whole system reliability and the use of optimisation models, is predicated on the generation, capture and use of high quality data. The data and communications strategy underpins their delivery.

Next steps

The next step is an evaluation and confirmation of the commercial and technology options for the delivery of mobile services to the railway, for operational and passenger 'added-value' applications, building on the earlier findings. This work will include the development of the commercial framework, as well as liaison with external suppliers and providers to determine the 'best fit' technical options across routes and according to demands. The wide-ranging opportunities in the operational communications sector call for projects to be taken forward as an integrated programme.

The operational communications strategy, with a focus on plans for putting in place the backbone network, is planned to be complete by July 2012.

Support for market take-up of applications that are reliant on communication services is planned through:

- Determining an approach to data and information sharing and development of guidance / standards for use by stakeholders
- Using COTS telecoms technology within rail as the default setting – through the use of standard interfaces and open architecture
- Supporting buyers and specifiers with the procurement of services

Links to key documents

Documents on the following research projects provide greater detail on some of the technology developments covered in this section.

- Development of a communications and positioning technology roadmap and action plan for GB railways (T809)
- Development of a cross-industry business case and spectrum valuation for wireless telecommunications (T911)
- Assessing the bandwidth demand for future communications needs (T817)

Rail industry demand for bandwidth is forecast to more than double by 2014.



Data and communications

Why do this?

To support rail operations, capacity management and customer service by providing a cost-effective, future proof communications systems

Context

- Demand for communication systems is growing to support real time remote diagnostics, traffic management etc.
- Passengers increasingly expect broadband connectivity. Operational communications systems increasingly require it too.
- The pace of innovation in communications technology requires the railway to adopt future-proof solutions to avoid continual problems of obsolescence.

Non-technical issues

- Commercial framework

Progress and Plans

Progress 2007 - 2010

- Initial road map identifying the technology services that are needed to deliver fixed and mobile high bandwidth communication (MHBC) services
 - Analysis of demand for MHBC services
 - Cross industry business case made for a rail broadband facility

Plans 2010 - 2014

- Requirements capture
- Evaluation of the business case and commercial options for mobile broadband services delivery
- Evaluation of technical options for the delivery of MHBC services - provider / supplier consultation; technology analysis; trials to confirm suitability
 - Survey of non-rail standards
 - Guidance on core rail characteristics
 - Draft policy on data and information sharing
 - Development of guidelines for standards re data / information access and sharing
 - Rail partnership with key industry organisations
- Industry dissemination and market engagement activities

Other developments

Previous sections of this document have outlined the developments we think would ‘change the game’. In addition to taking those things forward, TSAG is sponsoring a range of projects in other areas – and a selection of these are described below.

The ‘Mega-City Suburban’ project

Common speed and stopping patterns maximise capacity and may permit simpler technical standards. A ‘Mega City Suburban’ research project has reported on the potential benefits of segregation of network use by homogenous traffic type. Typically such a railway would have an intense operation of regular stopping-pattern trains offering high passenger capacity and relatively slow speeds. The infrastructure would be specified for use by trains of up to a maximum mass. Certain lines have been identified where this may be an attractive option without major investment in infrastructure. Further work would be required to develop these initial findings to project feasibility stage and operational trials.

The Freight Oriented Railway

Rail freight has its own unique challenges and the rail journey is but one element of its customers’ logistics requirements – but the opportunity to make a radical improvement in the quality of that rail element is part of the Freight Oriented Rail Network project being initiated alongside the passenger focused work – with a view to finding compatible outcomes. The project recognises the potential longer-term evolution of the structure of the rail freight market and of customer requirements in terms of payload, cube, journey times and service quality. The benefits and feasibility of running some freight at line speed is being examined in order to establish opportunities for improvements in route capacity, freight transit times and fuel efficiency. The issues of segregation also affect freight.

Whole Life Carbon Footprint of the Rail Industry

To underpin action to improve rail’s carbon performance, and inform the setting of carbon-based targets for 2014-19, this research identified and quantified the dominant sources of greenhouse gas emissions, split by traction (diesel and electric), staffing and services, and subcomponents (track, rolling stock, stations, depots, structures, electrification and control systems). Measures for improving the accuracy and coverage of carbon estimates were recommended. The three principal conclusions were: traction energy is the major emissions source, although non-traction energy is also significant; of the materials used by the railway, steel and concrete present the greatest opportunities for carbon reduction; electrification holds significant benefits when coupled with decarbonisation.

