Transport Systems and Integration Technology and Innovation Centre

Q and A – The proposition in brief

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This document has been commissioned from Arup by the Technical Strategy Leadership Group (TSLG – see 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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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.

System Optimisation and Operation	Energy Strategy and Management	End to End Journey (passenger & freight)	Modal Integration and Convergence
Traffic management and control systems (also includes multi-modal disruption management)	Propulsion energy management systems	E2E "journey assistant" systems (journey planning, ticketing, in-transit advice, freight logistics)	Land-based modal convergence technologies (PRT, guided bus-ways, road-trains)
Whole system energy demand management and optimisation systems		Transport demand management systems (passenger/freight flow management)	Economic modelling and planning systems for provision/use of mixed mode transport systems
Driver advisory systems	Sustainable energy production, storage and re-fuelling technologies	Inter-modal transfer and ‘seamless journey’ systems	
Driverless / automatic / autonomous vehicle operation	Energy efficient interfaces (surface technologies; wheel-guideway interfaces etc)	Security monitoring / management systems	
Intelligent / integrated braking control systems (closed loop control)	Light-weighting		
Asset health monitoring diagnostic / prognostic systems (reliability management)	Positioning / tracking systems, transport data and information systems		

'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
		Aerodynamics			

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Innovation themes can be considered in terms of specific technologies, which have different levels of alignment with other transport modes

Within each innovation theme there are a number of opportunities for innovation, including a range of areas where the UK is or could be in a world leading position in the rail sector and / or across transport modes. A list of potential innovations are provided in the tables below, including a summary of how closely they are related to innovations in other transport modes.

Systems Optimisation and Operation (Potential Innovations)	Areas of Alignment with other Transport Modes
▪ Automated train operation system (with ERTMS integration) ▪ Reduced cost driverless system ▪ Live scheduling control system and software ▪ Real time train positioning software and hardware (Doppler radar, video recognition, etc, all requiring systems integration) ▪ Intelligent traffic management (software supported by sensors) ▪ Sensors for health monitoring ▪ Intelligent braking systems (brake predicts own performance and integrates with other subsystems) ▪ Condition monitoring and prognostic algorithms / software ▪ Decision support software ▪ Modular infrastructure components and COTS components ▪ Non damaging vehicle track interaction	▪ Automated vehicle systems are of increasing interest in the road transport arena, as the idea of car trains and automated car spacing gains prominence. ▪ Intelligent traffic management and positioning software clearly have cross over in other modes, particularly if transport in the UK is ultimately to be regarded as a single system. ▪ Condition and health monitoring and modular infrastructure are also of key significance in road and marine in particular. ▪ Intelligent braking could form part of the traffic management / car train technologies for road transport.

Energy Strategy and Management (Potential Innovations)	Areas of Alignment with other Transport Modes
▪ Power electronics ▪ Electric traction converters ▪ Capacitor or Fuel cell technology ▪ Flywheel energy storage ▪ Regenerative brakes ▪ Whole system energy optimisation (optimum vehicle, optimum energy source, optimum ticket (or road) pricing strategy to produce most energy-efficient use of transport ▪ Smart grid concepts (imported into railway)	▪ Energy storage and use is a critical area for all sectors of transport. This goes beyond generation to optimising energy use both through vehicle / mode choice and using pricing strategies etc to spread the load on the transport network in such a way as to optimise energy use.

End to End Journey (Potential Innovations)	Areas of Alignment with other Transport Modes
▪ E2E journey planning mobile application ▪ Smart ticketing system hardware and software ▪ Intelligent signage ▪ Intelligent mobility (optimising nation's movement of passengers/goods; vehicles talking to each other) ▪ Information processing software to enable a cross modal connected service (goods and freight) ▪ Yield management concepts	▪ This theme is clearly equally applicable to all transport modes, and gains an added level of relevance when used to plan and deliver journeys on a truly integrated transport system, where we can imagine customers being able to optimise their journey for a number of different factors including time, carbon, availability of capacity (for freight), etc.

