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www.smartrail.net.au
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Approval to undertake this research project has been given by the Human Ethics Advisory Group (HEAG), Faculty of Science, Engineering & Built Environment, Deakin University.
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FOREWORD

With the technological revolution surging around the globe, businesses need to ensure they are in the best position possible to maximise the benefits and opportunities afforded by new and emerging technologies. Inherent in this is understanding the risks and obstacles that are likely to emerge in the context of a changing technological paradigm.

No-where is this more evident than in rail, which is undergoing significant change. This includes changes to how we move customers and freight in an ever-increasing online environment, how we move trains safely and efficiently around the network, and how we modernise the management of rail assets.

Forthcoming opportunities are evident with the Australian government investing significant resources to support passenger and freight growing tasks in cities and regional areas. Yet, the rail industry is confronted with overcoming both historical and new challenges. Smart Rail attempts to set a framework to address the historic and future challenges in a holistic and integrated manner.

The long-term common view of priorities, themes, timelines and actions embodied by Smart Rail show a commitment to ensure the Australian and New Zealand rail industry does more to prepare for change and improve its ability to adopt, deploy and keep pace with telecommunication and information-based technologies.

The Smart Rail Route Map represents a much-needed answer to industry requirements in relation to standardisation, integration and harmonisation and it has been fantastic to witness the high level of industry engagement and interest in the development of this framework.

The ARA Board supports the Smart Rail project. I am pleased to be part of this exciting initiative and look forward to seeing how the bigger picture and the Deakin University systems thinking approach to rail technology shaping the Smart Rail strategic framework can help us achieve valuable outcomes for the rail and broader transport industry, as well as the communities and businesses we serve.

Danny Broad  
Chief Executive Officer  
Australasian Railway Association
The Smart Rail Route Map is a 30-year technology neutral framework, communicated in a non-technical manner and owned by industry. This framework defines the rail industry direction, development initiatives and research programs for integration and support of next-generation digital and telecommunications technologies in the Australian and New Zealand rail environment.

Led by the Australasian Railway Association (ARA), the Rail Manufacturing CRC (RM CRC) and supported by Deakin University, the Route Map is being developed in the context of emerging opportunities through the rapid advancement in technology, increasing investment in infrastructure, growing passenger and freight service demand and changing customer expectations.

The Smart Rail Route Map aims to transition the rail sector towards systems that are flexible, connected, interoperable and using relevant information to deliver cross-industry benefits, including:

- safer operations
- improved reliability
- opportunities for greater innovation
- reduced costs through efficiencies, automation and technology selection.

Four Focus Areas were considered by industry to be most likely impacted by the introduction of new technologies, namely:

- Passenger Customer Experience (PCE)
- Freight Customer Experience (FCE)
- Traffic & Network Management (T&NM)
- High Performing Railways (HPR).
The four focus areas provided common reference points for discussions and helped define the key elements in the development process, including high level goals, objectives, initiatives and actions. The high-level goals and focus area objectives were used to set the aims for the industry in 30 years, whilst the initiatives and action items are the mechanism for achieving the goals and objectives.

The prioritised initiatives have been selected based on their ability to firstly meet the highest rated focus area objectives, as well as their ability to influence several industry wide goals.

The key outcome of the Route Map has been the development of a series of initiatives and action items that will enable the smarter integration of new technology into the existing and future rail networks, rolling stock and operational centres.

Outcomes

The ARA board is in the process of establishing an executive committee to guide the long-term implementation of the Smart Rail Route Map.

The four focus areas in combination with a systems’ modelling approach, facilitated by Deakin University’s Institute for Intelligent Systems Research and Innovation (IISRI), shaped the industry engagement and developed the definition of the following Route Map elements:

- **Industry Vision for Technology**
  
  - [Page 11]

- **Short-term Outlook** — top ten initiatives for short term commencement
  
  - [Pages 13, 14 and 16-54]

- **Long-term Outlook** — top 12 initiatives for longer term commencement
  
  - [Pages 13 and 14]

In addition, key relationships to other rail and transport industry initiatives were identified, including:

- National Freight and Supply Chain Strategy Progress Report
- i-TRACE program, implementing asset and asset component traceability from 2019 onwards, as a collaboration between GS1 and the ARA
- On Track to 2040 – 2nd priority area (Monitoring and Management)
- ACRI’s research on human factors of technology implementation
- ITS intelligent transport system methodologies.

Conclusions

- **Customer centric approach**
  
  The ongoing development of a customer centric focus will be crucial to both freight and public transit networks. Customer expectations will be central in the context of both passenger and freight sectors, which requires the rail sector to be interconnected with these broader transport networks. This applies both in the physical and virtual networks that current and future rail systems will be part of.