Rail Test and Trialling Facilities

Innovation is perceived by many in the rail industry to be hindered by lack of efficient access to test facilities in Great Britain, for instance to assist the development and introduction of new technology through type testing, commissioning, reliability development, proving concepts and staff training, etc. This issue applies not just to rolling stock and on-track plant or components, but also to infrastructure, signalling equipment and system interfaces. Research is investigating the extent of this problem and determining where any effort would most usefully be focused to deliver improvements.

Railway Functional Architecture

As a precursor to the development of a modular (COTS, 'plug and play' etc) approach to sourcing rail industry technology, with the potential benefits of shorter equipment life-cycles (eg lower whole life costs, greater scope for taking advantage of new technology more quickly, greater whole system reliability, better obsolescence management) there needs to be a common understanding of the 'functional architecture' of the railway. This is not architecture of the technological systems that the railway currently comprises, nor even of the systems that might feature on the railway of the future. Rather, it is an architecture that identifies the functions that have to be performed in order for a modern railway to operate. For instance, the functional architecture would not identify the need for track circuits, nor even train detection systems, but instead would state the need for a 'train location function' (ie we need to know where the trains are). TSAG has launched a project to build up a complete functional architecture for the railway.

Adapting to Extreme Climate Change

Extreme weather events in the last few years have shown that we have insufficient understanding of weather effects on our infrastructure. The rail industry needs to know how it will perform in the current and future climate to achieve: a highly reliable railway; increased capacity; value for money; a 'predict and prevent' ethos. The research being undertaken for TSAG will support these aims by providing information on the likely effects of the climate on asset performance and safety, both infrastructure and rolling stock. It will enable a prediction of likely asset and system behaviour for the next 50 years and facilitate planning for an affordable and cost-effective weatherproofing programme over a 20-year period. It will make use of the latest UK climate projections, published in 2009 by the UK Climate Impacts Programme (see www.ukcip.org.uk).

Low Adhesion Detection

A significant proportion of train delay and traffic disruption relates to incidents arising from loss of adhesion between wheel and track. A new technique for the dynamic real time detection of adhesion conditions has the potential to inform improved train braking strategies when low adhesion is detected, thus avoiding loss of adhesion. The method is a predictive technique based upon measuring what is happening dynamically to the wheelsets and bogie during normal running (ie prior to braking), and using this to deduce information about the level of adhesion available for braking. The basic feasibility of the approach has been established, and TSAG now aims to provide a formative theoretical and experimental basis for the new technique.

Optimising Interfaces

The programme of strategic research sponsored by TSAG is building on the work of the industry expert groups known as Systems Interface Committees (SICs), which predated the formation of TSAG. The SICs are focused on optimising five system interfaces, namely vehicle/structures, vehicle/track, vehicle/vehicle, vehicle/train control and communications, and vehicle/train energy. Each SIC chair, as a member of TSAG, has taken ownership of the relevant route maps, which will act as reference points for further SIC work planning. Building on the success of VTISM, TSAG is working with the SICs to define how further optimisation tools could be developed for the other system interfaces.

Technology Watch

The TSAG programme is benefitting from RSSB's investment in a new capability in knowledge and technology transfer that will further support the rail industry in identifying and implementing solutions. This service can actively monitor research activity and technical developments both from within and outside the GB rail industry. The objectives of the knowledge and technology transfer activities are to:

- Ensure outward scanning for technologies and solutions on behalf of the rail industry to support the 'innovation journey', from the evaluation of research opportunities to the development and

implementation of particular technologies and processes.

- Identify solutions from other countries and industries that are currently being developed or those already in existence that either directly address, or could be modified to address, the GB rail industry's needs and problems.
- Facilitate informed decisions about 'transfer opportunities' covering both technical applications and knowledge.

Examples of technologies being watched are the hydrogen fuel cell and the application of thermography to the wheel/rail interface.

Funding

While the case for research is compelling, the industry wants to make sure it is exploiting appropriate funding sources for the benefit of industry's long term objectives.

Funding development in each of the areas identified by TSAG represents a significant challenge, as the payback from strategic research, although potentially large, is typically longer term than that from technical research. The Strategic Research Programme was established in 2008 with an £11.5m grant from the Department for Transport (DfT) and a £3.25m contribution from RSSB. This enabled RSSB to establish the programme on behalf of the rail industry. However, at the time of production of this document, the government is reviewing all of its commitments to research funding.

