

# Transport Systems and Integration Technology and Innovation Centre

A Review of Opportunities for Rail in the  
Wider Transport Context

## Executive Summary

Revision 6 RSSB, September 2011

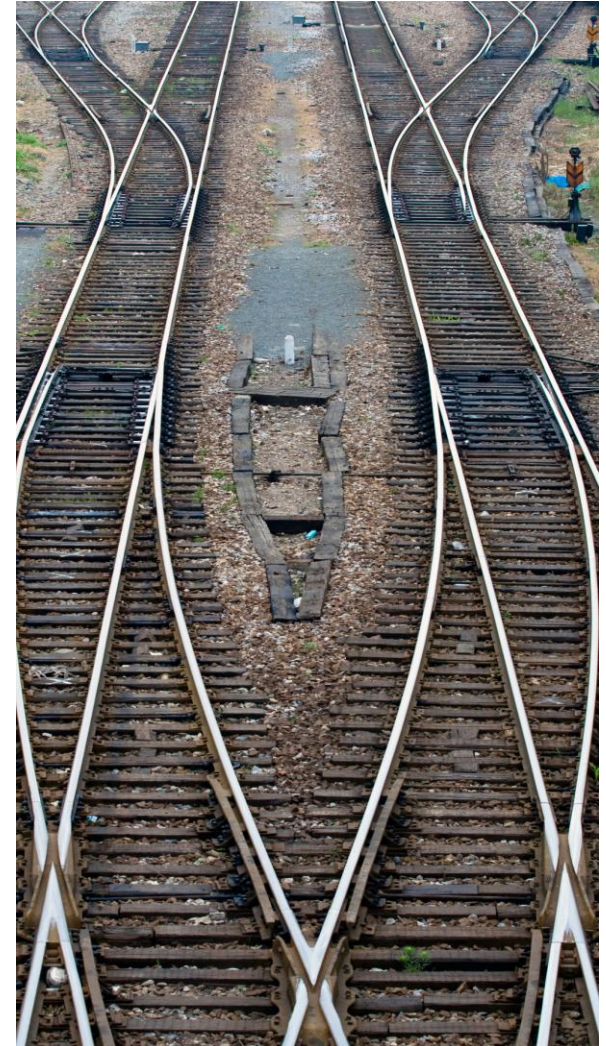
This document has been commissioned from Arup by the Technical Strategy Leadership Group (TSLG – see [www.futurerailway.org](http://www.futurerailway.org)) which is a cross-industry group focussing on the whole system, long term vision for the GB railway. Membership of the group comprises: Network Rail, Train Operating Companies, Freight Operating Companies, Rolling Stock Owning Companies, Railway Industry Association (RIA), the Association of Train Operating Companies (ATOC), RSSB, the Department for Transport (DfT), Transport Scotland, the Office of the Rail Regulation (ORR) and Rail Research UK –A representing Universities in the UK. This report is informed by over 200 man days of rail industry and academic input.

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## A Transport Systems and Integration TIC will support the TSB's vision of realising a network of world class innovation centres.

### The Vision

- In October 2010, the Prime Minister announced a £200+ million programme to be run by the Technology Strategy Board (TSB) to create a network of world-leading Technology and Innovation Centres (TICs). The TSB has announced ten candidate focal areas for future TICs, of which three will be selected.
- Of these ten potential focal areas, transport is one that can potentially open up billion pound global markets to UK businesses. It is also strategically important to the UK, as a Transport Systems and Integration TIC will not only serve to drive the UK Government's Plan for Growth through the transport supply chain, but also ensure the competitiveness of UK businesses by delivering benefits to the transport demand side by lowering transport costs of freight, reducing congestion and increasing productivity. The identification of leading edge technological advances and innovation in products, know-how and applications are crucial factors in ensuring these outcomes are realised.
- Good transport systems are an essential enabler of a nation's economic prosperity, and conversely congestion is known to cost a developed economy such as the UK hundreds of millions of pounds a year. With continuing population growth, the need for solutions to congestion, and the need to move ever greater volumes of freight, there is a considerable global market for innovation in transport. The TIC will be able to access this market, worth £120 billion per annum for rail alone.
- As evidence of demand, the TSB also requires research funding from other sources to match TSB's contribution. The Department for Transport (DfT) has already committed £7 million funding for a future TIC, and the size of the potential prize (from increased margins) delivered by innovations will also interest industry. As an illustration, to realise an annual prize of £800 million (for reducing rail energy costs, improving reliability, and increasing capacity), rail transport providers could be willing to invest £3.4 billion (see assumptions in Section 3.1). From the supplier's perspective UK rail businesses would also be interested in investing in research that leads to innovations that captures a share of the substantial global market.