- **Collaboration**
  
  Collaboration is critical to ensure there is a shared industry approach to putting in place the strategies to manage the effects of change. The success of the Smart Rail project is intrinsically linked with the rail industry’s ability to collaborate going forward. The ARA will provide the collaborative leadership, but strong industry buy-in is also required. Socialisation and collaboration is also required where initiatives are linked to broader transport industry and government activities.

- **Change management**
  
  The technology strategy must systematically consider human and operational work practices in its adoption. Without proactive change management policies, the adoption and implementation of modern technology systems may not meet its full potential.
Recommendations

**People, skills and competencies**

There is a need to increase the skills and competencies of the existing workforce, with regards to the new technology disciplines and develop the workplace to attract new entrants into the industry.

**Innovation and the rate of change**

The industry requires work practices that are supportive of rapid changes in technology and greater levels of innovation, while maintaining safety outcomes.

**Global technology standards**

It is vital that the rail sector broadens its outlook and keeps up with global standard technology to remain competitive. In an increasingly customer-centric transport sector, the flow-on effects of using outdated technology will constrain the industry significantly. By using global standard technology, the deployment of ‘smart tech’ will deliver an improved customer experience, better reliability and higher efficiency, while reducing the overall cost of technology.

**Data and Information management**

Well managed data will be the key enabler for a smarter rail network. Data, however, does not provide significant improvement without the development of useful analytics tools, relevant information frameworks and knowledge discovery techniques. The data-information-knowledge nexus, within a transport context, is the key technology development for future smart rail networks.

The initiatives and action items detailed in this report deliver the framework for change over the next five to ten years. As such, this report is the start of the undertaking for significant change within the rail industry and will require program management to overcome inertia and maintain momentum. Program oversight will be implemented through the formation of a high-level executive committee to manage and prioritise the range of initiatives, actions and projects for future implementation.

New or existing working groups and industry champions should be assigned to each initiative for analysis of the current industry situation and to develop more accurate timelines during execution.

Reviews of the initiative and action items for the route map on a five-yearly basis.

The continuation of the prioritisation methodology, systems modelling approach for decision making and a diverse mix of individuals per group is recommended.
WHO SHOULD BE INVOLVED?
- Customers
- Gov. and public transport authorities
- Rail infrastructure
- Rail network operators
- Rail industry supply chain
- R&D

WHO WAS INVOLVED?
- Gov. and public transport authorities
- Rail infrastructure
- Rail network operators
- Rail industry supply chain
- R&D

REALISATION | 2050 VISION
Realise an industry vision for a world class rail industry, supporting a liveable and sustainable society, through next-generation digital and telecommunications technologies.

START | Why a 30 year industry Route Map?
To help industry meet society expectations from the entire transport system

Technology change needs collaboration, innovation and know-how
Digital transformation will address evolving customer and business expectations

Outcomes of the 2016 Telecommunications and Technology Forum (TTF)

INDUSTRY CONSULTATION
Workshops, group and individual discussions

SMART RAIL MESSAGES
> Think customer
> Move faster, adapt and innovate
> Proactively manage technological change
> Collaborate to remain competitive
> Upskill and master to thrive
> Align with global standards
> Use data to inform & perform

TRACKING
Review progress every 5 years

IMPLEMENTATION
> Activate working groups and project management functions
> Implement selected initiatives

2019

PHASE 1 | Development
30 YEARS PASSENGER AND FREIGHT OUTLOOK

DIRECTION
> Vision, goals and objectives
> Prioritised initiatives

START | PHASE 2
Implementation

START | PHASE 1 | PHASE 2
2018 | 2019 | 2050

2018

30+ YEARS

2019

INTERIM REPORT
Introduc tion

Smart Rail reflects the rail industry’s shared desire to identify a long-term vision for technology in the rail sector through the establishment of a common view of priorities, themes, timelines and actions for the next 30 years. The aim of this Route Map is to provide a framework for integration and support of next-generation digital and telecommunications technologies.

These new technologies present the challenge of transforming how the rail industry will operate in the short to medium term, but also provide significant opportunities in improving customer experience, on-time deliveries for freight and operational safety, while providing a lower cost, more reliable and higher value service to customers.

A key lesson from other sectors undergoing digital or technological disruption is that change is inevitable for the transport sector, therefore the rail sector needs to prepare for change and be willing to adjust its structure, processes and work practices with the introduction of new technologies. The way of the future will be a highly connected and integrated transport sector, with significantly higher levels of automation and digitalisation. Innovation and new ways of building, operating and maintaining rail networks will be expected, improving the responsiveness and flexibility of future rail networks.