The sort of research undertaken for TSAG will only take us so far, and opportunities are being developed to expand the research pool through co-funding arrangements. Funds may be available from academic, other public sector bodies or private sector companies. Particular examples where this programme is leveraging external funding include the strategic partnership between the Engineering and Physical Sciences Research Council (EPSRC), RSSB and DfT, in relation to projects on improving network capacity. EPSRC matches the funding from the rail industry. Discussions are also under way with the Technology Strategy Board to investigate potential support.

It may be appropriate to build an industry business case for significant investment in development and test facilities, and TSAG is considering this further.

European Union funded research (under the Framework Programme for research) continues to be a valuable means of leveraging both funds and expertise. The gearing of funds can be very significant – eg for a research project on capacity where its own contribution is €1m, Network Rail is obtaining EU funding of €29m.

Links to key documents

Documents on the following research projects provide greater detail on some of the technology developments covered in this section.

- Railway functional architecture (modular trains and infrastructure) (T912)
- Whole life carbon footprint of the rail industry (T913)
- Creative continuity – exploring mega-city suburban network segregation (T915)
- Adapting to extreme climate change (T925)

Consultation

TSAG would like your views on issues raised in this document.
The answers will help us guide the development of the programme and the second edition of the Rail Technical Strategy.

Please answer the following questions and send your replies by email to: tsagconsultation2010@rssb.co.uk

or by post to:

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1 Torrens Street, London, EC1V 1NY

by 17 December 2010.

All feedback is welcome – the questions below are designed to help prompt your thinking, but don't feel constrained by them.

| | |
|-------------------|---|
| Question 1 | Have we understood the context – ie are we dealing with the right business issues and tackling the right problems? |
| Response | |
| Question 2 | Have we got the right 'key interventions'? – ie are there any other whole system issues that should be given this level of priority, and if so, why? |
| Response | |
| Question 3 | Do you agree that industry needs to change to become better at enabling innovation? And are the steps described in this document the way to achieve this? If not, what else should be done? |
| Response | |
| Question 4 | What significant technology issues would you like to draw attention to – particularly any not mentioned in this document? |
| Response | |
| Question 5 | How would you like to engage further in this process? |
| Response | |
| Question 6 | Is there any other matter, not covered in this document, which you would like TSAG to consider? |
| Response | |

Appendix 1 – The Rail Technical Strategy and TSAG

The Rail Technical Strategy

The RTS supports national policy for the development of the railway over a 30-year planning horizon. The 2007 document, published alongside the Department for Transport White Paper ‘Delivering a Sustainable Railway’, gave as its stated purposes:

- To establish and document an industry view of the technical changes that need to be made to the railway.
- To create a ‘road map’ showing how change can be achieved (and the RTS listed the six principal delivery mechanisms:
 - Creation of appropriate incentives
 - Appropriate standards and guidance for the specification of asset renewal
 - Harmonisation of objectives for major projects
 - Definition of key priorities for long-term research
 - Helping to shape Britain’s response to European initiatives
 - Application overall of a whole life, whole system cost approach

TSAG

Ownership of development and delivery of the RTS sits with the owners and operators of the railway. To assist them, the Technical Strategy Advisory Group (TSAG), a cross-industry expert body made up of senior executive staff, is charged with developing and championing implementation of the strategy, supporting communication, managing strategic research, identifying opportunities, barriers and actions. TSAG oversees the work of the industry’s Systems Interface Committees (SIC) and other groups with pan-industry technical development roles. Given the whole system, whole life perspective of

TSAG, it is important that all sectors of the railway are represented. Since the RTS was published, TSAG has led the industry activity programme to take forward the strategy, by developing vision in each key technology area, commissioning research and technology watches and building understanding around implementation issues and their solutions. Critically, TSAG is investing energy in creating an environment within the rail industry in which technical innovation is embraced and building supplier confidence in the business case for innovation. These developments form the basis of the material presented in this document and are the output from TSAG’s work to date which can be summarised as:

| |
|--|
| Establish research programme and management |
| Developed rail technology development plan with experts |
| Analysed plan and distilled 8 key themes |
| Launch the initial strategic research scoping studies |
| Develop 16 route maps – one for each technology area |
| Input technology development proposals to industry plans for HLOS2 (CP5) |
| Commission strategic research programmes |

What makes TSAG distinct is that it is not responsible for implementing or planning rail technology over the short or mid term, but has a remit to address future opportunities over a 30-year horizon.