- With such an opportunity, is there a need for a transport focused TIC? Will the market respond to this demand without government support?
- Key market failure arguably arises from the industry's traditional siloed approach to working, with suppliers and transport operators not regularly collaborating resulting in lost opportunities. The key role of a Transport Systems and Integration TIC will be to break down existing silos in the industry and facilitate joint working to identify and develop new innovations.
- This is particularly true of cross modal innovations, where no single organisation has a mandate to bring together organisations of different sectors to identify integrated opportunities for innovation. The TIC will not only facilitate collaborations and partnerships, but also facilitate the process of innovation. It will facilitate the innovation process by promoting strong collaborations between partners, create opportunities to use the UK as a test bed to prove innovations, and as a result generate interest from international markets.
- **A Transport Systems and Integration TIC will support the TSB's vision of realising a network of world class innovation centres. It will be a global centre for innovation excellence that joins up the fragmented innovation landscape in UK transport, facilitating UK economic growth through exports, commercialising UK research that would not otherwise be conceived, and also achieving strategic priorities in terms of CO<sub>2</sub> reduction and energy security.**

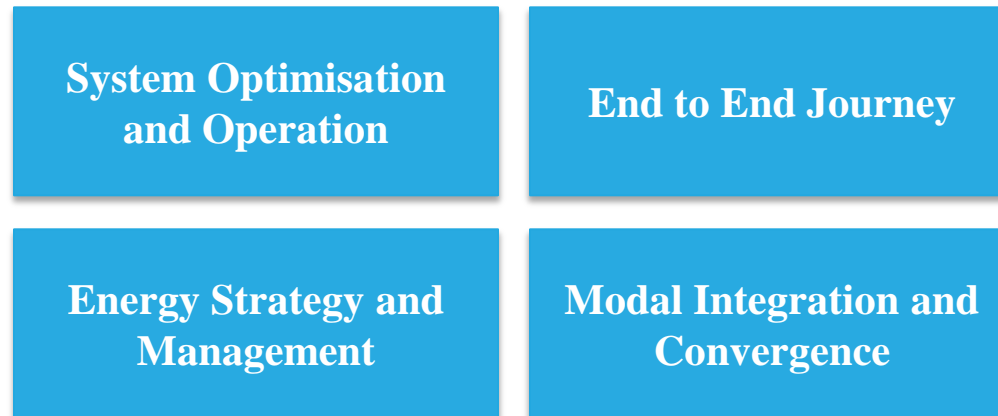
The **vision** of the Transport Systems and Integration TIC is to be recognised as a global centre of excellence, establishing the UK as a hub of transport innovation, and generating significant income and employment for the UK.

Its **mission** is to accelerate the design, development, demonstration and deployment of truly integrated innovations, formed through the collaboration of suppliers, industrial customers, industry bodies and policy makers.

The TIC will focus on four innovation themes ‘System Optimisation and Operation’, ‘End to End Journey’, ‘Energy Strategy and Management’, and ‘Modal Integration and Convergence’