Modal Integration and Convergence (Potential Innovations)	Areas of Alignment with other Transport Modes
▪ Personal Rapid Transit ▪ Guided busways ▪ Road-trains ▪ New business models for transport provision	▪ This theme is applicable to multiple transport modes. It looks at new models for modal integration, where the traditional technology, systems and business models for transport in each mode are radically changed. It takes innovations and best practices in one mode, for adaptation in another. ▪ By considering 'Transport' as an entire system, new business and economic models can be developed to shape how transport is provided in the future. A system view will ensure that transport infrastructure can be 'optimised' to maximise economic impact (e.g. Optimisation of transport corridors to maximise property value or economic development by considering benefits / impacts of building a highway vs a railway)

Core activities (**X**) and secondary activities (x) of similarly focused organisations are highlighted below, in comparison to the proposed activities of the Transport Systems and Integration TIC

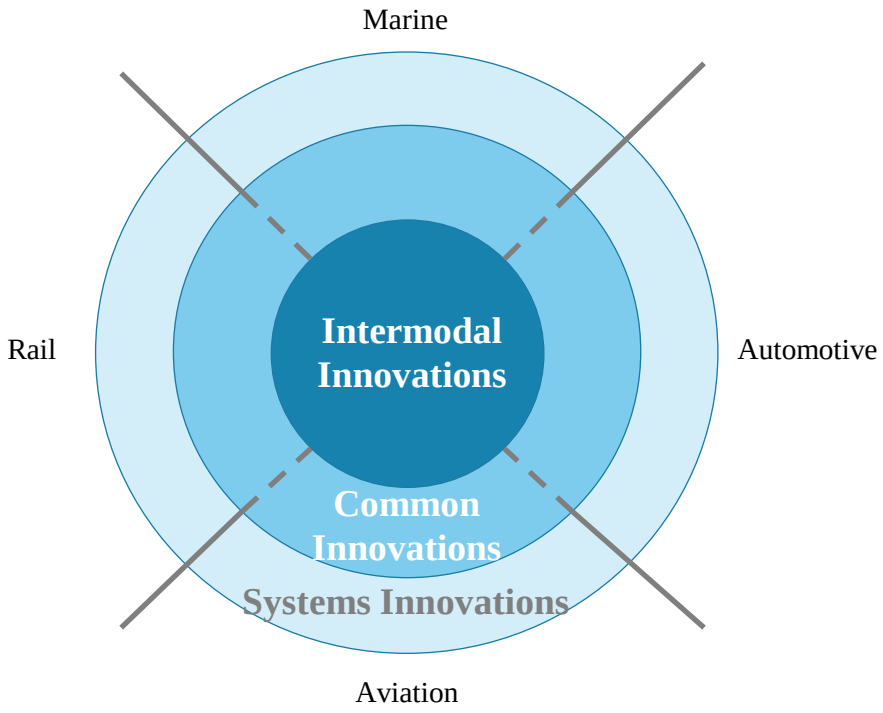
The table below sets out the activities carried out by Fraunhofer Institutes, MIRA Ltd, TTCI, TNO, RIAust, IfS, Network Rail and RSSB, compared to the proposed activities of the TIC. Further details are available in the Supporting Information section of this document (AnnexB).

		Fraunhofer	MIRA	TTCI	TNO	RIAust	IfS	NR	RSSB	TIC
Facilitation	Facilitation of Collaborations						**X**	x	**X**	**X**
	Research Management						x		**X**	
	Dissemination						**X**	x	x	
Research and Development	Core Research	x			x					X(whole system)
	Research Screening	x	x		x				x	x
	R&D / Demonstration	**X**	**X**	x	**X**			x	x	**X**
	Prototyping and Sandpitting	x	x	x	x			x		**X**
	Operational Testing / Integration		x	x	x (spin-out)	x		x		**X**
	Commercialisation / Launch				x (spin-out)	**X**	x			x
Service Provision	Engineering / Design Services		x	x						
	Testing Services	x	**X**	**X**				x		x
	Training Provision	x	x	**X**		x				x
	IP Management / Licensing	x			x	x	**X**		x	x
	Certification Services	x	x	x				x		

The TIC is an organisation that accelerates and forces innovation, breaking down silos to enable truly integrated innovation

The following list summarises the potential business model of the Transport Systems and Integration TIC. It forms the basis of the next section of this report and the pitch to the Technology Strategy Board.