Appendix 2 – Initial activities and progress to 2010

The priorities described in this document were arrived at through a co-ordinated programme of activities:

The RTS 2007 had identified 8 ‘industry long-term themes for change’

| |
|---|
| Optimised track train interface |
| High reliability high capacity |
| Simple flexible precise control systems |
| 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 |

Initial route mapping was undertaken with the help of the Institute for Manufacturing at the University of Cambridge, between August 2008 and April 2009. This process considered where the industry was positioned in terms of its technology and why and in what way it should move on to a different position in the long term. A set of 30-year aspirations were adopted for each of the ‘4C’ challenges referred to in the 2007 White Paper. These were:

- Customer – shifting customer satisfaction from 90% (2008) to 99% (2038)
- Cost – halving the unit cost of operating the railway from 2008 to 2038
- Capacity – doubling of capacity from 2008 levels by 2038
- Carbon – halving carbon impact of the railway at point of use from 2008 levels by 2038

These challenges set the ‘destination’ for the route maps.

It was recognised that to be effective the process of producing the route maps would need to fully involve the rail industry, drawing on its pool of technical expertise. A series of workshops was held to consider each of the eight themes identified in the Rail Technical Strategy. The sessions were each attended by senior managers and directors of passenger and freight train operating companies, infrastructure contractors, manufacturers and suppliers, rolling stock leasing companies, Association of Train Operating Companies, Rail Freight Group, Rail Industry Association, Network Rail, DfT, ORR, RSSB, and London Underground, together with passenger groups, transport economists, academic interests and experts from other industries. The wide ranging input from senior people with knowledge of all aspects of the rail industry provides an assurance that the outputs can be considered robust.

The workshops considered a total of 200 applications which were evaluated for importance in contributing to the ‘4C’ challenges. From this process, 64 applications were progressed and subsequently consolidated to 50; these were tested against the set of four future ‘scenarios’ developed by RSSB for the Sustainable Rail Programme. Finally, a specification was produced for each application and for some, outline implementation plans were developed.

The 50 applications were ranked by their likely contribution to the ‘4C’ challenges over 30 years and their relevance to the four future scenarios. Significantly, there was a high degree of correlation between the rankings and 15 applications were identified as having the highest priority. Some of the applications would require major capital investment to make significant changes to the infrastructure or rolling stock (or both) whereas others are enablers, with the potential to enable new activities to take place.

The applications were used as an input to the development of a set of route maps. These show how the applications mesh with existing industry technical and planning activities and were drawn up in close consultation with industry technical experts to reflect the eight RTS themes. They also identify where research is needed to input to the industry's strategic planning. The final 16 route maps are:

| |
|-----------------------------------|
| Optimised track train interface |
| ATO & Cab signalling |
| Station capacity |
| Operational communications |
| Active load management |
| Traffic and disruption management |
| Network capacity |
| Reduced energy requirements |
| Segregated railway |
| Electrification systems |
| System reliability |
| Alternative fuels |
| Lower cost railway assets |
| Management of technical change |
| Low carbon assets |
| Intermodal integration |

A summary view of the 16 route maps is in Appendix 3.