#### Innovation Areas

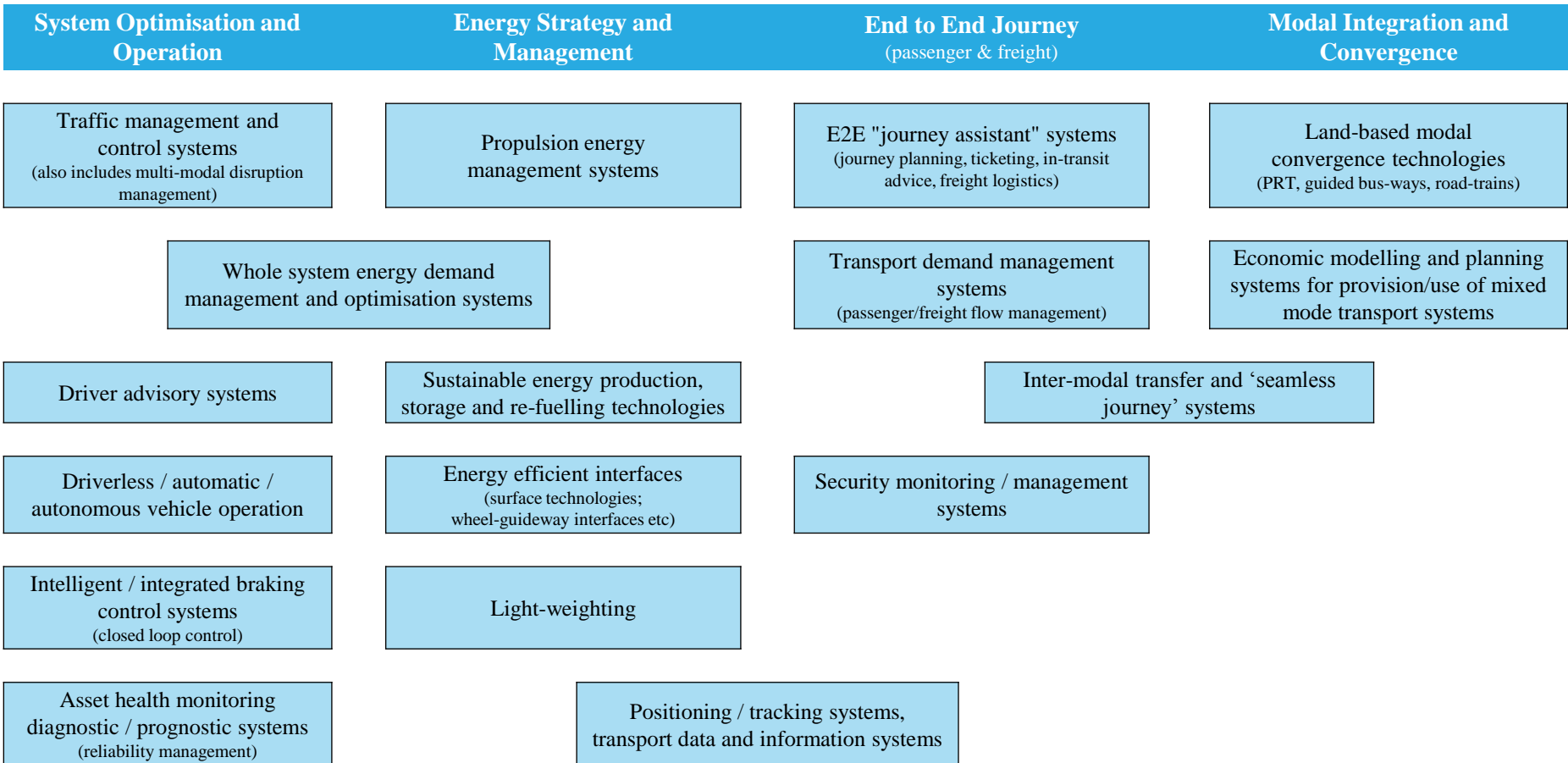
- The innovation focal areas of the TIC can be categorised into four key innovation themes. These themes respond strongly to key global trends and drivers, to trends that will shape the UK in the future, and are also applicable to all transport modes.
  - **System Optimisation and Operation:** Covers topics that range from transport system reliability to asset management.
  - **Energy Strategy and Management:** Includes both energy production and energy use.
  - **End to End Journey:** Includes technologies that facilitates a seamless journey for passengers and freight.
  - **Modal Integration and Convergence:** Technologies that physically facilitate cross-modal transfers; convergence of transport modes (e.g. Personalised rapid transport systems); business models for integrated transport provision.



- Additional comparators used to validate the four themes were the Automotive Council’s recently endorsed technology focus areas for a TIC, and the Marine Industries Leadership Council’s (MILC) themes for innovation.

Key innovation areas the TIC will focus its efforts on are ‘System Optimisation and Operation’, ‘Energy Strategy and Management’, ‘End to End Journey’, and ‘Modal Integration and Convergence’

The technology, systems and process areas can be categorised into four key innovation themes. Although this has been developed through consultation with railway industry stakeholders, the themes are applicable to all transport modes.



The table below describes each theme in relation to integration of transport modes as seen from the rail sector. While some of the innovation and technology areas described below are rail specific, the majority are applicable across the different transport modes.

<b>System Optimisation and Operation</b>	<p>This theme deals with a wide range of topics from transport system reliability to asset management. It covers a number of technology and innovation areas, including:</p> <ul style="list-style-type: none"> <li>▪ Control systems, Next generation traffic management, Driver advisory systems, Intelligent braking / control systems, Asset health monitoring / condition monitoring</li> <li>▪ Whole system energy demand monitoring and optimisation systems (Note: This in particular crosses over with Energy Strategy and Management theme)</li> </ul>
<b>Energy Strategy and Management</b>	<p>While energy strategy and management is a common theme across virtually all business sectors in the UK. In terms of transport it has particular unique areas of focus that is unique and additive to what is already occurring. This includes both energy production and efficient energy use. For example:</p> <ul style="list-style-type: none"> <li>▪ Propulsion energy management systems, sustainable energy production, alternative fuels, storage and refuelling, energy efficiency interfaces, light-weighting (lighter trains to reduce energy consumption), differential ticket pricing for choosing low-energy routes, differential timetable management optimising for different criteria at different times of day (such as capacity, energy use)</li> </ul>
<b>End to End Journey</b>	<p>At one level, the end to end journey as a theme is the embodiment of what transport systems integration means. However, more specifically it can be interpreted as a journey planning and traffic management topic as follows:</p> <ul style="list-style-type: none"> <li>▪ E2E journey assistant systems (journey planning, ticketing, in-transit aid device – dynamic journey planning, freight logistics), Transport demand management systems (passenger and freight flow management), Security monitoring / management systems</li> <li>▪ Inter mode transfer and seamless journey systems (Note: This in particular crosses with Modal Integration and Convergence theme)</li> </ul>
<b>Modal Integration and Convergence</b>	<p>Whereas the End to End journey theme is about improving the connectivity between different transport modes, this theme is about: Challenging conventional concepts of the various modes – specifically, looking at modes that combine the best of rail and road transport</p> <ul style="list-style-type: none"> <li>▪ Personalised Rapid Transit (PRT) systems, guided busways, road trains etc</li> <li>▪ Developing economic models and toolkits to optimise the mix of transport modes for given situations (such as mega cities).</li> </ul>