- 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 TRL 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.

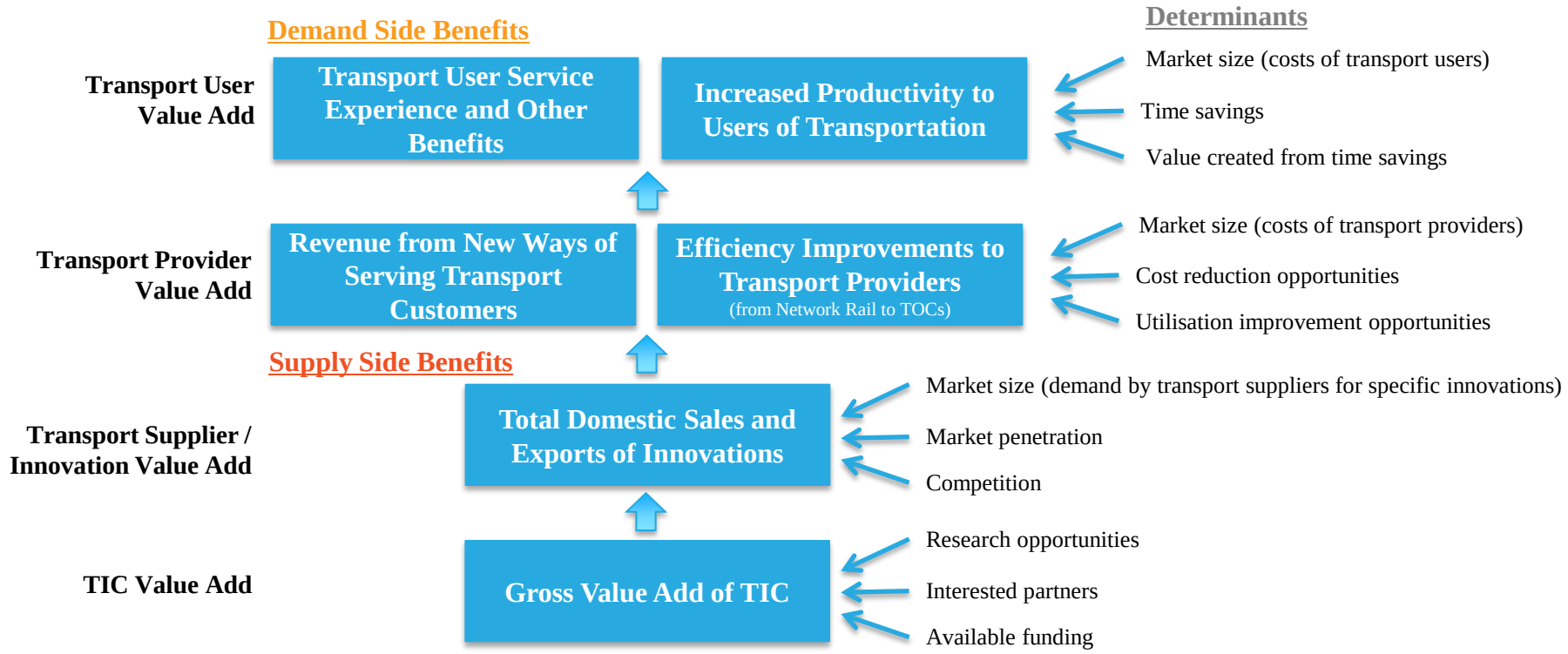


- The TIC will enable operational testing, as innovation within the project environment needs to be supported by demonstration in an operational environment. For rail in particular, finding a suitable test facility is seen as a barrier to innovation. The TIC will facilitate testing on an operational railway, as well as build relationships with existing organisations offering test facilities and coordinate access into them. This will benefit both projects that need test facilities as well as providing a pipeline of projects for these existing test facilities (this pipeline will facilitate improved planning and increased utilisation of existing test facilities). As the TIC grows to an organisation with £15-£20m annual income, demand will increase to a level that may justify the need for a dedicated railway test track. This demand will create interest from investors to finance such a facility with minimal to no government subsidy, and with the TIC taking on the full lease or acting as anchor tenant.
- For rail, beyond operational testing, the TIC will engage groups such as TSLG, RSSB, DfT, London Underground and Network Rail to ensure 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 are protected, but benefits resulting from foreground IP are shared and retained by the innovation partnerships.
- This is the unique value proposition of a Transport Systems and Integration TIC. It is 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.