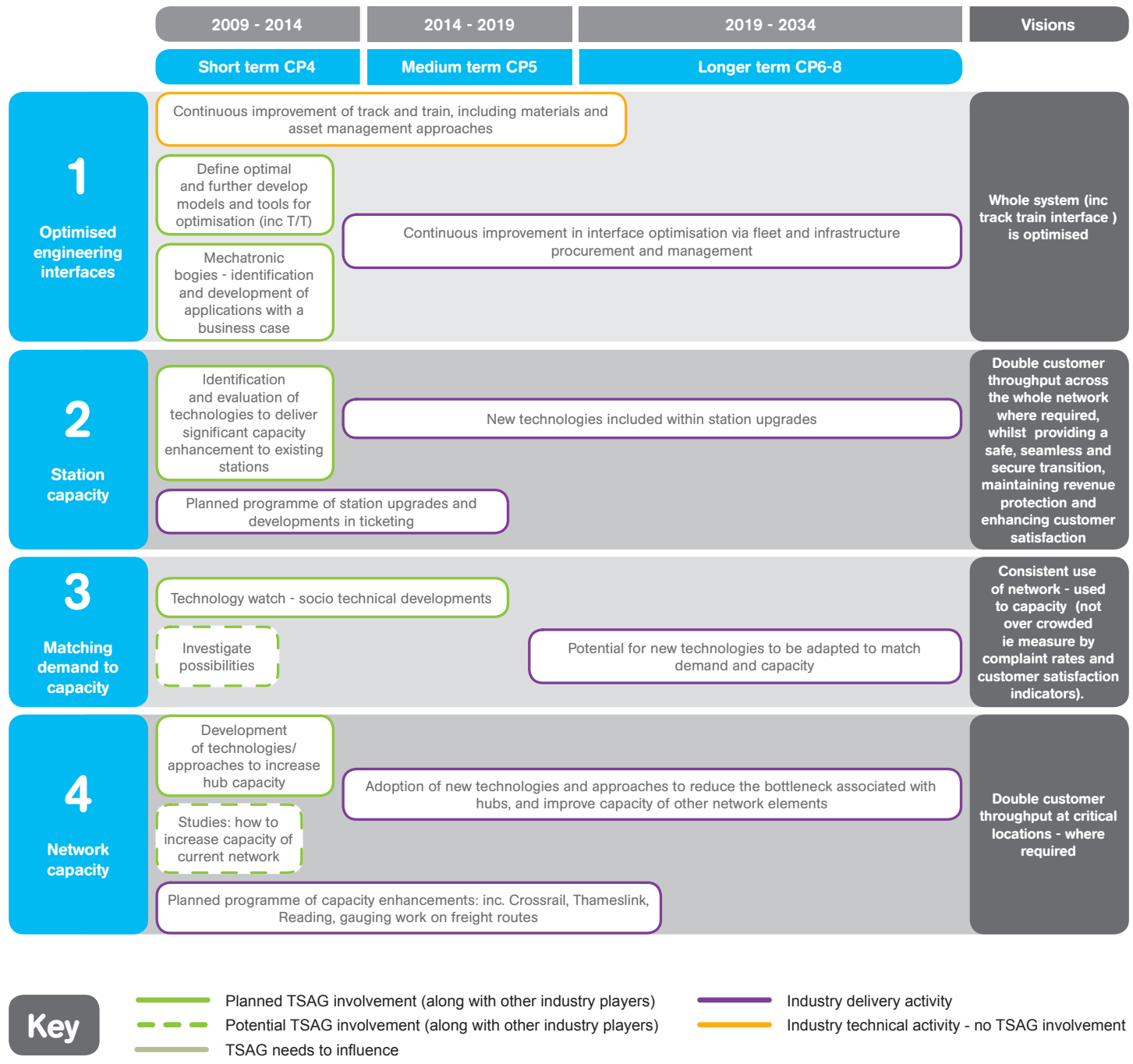
The route maps were subjected to an intensive stakeholder review to validate their vision and detail, and the costs and benefits to the rail industry. They were also assessed for their contribution towards the 4C challenges, not only over the full 30-year timeframe but also how they might achieve significant results in the medium term up to 2019. The review also identified themes for a 'technology watch', keeping track of technological developments outside Britain's rail industry. The really key activity, however, was in determining ways in which the gap between activities already planned and what would be need to achieve the vision could be closed. The review endorsed the route maps and identified areas where TSAG needed to initiate evaluation work to establish base positions or ensure that gaps were filled. It grouped the proposed interventions into those that would make a key difference to the industry ('change the game'), those to help with the technology choices industry needs to make, and those aimed at solving specific industry problems.