‘System Optimisation and Operation’, and ‘Energy Strategy and Management’ are relevant innovation themes for the TIC as they respond to a number of important trends and drivers

Specific areas of alignment with global and UK drivers, EU research priorities, the Automotive Council and MILC’s innovation themes have been provided in the following tables, with the **highlighted cells** showing the areas of alignment.

Innovation Themes	Key Global and UK Drivers	UK World Leading Rail Research Areas	EU Priorities	Automotive Council Technologies	MILC Technology Themes
System Optimisation and Operation	Changing levels and shape of demand	Vehicle dynamics	Intelligent mobility	Energy storage and management	I-ship (decision support)
Energy Strategy and Management	Tech. Improvements	Vehicle-track interface	Energy / environment	Electric motors and power electronics	Lean support processes
End to End Journey	Environmental sustainability	Noise and vibration	Personal security	Internal combustion engines	Anti fouling coatings
Modal Integration and Convergence	Resource Constraints	Transport economics	Test, homologation and security	Lightweight vehicle and power train structures	Green propulsion
	Legal Drivers	Human Factors	Enabling technologies	Intelligent mobility	Ergonomics / Ease of use leisure craft
	Globalisation	Rail freight / logistics	Strategy and economics		Ballast water solutions
	UK industry capability	Track and railway structures	Infrastructure		Vessels and systems
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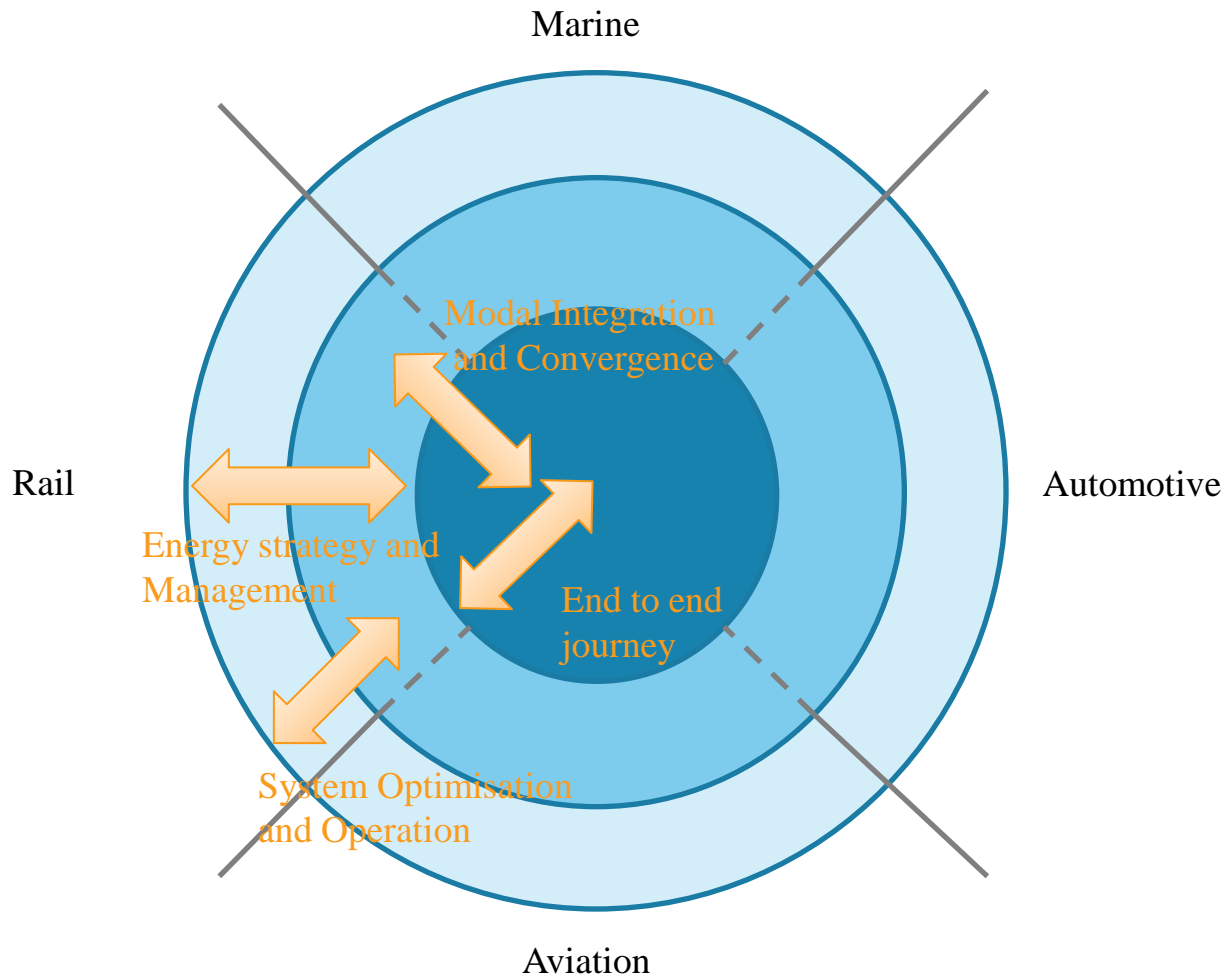
  