The Australian and New Zealand rail industry has historically been a significant investor in new technology and has adapted to numerous technology transitions in the past, but the upcoming transition will occur at a higher rate of change.

The industry must be prepared to adapt and upgrade technology at a much faster pace than it has previously. To achieve this, the Smart Rail Route Map described in this report develops the framework in which digital and communications-based technologies will help meet the challenge of the upcoming digital evolution.
Background

The Australasian Railway Association’s (ARA) National Telecommunications Committee instigated a forum to stimulate sharing and discussion on the numerous telecommunications and technology initiatives within the industry. An outcome from the first ARA Telecommunications and Technology Forum (TTF) in 2016 was the apparent industry wide interest in establishing a strategic direction for the Australian and New Zealand Rail Industry’s adoption and deployment of telecommunications and technology-based systems. To address this direction, the ARA introduced the ‘Smart Rail Route Map’.

The project has been led by the ARA and the Rail Manufacturing Cooperative Research Centre (RM CRC) and supported by the Institute for Intelligent Systems Research and Innovation (IISRI) at Deakin University. The Deakin University project team was engaged in 2018 to facilitate the development of the Route Map, using their knowledge of complex systems, modelling, data analytics and computational intelligence.

Development, engagement & relevant documents

Industry engagement was the core component employed during the development phase, with nine workshops and a series of individual and group discussions with industry representatives and future leaders. The aim of the engagement was to map strategic pathways to address key requirements and challenges for a competitive rail sector over the next 30 years, specifically relating to technology disruption and innovation.

To highlight these requirements across all sectors of rail, the Smart Rail Route Map draws its development primarily from capturing the voice of the industry, through consultation, and key industry documents including:

- Deloitte Access Economics Report
- The National Rail Industry Plan for the Benefit of Australia
- The Rural and Regional Affairs and Transport References Committee’s October 2017 report
- Inquiry into National Freight and Supply Chain Priorities
- The Rail Technical Strategy Capability Delivery Plan (CDP)
- On Track to 2040.

Prioritisation of technology & telecommunications initiatives

Focus areas

Four key focus areas were considered by industry representatives to be most likely impacted by the introduction of new technologies, namely: Passenger Customer Experience (PCE); Freight Customer Experience (FCE); Traffic and Network Management (T&NM); and High Performing Railways (HPR).

Prioritised initiatives

The focus areas, in combination with a system modelling approach, allowed for targeted identification of key elements, including high level goals, objectives, initiatives and actions.

The initiatives that would most likely maintain the competitiveness of the rail industry for the next 30 years were prioritised from a list of 21 specific goals and the 36 focus area objectives (annexes 1 and 2).
The prioritisation method permitted the design of a dynamic and adaptable Route Map encompassing both short and long-term elements that can be reviewed and adjusted periodically. These key elements include:

- **Industry Vision for Technology**
  
  Page 11

- **Short-term Outlook** – top ten initiatives for short term commencement
  
  Pages 13, 14 and 16-54

- **Long-term Outlook** – top 12 initiatives for longer term commencement
  
  Pages 13 and 14

The vision for technology is explained in the next section followed by a summary of both the short-term and long-term priority initiatives and concludes with a detailed description of the short-term initiatives and action items for implementation.

**Table 1, four focus areas**

<table>
<thead>
<tr>
<th>Focus areas</th>
<th>High level description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Customer Experience</td>
<td></td>
</tr>
</tbody>
</table>
  - Customised information services, where relevant information is communicated directly to customers  
  - Automated disruption management and communications  
  - Predictive journey planning, options for overcoming disruptions, choosing routes and modes based on preference |
| Freight Customer Experience  |  
  - End-to-end journey planning and replanning  
  - Supply chain collaboration (data and information)  
  - Options for more efficient and flexible network route planning  
  - Improvements for reliability of service and disruption management/recovery |
| Traffic and Network Management|  
  - Control systems that know where the trains are, and manage how they behave  
  - The ability to optimise for capacity, performance, cost, safety, reliability, energy, efficiency and carbon emissions in real time |
| High Performing Railways     |  
  - World class asset management  
  - Widespread predictive maintenance informed by remote monitoring systems that maximise reliability and availability at reduced cost  
  - Maintenance programming/techniques that minimise the impact on services |
Vision for Technology

A world class rail industry, supporting a liveable and sustainable society, through next-generation digital and telecommunications technologies.

The Australian and New Zealand rail industry will enable access to an optimised, intuitive and integrated physical and digital rail system that is connected across the rail network and other transport modes.