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.

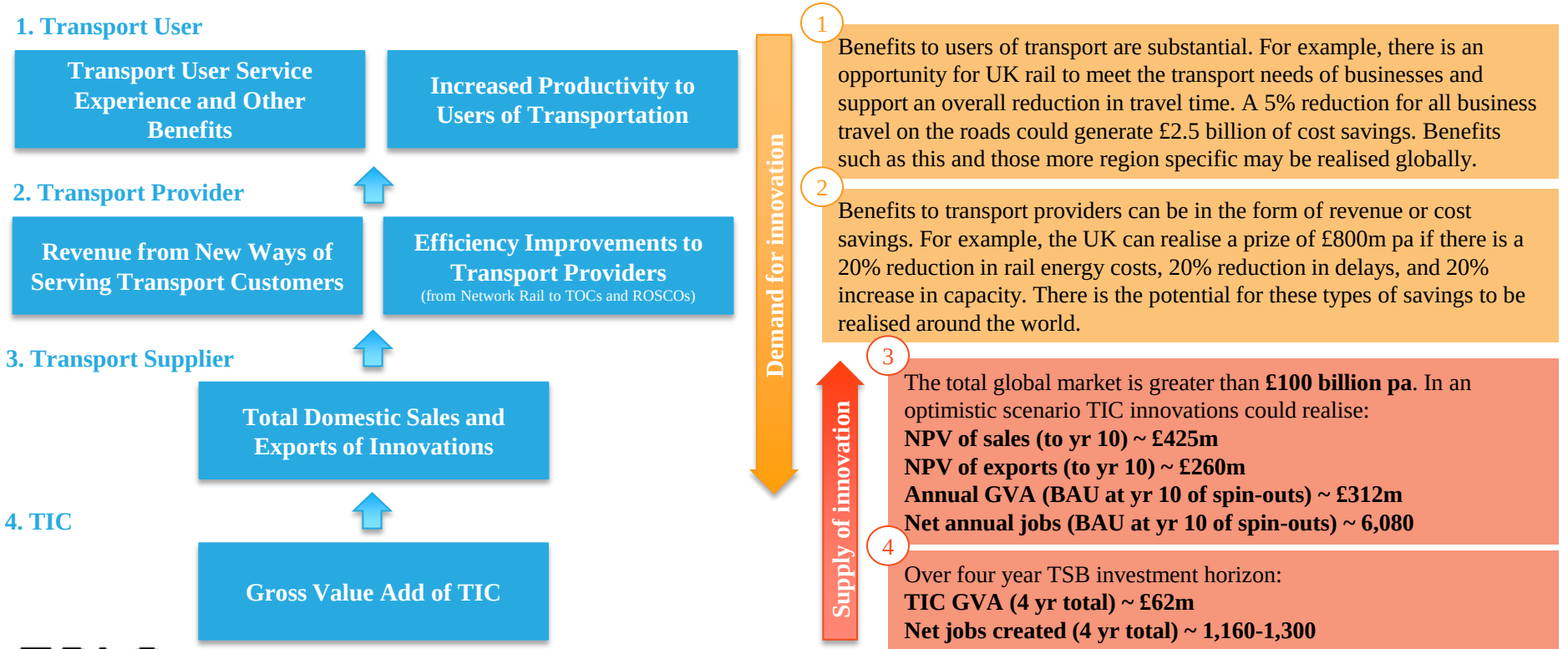
Economic benefits that result from the TIC can be considered in terms of those that result from the 'Supply Side' (i.e. benefits from TIC itself and from the innovations that come out of the TIC), and from the 'Demand Side' (i.e. benefits to transport providers using innovations from the TIC, and from 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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This is slide 17 and 80 in the full report