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## The TIC will facilitate collaborations, bringing organisations together to create intermodal, common and systems innovation

### Value Proposition of the TIC

- The Transport Systems and Integration TIC is about integration and cross sector innovation, bringing together organisations that would not otherwise come together. This applies for innovations that bring all transport modes together (**intermodal innovations**); to those innovations that can be adapted for use across multiple transport modes (**common innovations**); and innovations that integrate systems but only relevant to a specific transport mode (**systems innovations**).
- The TIC will begin by facilitating collaborations. These collaborations will be between the knowledge base and industry, involving large suppliers as well as SMEs. In addition, the TIC will ensure that innovation opportunities with respect to the demand side of transport are tapped into, providing a forum that will create intermodal collaborations. The TIC will break down silos present in the industry, bring subsystems together, facilitating conversations amongst the supply side and with the demand side. This will lead to new innovations and partnerships that would not have otherwise occurred. Hence the innovations that come out of a TIC are not specific technologies or services, but are integrated systems that only exist because traditional barriers have been broken down.
- After the potential innovations and associated partnerships have been identified, the TIC will play a key role in making the innovations happen through design, development, demonstration and deployment (taking innovations through Technology Readiness Levels 4 to 6).
- The TIC is a location where innovation partnerships can ideate, play and test. Prototyping, sand pitting and simulations will be possible through facilities and synthetic environments provided within the TIC.
- The TIC will enable operational testing, as innovation within the project environment needs to be supported by demonstration in an operational environment.
- The TIC will engage groups including public sector and private sector industry bodies, policy makers and industry. Using rail as an example, these include cross industry bodies and such as TSLG, RSSB, DfT, London Underground and Network Rail, which will ensure that innovations are included in the next round of rail standards and requirements, creating a demand for innovations. This will provide UK industry with a head start, enabling the innovation to be demonstrated operationally in the UK and attract interest internationally, leading to exports.
- The TIC will have access to entrepreneurial skills and experts in intellectual property management and licensing, ensuring that background IP of partner organisations is protected, but benefits resulting from foreground IP are shared and retained by innovation partnerships.
- This is the unique value proposition of a Transport Systems and Integration TIC. An organisation that accelerates and forces innovation, breaks down silos to enable truly integrated innovations, where the supply and demand side work together with policy makers in collaboration. Collaborations that will bring innovations to market sooner, and address the most significant market failure in the railway industry. The TIC will firstly address UK needs, and then use this to leverage and create global opportunities.