The successful implementation of digital and telecommunication technologies will support efficient, reliable and safe passenger and freight services that meet customers’ expectations and requirements.
30 YEARS OUTLOOK >>

Prioritised Initiatives

Figure 1 shows a 30-year framework timeline for ten shorter-term initiatives and 12 of the longer-term initiatives prioritised during the workshop consultation process. A five-year review timeframe is proposed, and whilst some of the short-term initiatives continue past the first review, they must begin in the short term to address issues of importance. Short-term initiatives are described in detail in this report, while the longer-term initiatives are listed for future refinement.

Short-term Outlook
Introduction and structure of prioritised initiatives for short term commencement

The top ten priority initiatives and a list of high-level actions to implement over the next 5-10 years are described in detail in this report from page 14 to 52. Each short-term initiative is described using the following structure:

1. Initiative vision and value
2. Key challenges in achieving the vision
3. Scope of work.

Systems mapping, using Deakin University’s STICKE platform, allowed the identification of key action clusters for each prioritised initiative, ultimately achieving a common structure for proposed actions around two major themes per initiative as per table 2.

The major initiative themes will often include subthemes to further group key actions and ideas.

Links between initiatives and to the broader transport industry

Note that themes and subthemes may be relevant to more than one prioritised short-term and/or longer-term industry initiative. Themes and subtheme action items may express the links to other initiatives or actions, to the broader transport industry, as well as government strategic and ongoing activities.

Long-term Outlook
Introduction of initiatives for longer-term commencement

A series of longer-term initiatives for the rail sector have also been identified through the consultation process. These include projects related to a long-term evaluation of threats and opportunities to the sector; as well as initiatives for moving the industry towards faster rates of change for technology and the associated operating practices such changes may encompass.

12 longer term initiatives are listed in this report, which have been prioritised in a similar manner to the shorter-term initiatives (figure 1, after the short-term initiatives). It is anticipated these items will be reviewed after five years.

The key technologies that are likely to be introduced in the next 5-10 years that will have significant impact on the design, installation, operation and maintenance of the rail network. It is anticipated that these technologies will improve customer service and experience, allowing for greater safety, while operating at higher levels of service and lower overall costs.

New technologies will require a shift in the skill-sets in the rail sector towards automation, data management, Artificial Intelligence (AI), Machine Learning (ML), stochastic modelling and knowledge discovery. Further to this, people management skills will move towards the interface between human and digital workspaces.

The changes likely to occur over the next ten years will have significant impact on the methods for managing the rail networks. Change management techniques will be required to enable the transition towards a more innovative and rapidly evolving workplace.

Table 2, initiative themed actions

1. Initiative vision and value
2. Key challenges in achieving the vision
3. Scope of work.
**30 YEARS OUTLOOK**

**SHORT TERM PRIORITIES & LONGER TERM INITIATIVES FOR REVISION**

**PRIORITISED INITIATIVES FOR SHORT-TERM COMMENCEMENT**

1. Disruption management for passenger rail
2. Customised information services for passenger rail
3. Predictive journey planning techniques for passenger rail
4. Real-time information for freight customers
5. Data sharing platform across the supply chain
6. Identify key data requirements for T&NM
7. AI and automation for system management
8. Management of technology legacy systems
9. Up skill the industry
10. Improve safety through advanced technology

**LONGER-TERM INITIATIVES**

11. Management plan for interconnected rail systems
12. Integration plan for TMS into other transport modes
13. Change management program for industry culture transition
14. Predictive information services
15. Automated disruption management
16. Multi-modal efficiency
17. Management plan for digital train control
18. Incentives for investment and productivity
19. Digital & communications technology upgrade strategy
20. Cyber-security
21. Customer centric framework
22. Strategic surveillance for future threats and opportunities

---

**FIGURE 1** 30-year framework timeline with estimated duration for ten short-term initiatives and 12 of the longer-term initiatives prioritised during the workshop consultation process.

---

**VISION FOR TECHNOLOGY AROUND FOUR FOCUS AREAS**

- **Passenger Customer Experience**
  - Safe, Streamlined
  - Value from data

- **Freight Customer Experience**
  - Cost effective
  - On-time delivery

- **Traffic & Network Management**
  - Optimised & Adaptable
  - Cultures

- **High Performing Railways**
  - Efficient & Reliable
This initiative is aimed at communicating effectively with customers during disruptions about alternative options that may be available for them, based on the information available at the time. The largest change in the near future will be the ability to communicate directly with customers affected via disruptions, rather than broadcast or information board notices. The overall aim is to move toward automated communication systems.