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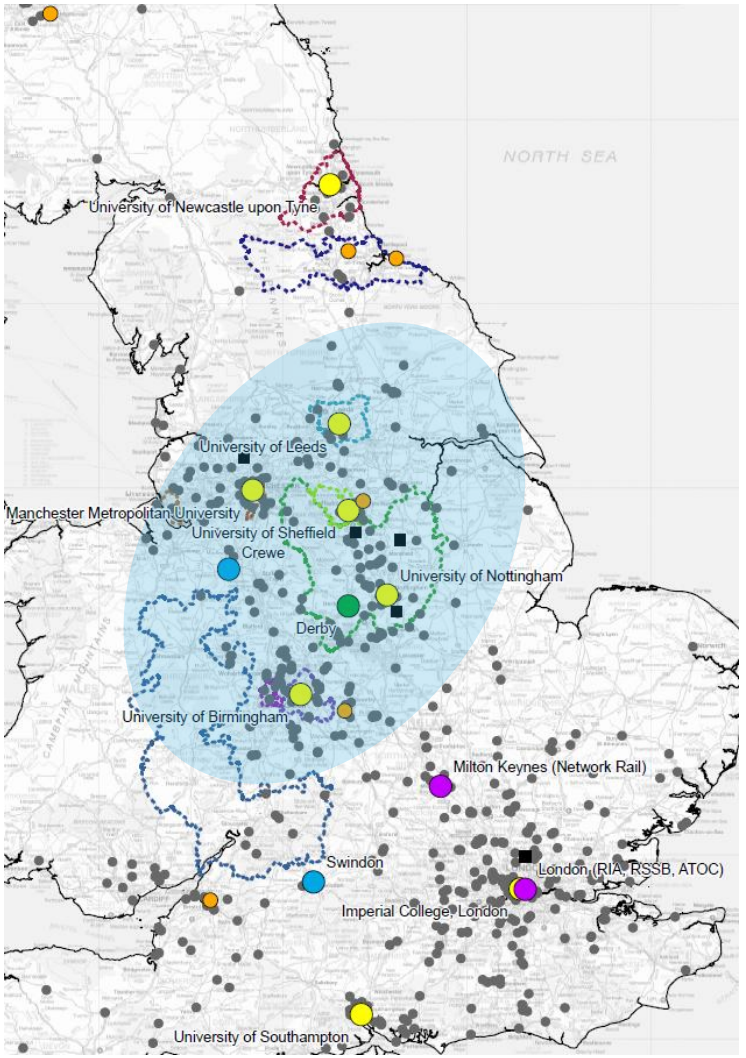
The Midlands and Yorkshire provide a base of universities and supplier activity in rail, providing an opportunity to generate mutually reinforcing relationships that can drive innovation

There is a need for a built centre for the TIC. This provides a place where collaboration can occur. Locating centres of excellence around clusters of existing innovative activities in cities or regions can be highly beneficial, as proximity to universities and businesses can generate mutually reinforcing relationships. For rail in particular, clusters of activities include:

- Rail Industry Suppliers: Modern Railways (2011 Update) identified over 700 suppliers to the railway industry. Postcodes of these suppliers have been mapped out on the adjacent diagram.
- High Value Manufacturing TIC: High performing centres for manufacturing are located in Rotherham, Coventry, Strathclyde, Sedgefield, Redcar and Bristol.
- Test tracks: Test tracks (excluding Heritage Railway test tracks) include the Old Dalby Test Track, Barrow Hill Test Facilities, Hertford Loop Line, High Marnham test track and East Lancashire Railway Company Test Track.

The adjacent map, highlights the presence of significant business and academic activity around the Midlands and Yorkshire. Depending on the profile of clusters for the other transport modes, consideration should be made for locating the TIC in this area.

Derby presents a potential opportunity as it is the location of Rolls Royce and Toyota (based in the outskirts of the city). Derby is also notable as a traditional centre of UK rolling stock manufacturing; Bombardier's recent move towards closure of its site there may present an opportunity for a TIC to capitalise on an existing and available skills and knowledge base.



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