**Key:**

**Intermodal Innovations:** Innovations that bring all transport modes together

**Common Innovations:** Innovations that can be adapted for use across multiple transport modes

**Systems Innovations:** Innovations that integrate systems but only relevant to a specific transport mode

## Activities of the Transport TIC can be divided into Strategic Activities, Core Activities and Secondary Services

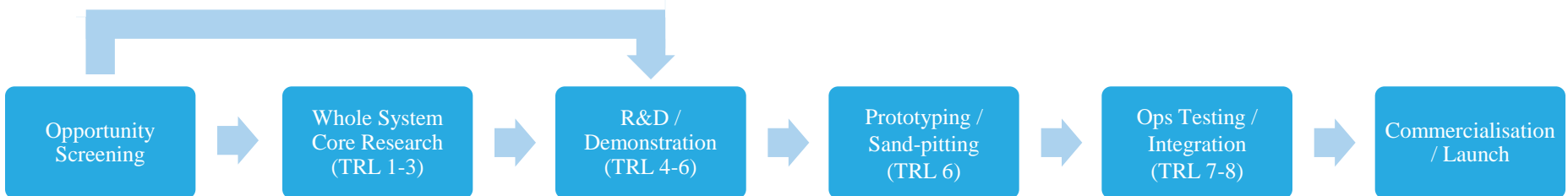
The business model of the TIC represented by the activities in the diagram below consists of Strategic Activities, Core Activities and Secondary Services (this is a development of the ‘potential activities’ previously mentioned). The strategic activity, ‘Transport Systems Facilitation’ is an adaptation of the ‘Facilitation of Collaborations’ activity previously described, and relates to the role of the TIC in bringing together relevant collaborators and partners for the innovation. Partners will change over the lifecycle of the innovation, as the innovation progresses from an idea through to commercialisation.

The core activities begin with Research Screening can either lead straight into Core Research (only in respect of whole transport system research which doesn’t currently occur) or into Research, Development and Demonstration. These activities form the core service offering of the TIC, however in the medium to long term, additional ‘secondary’ services can be offered by the TIC to improve utilisation of its staff and assets and generate additional sources of revenue.

### Strategic Activities



### Core Activities (Value Chain) of Transport TIC



### Secondary Services



## The role of the TIC in Integrative Facilitation, spans across its Core Activities and will bring together key organisations including industry bodies, regulators, rail customers, rail suppliers and academia

The TIC will bring together relevant collaborators and partners over the lifecycle of the innovation. The key roles of partners will change over this lifecycle, and are described in the table below.

	Research Screening	Whole System Core Research	R&D / Demonstration	Prototyping / Sandpitting	Ops Testing / Integration	Commercialisation / Launch
TIC	<ul style="list-style-type: none"> <li>Bring together the organisations below to create collaborations.</li> <li>Potentially have a higher success rate in securing project funding.</li> <li>Feed into research agenda of universities.</li> </ul>	<ul style="list-style-type: none"> <li>Core research carried out by the TIC will be whole systems innovations.</li> <li>Promote strong collaborations between partners.</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D and demonstration projects must be intermodal, common or systems innovations.</li> <li>Promote strong collaborations between partners.</li> </ul>	<ul style="list-style-type: none"> <li>Provide / coordinate access to test facilities (either owned by the TIC or other partners).</li> <li>Promote strong collaborations between partners.</li> </ul>	<ul style="list-style-type: none"> <li>Provide / coordinate access to test facilities (either owned by the TIC or other partners)</li> <li>Promote strong collaborations between partners.</li> </ul>	<ul style="list-style-type: none"> <li>Support launch of innovations</li> <li>Provide organisations (in particular SMEs) with access to entrepreneurship skills, IP management and licensing</li> </ul>
Public / Private Industry Bodies	<ul style="list-style-type: none"> <li>Upfront support / input into innovations to ensure there is downstream demand.</li> <li>Bring forward innovation ideas.</li> </ul>	<ul style="list-style-type: none"> <li>Made aware of progress of innovations.</li> <li>Input as required.</li> </ul>	<ul style="list-style-type: none"> <li>Made aware of progress of innovations.</li> <li>Input as required.</li> </ul>	<ul style="list-style-type: none"> <li>Made aware of progress of innovations.</li> <li>Input as required.</li> </ul>	<ul style="list-style-type: none"> <li>Made aware of progress of innovations.</li> <li>Input as required.</li> </ul>	<ul style="list-style-type: none"> <li>Champion inclusion in future rounds of standards and requirements.</li> <li>Purchase innovations.</li> <li>Supply to customers.</li> </ul>
Regulators and Policy Makers						
Industry Customers		<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Support testing needs.</li> </ul>	<ul style="list-style-type: none"> <li>Support testing needs.</li> </ul>	
Industry Suppliers		<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	
Academia		<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Research partner.</li> </ul>	<ul style="list-style-type: none"> <li>Further input as required.</li> </ul>	

Some activities carried out by the TIC (facilitation, opportunity screening and core research) will not generate any direct income and as such, TSB core funding will be used to cover these costs

	TIC	Costs covered through	CapEx Needs
Facilitation	Transport Systems Facilitation	X ▪ TSB funding	
	Research Management		
	Dissemination		
Research and Development	Opportunity Screening	X ▪ TSB funding	
	Whole System Core Research	X ▪ TSB funding	
	R&D / Demonstration	X ▪ Research contracts	▪ TSB funding
	Prototyping and Sandpitting	X ▪ Research contracts	▪ TSB funding
	Operational Testing / Integration	X ▪ Research contracts	▪ TSB funding
Service Provision	Commercialisation / Launch	X ▪ Investor partner	
	Engineering / Design Services		
	Testing Services	X ▪ Testing income	
	Training Provision	X ▪ Training income	
	IP Management / Licensing	X ▪ License income	
	Certification Services		

Core activities are highlighted with (X) and secondary activities (x)

**Transport systems facilitation** will generate no revenue, hence costs of facilitation will be covered by a portion of TSB funding.

