ROLLING STOCK
Sensors pick up defects and send automated reports which get turned into a maintenance schedule.

Emerging defects are picked up before failure.
VISION
Mass- and energy-efficient, low whole-life cost rolling stock meets the evolving needs of its customers

OBJECTIVES
Rolling stock designed, built and operated to minimise whole-life, whole-system costs
Continuous improvement of rolling stock mass, energy and carbon efficiency
Optimised rolling stock interface with infrastructure systems
Rolling stock better adapted to meet passenger and freight requirements

STRATEGY
Continue to adopt and adapt new technologies for cost and operational improvements
Develop a range of appropriate alternative traction power sources
Produce standard architectures for rolling stock sub-systems
Improve the operational capabilities of freight rolling stock

ENABLERS
Improved sub-systems
Open interface standards to facilitate plug-and-play technologies
Guidance documents – Key Technical Requirements for Rolling Stock
Shift2Rail Joint Technology Initiative
Cross-interface remote condition monitoring
# ROLLING STOCK

## CONTEXT

2.84 The maintenance and financing of rolling stock in the UK is valued at £1.8bn/year, approximately 15% of the total railway operating cost\textsuperscript{11}. The passenger fleet consists of 64 classes with 12,000 vehicles and an average age of 17.3 years\textsuperscript{12}. The purchase of rolling stock for Thameslink, Crossrail and the Inter City Express Programme (IEP) is likely to reduce the overall average age of rolling stock and will increase carrying capacity markedly.

2.85 The supply chain for rolling stock is international, with the UK a relatively small part of the market for major manufacturers. This strategy assumes that train operators work in conjunction with rolling stock asset owners. Train operators, who understand their markets, will specify requirements and suppliers will deliver product and service solutions from their portfolios. To promote system optimisation, TSLG can support the development for a better understanding of interface issues and the introduction of appropriate market incentives into technical requirements, franchise agreements and other commercial contracts.

2.86 The continuing success of rail freight, up by more than half over two decades, risks being tramelled by technical limitations. Freight rolling stock is designed for and operated on, standard 60 and 75 mph services, which are increasingly out-of-step with line speeds on mixed traffic routes. Poor acceleration and deceleration causes freight trains to be held back on loop lines, waiting for paths that will not interfere with faster traffic.

\textsuperscript{11} Rail Value for Money study, 2010/2011

\textsuperscript{12} National Rail Trends Yearbook, 2010/2011

## VISION

2.87 Rolling stock is mass- and energy-efficient and engineered for flexible use under a range of operating concepts, including approaches such as train convoys. Whole-life costs are reduced continuously through the rapid introduction of new technologies that improve reliability and operation.

2.88 Optimising at a whole-system level, rolling stock design takes account of the interfaces with infrastructure. Standardised sub-system interfaces contribute to improved cross-system efficiency.

2.89 Efficient drive-trains are powered by a range of sources with associated energy recovery systems, which allow locomotives and multiple units to operate on and off the electrified network. Adhesion-aware braking systems have been introduced and contribute to reduced train headways and increased network capacity.

2.90 A new generation of freight rolling stock is designed to optimise the gauge and allows more freight trains to operate compatibly with intensive passenger train operation.

2.91 Comfortable and attractive train interiors create a more satisfying environment for passengers. Cabin layouts make the best use of available gauge and the capabilities of new materials.
OBJECTIVES

2.92 Rolling stock is designed to meet business requirements and takes account of the whole-life cycle. Standard system architectures have flexible designs for cost-effective upgrades and fewer maintenance processes. Couplings, train control and onboard systems support diverse operating approaches such as train convoying.

2.93 Rolling stock design and operation is improved continuously, for example:
- Mass efficiency balances strength, safety and capacity
- Energy for traction and recovered from braking systems is optimised continuously
- Energy losses from other systems are minimised
- Upgradeable rolling stock designs encourage the use of new low carbon materials and processes

2.94 A whole-system approach, which optimises the interfaces between rolling stock and other systems, reduces track wear, suspension and body fatigue, improves condition monitoring and minimises environmental impacts such as noise, vibration and waste disposal.

2.95 New vehicle interior layouts reflect changing patterns of demand and passenger demographics. The interiors are optimised for purpose, such as fast boarding and alighting for commuters, or comfort and facilities for long-distance high-speed or rural trains. New materials are used to reduce mass and increase durability and attractiveness.

STRATEGY

2.96 The adoption and adaptation of new technologies, processes and tools should continue to optimise whole-system, whole-life performance, for example:
- Components and sub-systems would be designed to meet performance objectives
- The ability to upgrade vehicles through their life would be developed to improve mass and energy efficiency
- Reliability, availability and maintainability would be improved

2.97 Good links with developments in materials science should be maintained, for example through the Transport Systems Catapult and evaluation should be sponsored to understand how new materials can be adapted for rolling stock use.