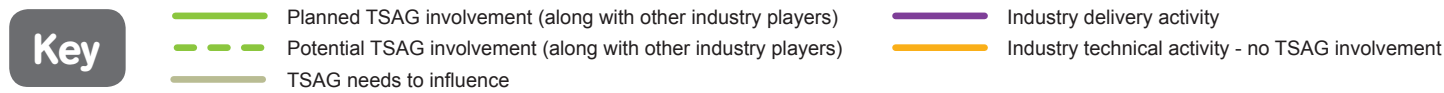
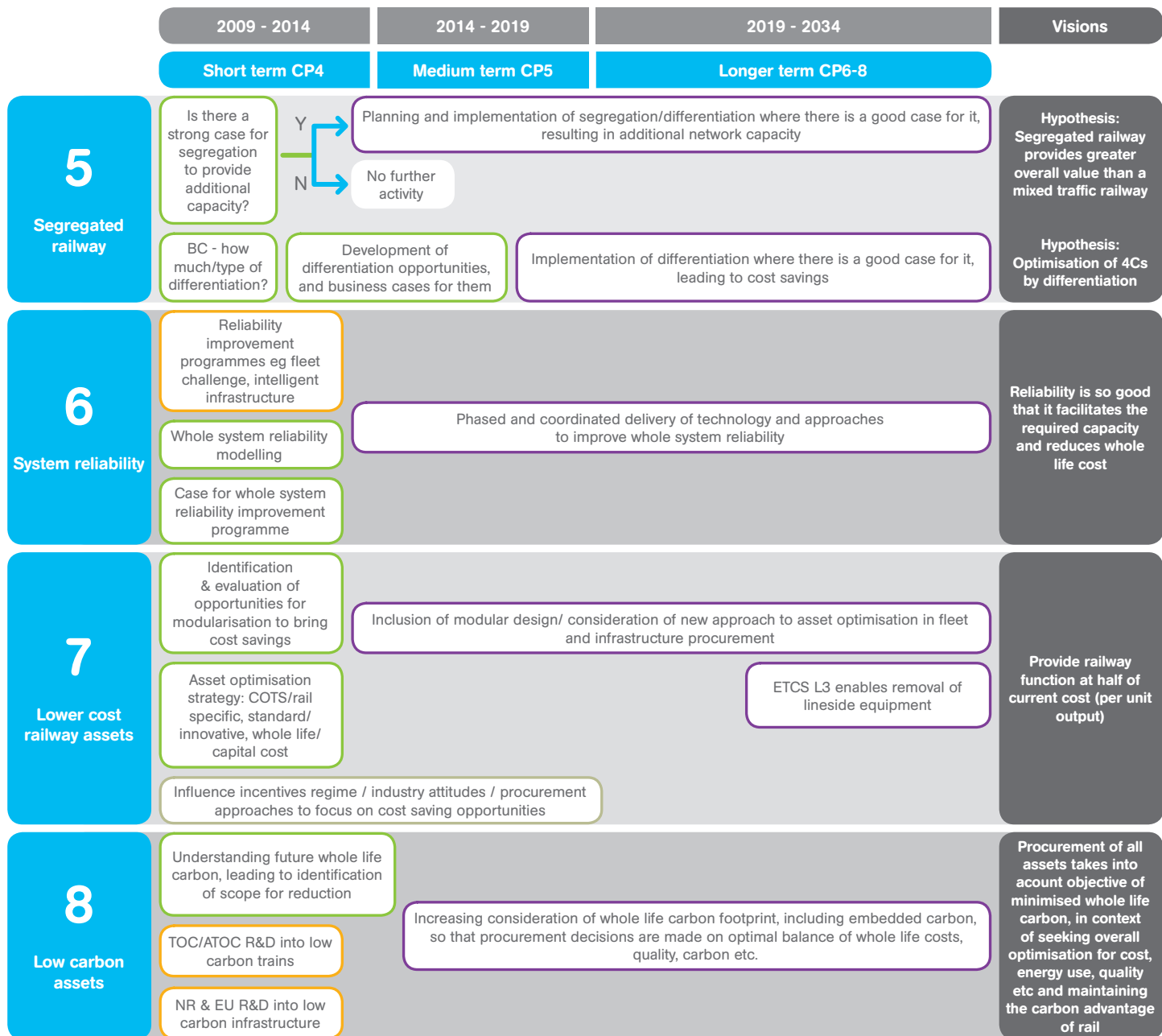
In addition, a set of start-up projects were put in place to launch and build the programme. These related to:

- Remote Condition Monitoring
- Reliability
- Enabling Innovation

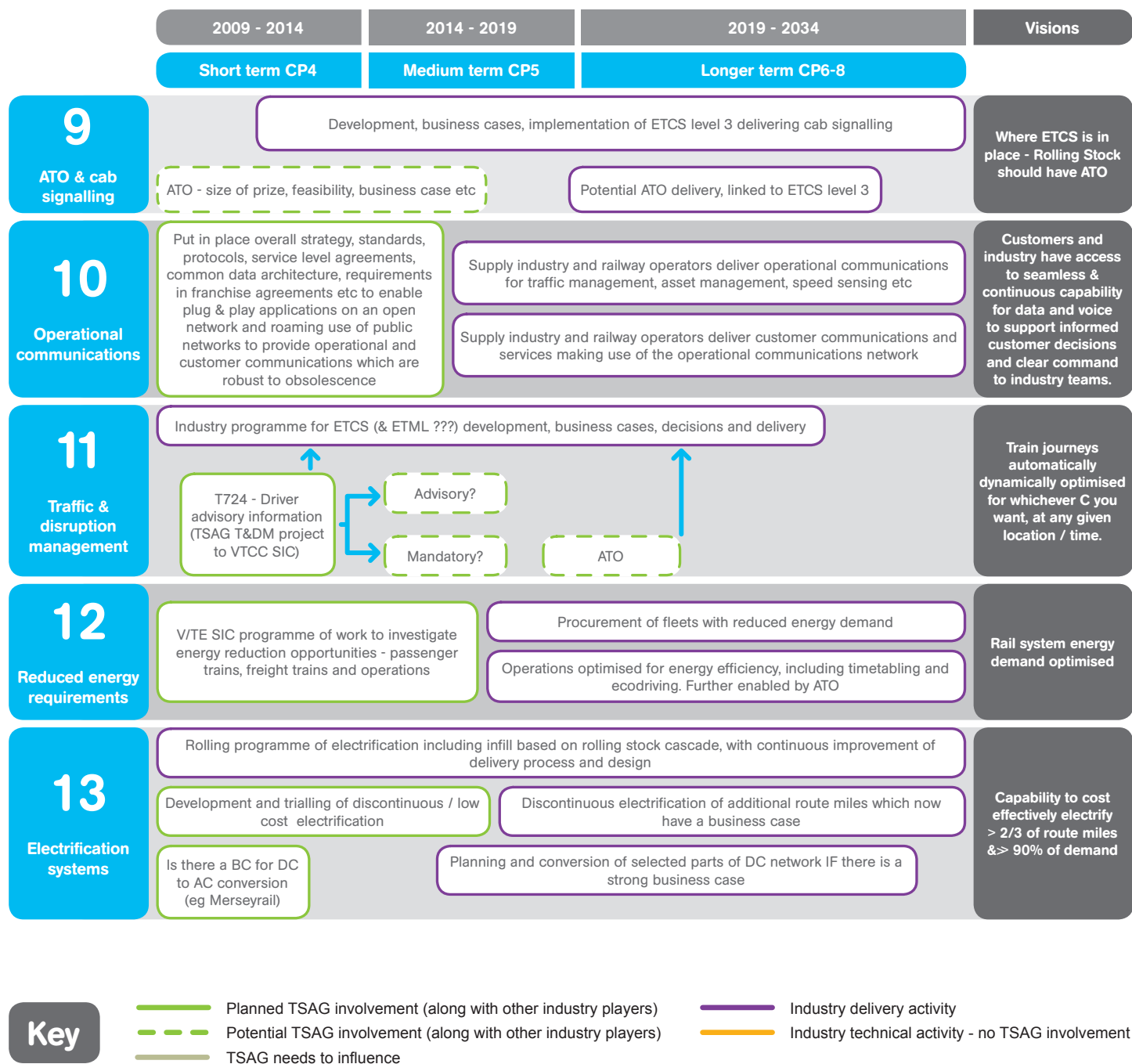
Opportunities for collaboration with research bodies beyond the industry were pursued. This enabled the programme to leverage co-funding, and to contribute to the delivery of solutions relevant across the transport sector. Examples are the joint work with the Engineering and Physical Sciences Research Council (EPSRC) and prospective developments with the Technology Strategy Board (TSB) and the emerging industry Knowledge Transfer Network.