**Whole system core research** activities will be minimal and only in respect of whole transport system research which doesn't currently occur. It is likely to generate no income at TRL 1-3, hence costs will be covered by a portion of TSB funding.

**R&D / demonstration, Prototyping and sandpitting, and Operational Testing / integration** costs can be covered by contract research funding. Any initial set-up costs for equipment, IT and a synthetic environment can be covered using a portion of TSB core funding.

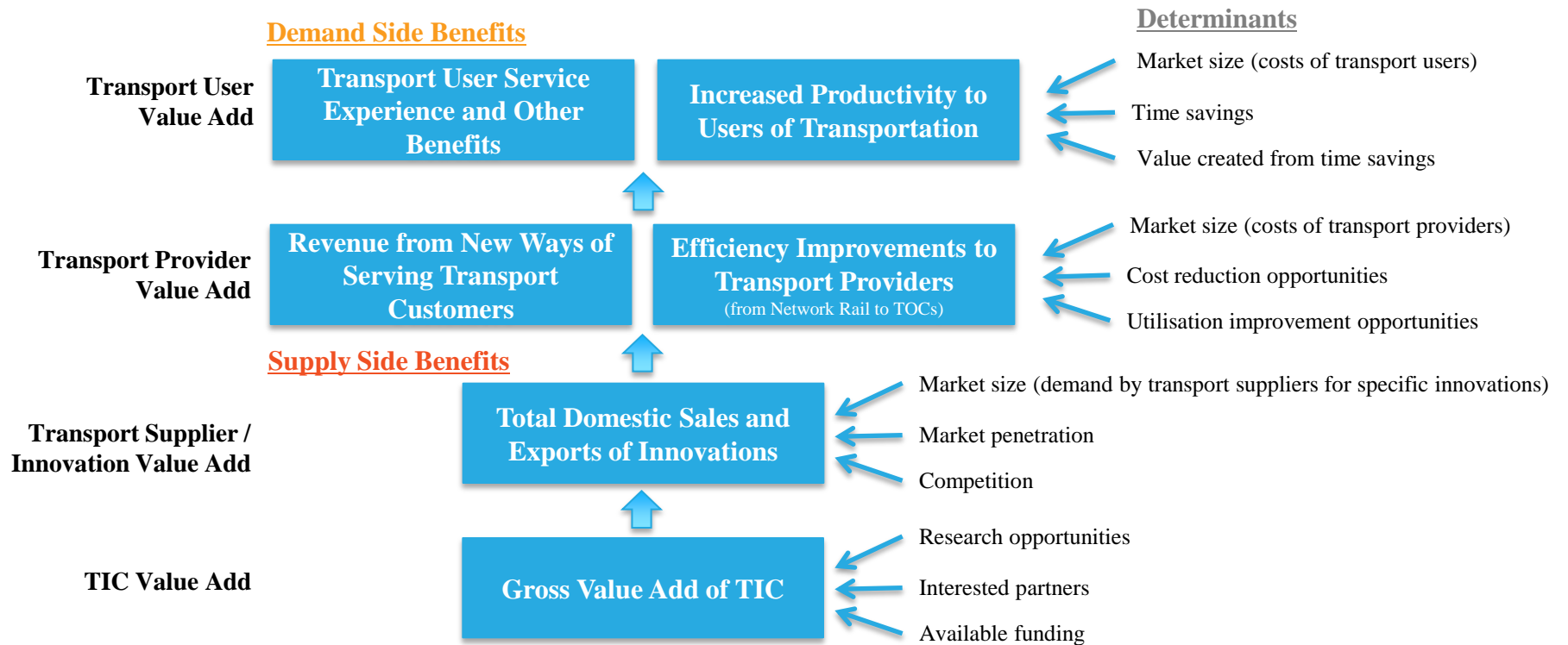
**Commercialisation / launch** costs can be provided by an investor partner. This partner can be a rail supplier, venture capital or lenders (depending on risk).

By providing **Testing Services, Training Provision, and IP Management / Licensing**, utilisation of staff and assets will increase, and generate additional income. Licensing of IP will potentially occur in later years of operation.