2.98 In collaboration with the supply chain, rolling stock drive trains should be developed with multi, dual or hybrid energy sources that are capable of working on or off electrified parts of the railway. This work should include:
- Low or zero carbon fuels
- Stored energy
- Multi-fuel engines
- An active, constant watch and assessment of traction solutions and hybrid engines from around the world
2.99 Diesel engine efficiency and lifespan should be improved to maximise the life of current diesel-powered rolling stock. Adjacent diesel technology, especially marine, should be assessed for the transferability of developing technologies.

2.100 Modular build using standard designs could further reduce costs. The European project MODTRAIN identified a 15% cost reduction for manufacturing and a drastically reduced number of parts on standardised components.

2.101 A vehicle-based functional architecture should be produced and maintained. This should be supported by appropriate common subsystem architectures and open interface standards for hardware and software that promote the development of modular approaches to system design, development, upgrade and maintenance.

2.102 Work should be undertaken with freight operators to specify the next generation of freight rolling stock.

ENABLERS

2.103 The overall efficiency and effectiveness of rolling stock will be delivered increasingly through progressive improvements in sub-systems, including:

- Mechatronic bogies
- Adaptive braking systems
- Improved passenger compartments
- Integrated diagnostic systems

2.104 Innovative bogies designs could minimise track impact and wear while extending the operating range of trains and reducing track access charges and energy use.

2.105 Matching braking forces with adhesion and speed while maximising energy recovery may be achieved through using a combination of braking systems such as pneumatic, magnetic and eddy current.

2.106 New materials may allow thinner, thermally-efficient passenger compartment ‘skins’ to reduce weight and energy loss.

2.107 Technical Specifications for Interoperability (TSI) and other standards and guidelines for the development and qualification of railway systems are being developed, updated and consolidated. This, coupled with work by the Enabling Innovation Team (EIT) to present common subsystem architectures, will promote the development of efficient plug-and-play equipment and sub-systems.

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13 RSSB T860 Benefits of all-electric braking (in progress)
2.108  *Key Technical Requirements for Rolling Stock*, an ATOC publication, assists procurers of new rolling stock by providing guidance on key requirements under a range of headings: technical, performance, passenger-facing, driver-facing and communications/diagnostics.

2.109 The Shift2Rail Joint Technology Initiative aims to provide a Europe-wide focus for the development of rolling stock.

2.110 A cross-industry commercial and technical framework needs to be established to allow asset condition data to be shared and exploited across all infrastructure and rolling stock asset types. This could improve asset performance and reduce asset maintenance costs.

2.111 Deployment of RCM technology and associated analytical toolsets improves rolling stock reliability and maintainability. This would lead to increased availability, which would reduce cost and capture potential revenue. Cross-interface RCM (XIRCM)\(^{14}\) has identified significant savings by associating train and infrastructure RCM – trains monitor infrastructure and vice-versa.

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\(^{14}\) RSSB T1010 Cross-interface Remote Condition Monitoring Programme (in progress)
### RTS Rolling Stock

#### Themes - Rolling Stock

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#### CONTINUE TO ADOPT AND ADAPT NEW TECHNOLOGIES THAT PROVIDE COST AND OPERATIONAL IMPROVEMENTS

- **New Technologies**
  - Support & engage with Shift2Rail Joint Technology Initiative
  - Evaluate to evaluate new technologies
  - Maintain technology watch

- **New Processes**
  - Employ Remote Condition Monitoring on rolling stock
  - Cross Industry RCM Group

- **New Tools**
  - DRAAS Development

#### DEVELOP A RANGE OF APPROPRIATE ALTERNATIVE TRACTION POWER SOURCES

- **Rolling Stock Sub-systems**
  - Evaluate, develop and apply adhesion-independent & other braking technologies
  - Mechatronic logistics - identification and development of applications with a business case
  - Energy efficient drive systems
  - Improve passenger train interior designs for comfort, access, durability

- **Traction Power**
  - Monitor and evaluate new fuels
  - Multi, dual & hybrid traction drives
  - Active monitoring of traction solutions and hybrid engines being/employed around the world
  - Improve diesel engine efficiency and life

- **General**
  - Defined on-board systems architectures (including definitions and interfaces)
  - Advance modelling techniques
  - Develop whole system modelling to examine interactions

- **Train**
  - RST TSI (High Speed)
  - Design criteria for versatile passenger rolling stock
  - Design criteria for versatile freight rolling stock
  - Promote right-mass train design

- **Sub-Systems**
  - EU MODTRAIN Project
  - Determine and advise on use of open standards within the rail industry

- **Freight Rolling Stock**
  - Improve overall operational capability of freight trains & wagons
  - Produce freight specific system requirements
  - Improve freight trains and locomotive performance (speed, acceleration, braking)

#### Mass and energy efficient, low whole-life cost rolling stock meets the evolving needs of its customers

**Vision**

- Industry Delivery Activity
  - TSLG Completed activity
  - TSLG In progress
  - TSLG Planned
  - TSLG Potential

*All dates and durations should be regarded as indicative*