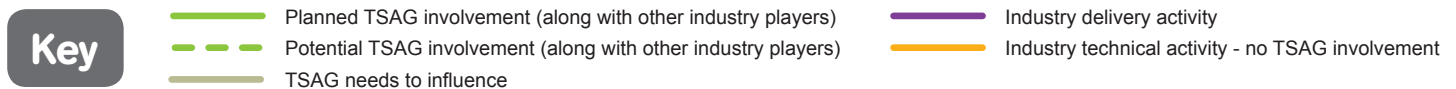
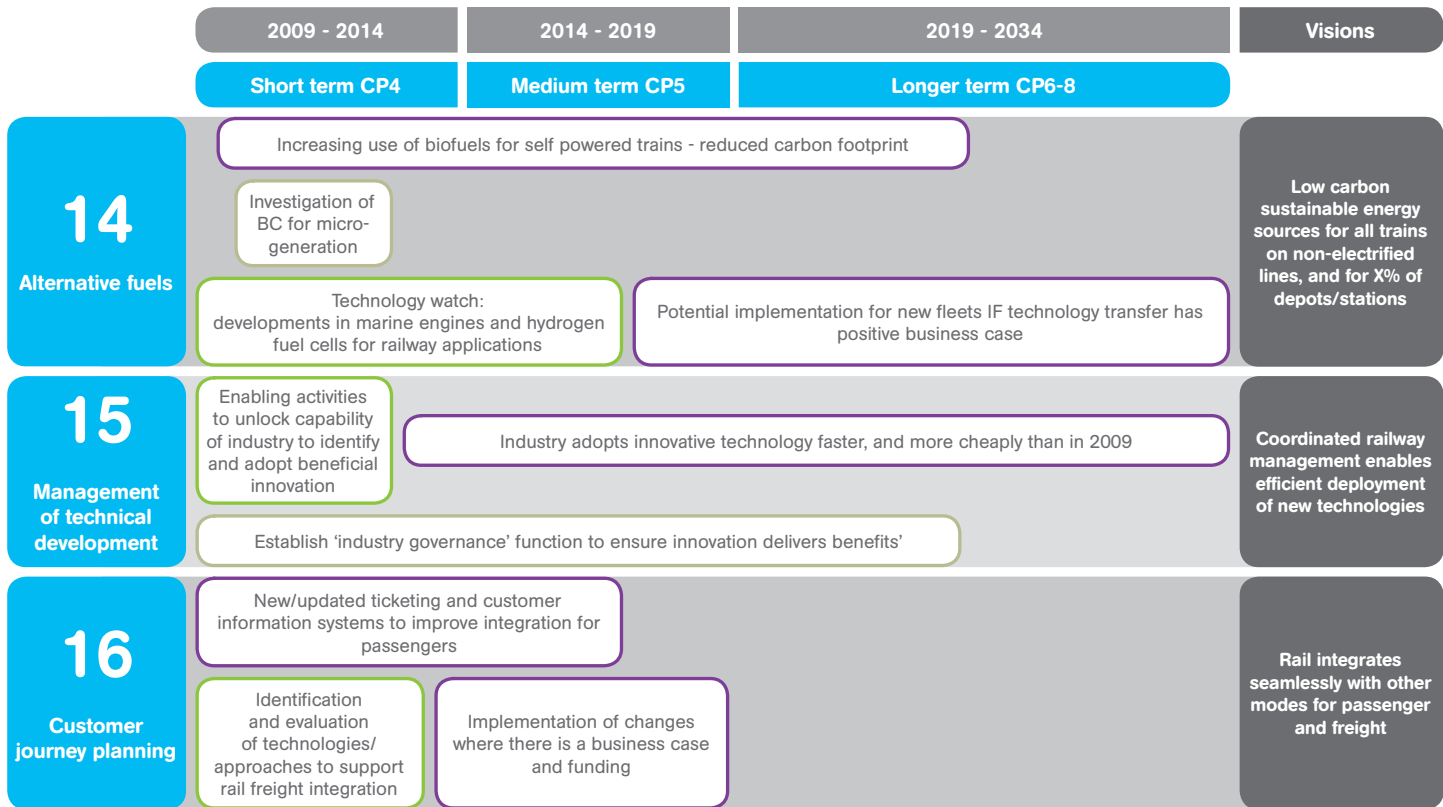
Appendix 3 – Summary of Route Maps





Appendix 3 – Summary of Route Maps Continued





Appendix 4 – Membership of TSAG (September 2010)

| Name | Organisation |
|------------------------|---|
| Steve Yianni | Network Rail (Chair of TSAG) |
| Andrew Coombes | Network Rail |
| Dyan Crowther | Network Rail |
| Alan Bennett | Rail Freight Group (representing freight operation) |
| Richard Davies | ATOC (representing passenger operation) |
| Louise Shaw | ATOC (representing passenger operation) |
| Francis How | Railway Industry Association (representing suppliers) |
| Roger Goodall | Loughborough University (representing RRUKA) |
| Clive Burrows | VTC&C SIC (First Group) |
| Andy Doherty | V/T SIC (Network Rail) |
| Tim Gilbert | V/S SIC (Porterbrook) |
| John Hawkins | V/V SIC (First Group) |
| Tony Mercado | V/E SIC (DfT) |
| James Hardy | RSSB |
| Len Porter | RSSB |
| David Clarke | DfT |
| Jim Bostock | ORR |
| Martin McKinley | Transport Scotland |



TSAG

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Enabling innovation

Next generation traffic management

Energy strategy

Whole system reliability

Data and communications

You see things; and you say "Why?"
But I dream things that never were; and I say "Why not?"

George Bernard Shaw