## Wider economic benefits of the TIC can be considered in terms of those that can be attributed to the **Transport User**, the **Transport Provider**, the **Transport Supplier**, and the **TIC itself**

Rail projects and enhancements typically offer significant public benefits. Examples include DfT’s proposals for HS2, which the Department’s analysis for the recently-closed consultation indicates would generate £2.6 of economic benefits for every £1 invested. Likewise, Crossrail’s July 2011 business case update estimates that it will generate up to £4 of economic benefits for every £1 invested.

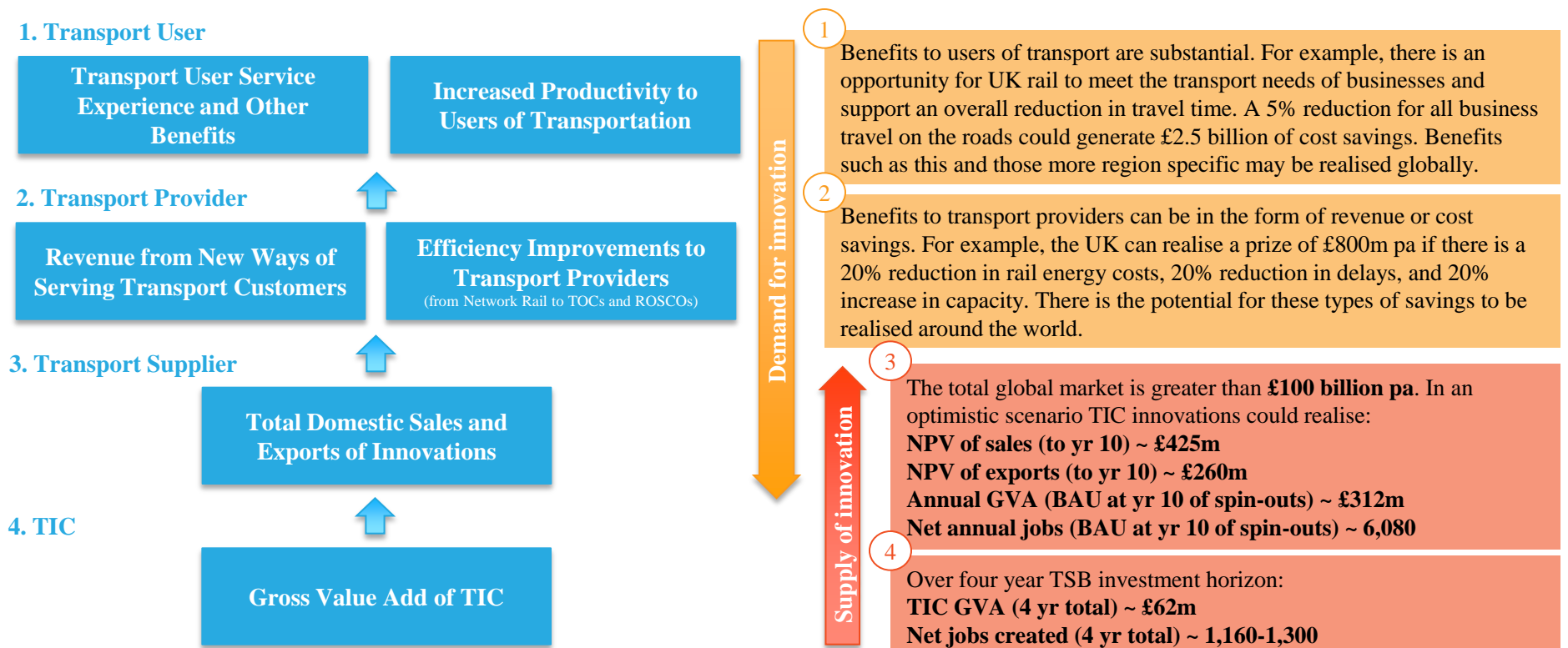
Economic benefits that result from the TIC can be considered in terms of those that result from the ‘Supply Side’ (i.e. benefits from TIC itself and from the innovations that come out of the TIC), and from the ‘Demand Side’ (i.e. benefits to transport providers using innovations from the TIC, and from transport customers using services of transport providers). The determinants that influence each of the benefits are set out in the diagram below.



## Economic benefits are substantial: TIC innovations can tap into a global market in excess of £100 billion

The diagram below illustrates the scale of benefits the TIC can contribute to and highlights the significant additional benefit it will realise for the UK economy by addressing market failures. The key economic benefit will be in helping UK transport suppliers tap into a global market worth in excess of £100 billion for rail alone.

By definition the innovations in question have not occurred; hence the benefits that the TIC will realise through innovations are purely high level estimations. The value of the Transport Systems and Integration TIC when compared to other TICs should not be judged purely based on these numbers. It is the overall value proposition offered by the Transport Systems and Integration TIC, its role in creating new methods of innovating that should create significant additional value to the UK.





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