Automated communication systems will also enable effective communication flows between train control centres, operators and customer service personnel to achieve the best possible customer interaction outcomes during disruption times. These new communication systems will operate in parallel with existing broadcasting technologies, i.e. train and station announcements, information board messaging, text and app messaging to devices.

Faster decision making will be required to determine the cause and duration of disruptions, to enable customers better options for travel. This decision making will be supported with historical data, predictive analysis and where necessary modelling and machine learning techniques.

### Key challenges in achieving the vision

**Change management and industry work practices**

Developing the technologies for prevention and recovery can only occur if the key system communicators have all the information and data available. The dynamic between operations and customer service must be managed, such that information is provided to customers in a timely manner.

**Disruptions**

Disruptions can be caused by a variety of factors, including network degradation, rail operators’ faults, extreme weather, climate change, natural events, trespassers, medical emergencies, rolling stock breakdowns or other failure issues. A causal breakdown of the types of disruptions and methods to alleviate them will lead to improved reliability. While such analysis is not part of this initiative, there will be an ongoing review of the disruptions that can be mitigated through new digital technologies.

### Scope of work

*Figure 2* shows initiative 1’s linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into five subthemes:

1. Passenger data standards
2. Customised information service - Link i2
3. Journey planning - Link i3
4. Change management
5. Skills and training.

The further development of these ideas should be planned and qualified through relevant working groups.
Disruption management for passenger rail

**Starting Actions**

1.1 Align or establish i1 working group, expand action list based on i1 and Smart Rail vision and scope and establish project management function

1.2 Identify key stakeholders and formulate value proposition accordingly

**Initial outcomes**

1.3 Working group ownership of implementation plan and ready to execute

1.4 Industry engagement and government commitment

**Implementation**

2.1 Project controls

2.2 Project updates

2.3 Share lessons learnt

**Technology and Processes**

A. Passenger data standards
   - define data standards

B. Location and service information from customers

C. Customised information service
   - use custom info services to directly inform passengers - Link i2

D. Automated disruption communications

E. Journey planning
   - customised journey options during disruption - Link i3

F. Change management
   - program of customer-based communications

G. Skills and training
   - training for disruption-based communications

**People and Management**

- Define data standards for location and service information from customers
- Use custom info services to directly inform passengers
- Customise journey options during disruption
- Establish working group and project ownership
- Align with industry engagement and government commitment

**Timeline**

- 2019 - Jan
- Revision 1
- 2019 - Feb

**Additional themes and actions identified through revisions**
**Figure 2**, Initiative 1 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Initiative vision and value

The aim of this initiative is the development of information services directly to passenger customers. This involves a two-way communication between customers and organisations via three key activities:

- capturing customer requirements, feedback and data
- supporting the advancement of customer directed communications
- facilitating corporate alignment to customer requirements.

The design and development of customised information services, digital media and content strategies will support the delivery of reliable and relevant passenger information.

In the next five years, customers will expect convenient travel plans, along with the access to real-time information updates and predictive information services.

Sophisticated data analytics of evolving customer expectations and preferences will improve alignment of corporate goals and allow the identification of new information-based revenue opportunities.

Beyond the next five years, customised visual communications will be enhanced and integrated into next level gateways for customer engagement, such as augmented reality (AR) and virtual reality (VR).

Key challenges in achieving the vision

Demographic trends and customer data-information-knowledge nexus

Changing population and demographic characteristics are major drivers for both customer information services (i2) and journey planning (i3). In addition to population growth, demographic trends that require effective technological adaptation include:

- people moving to different suburbs and rural areas
- the increasingly tech savvy and aging population shifting communication to devices
- technologies to support millennials beyond the next ten years.

Segmentation analysis is key when designing relevant value-added propositions that consider different passenger types, how passengers interact with services and evolving passenger expectations.

Many rail operators in the sector have already performed significant work that can be leveraged nationally through knowledge sharing and lessons learnt platforms for customer experience. Such collaboration can only be achieved, however, through aligning strategies across the range of organisations involved with the initiative.

Value from data and commercial opportunities

The application of data analytics to customer expectations and preferences can assist in identifying commercial opportunities around the information and services that passengers are seeking as part of their journey.

Decisions need to be made on the best approach to managing data, whether a commitment to open data, allowing the marketplace to make decisions on journey planning, or a consolidated effort from state governments and organisations to build central journey planning tools.

Cyber-security and privacy risks

Value-added information is data rich and thus has risks associated with cybersecurity and privacy. These risks are rapidly evolving, impacting the management of data storage, information sharing and security provision.

Two areas of greatest risk for operators are, firstly the use and augmentation of customer data to achieve service innovation is often challenged by privacy legislation. Secondly, cloud-based computing services are changing rapidly and will form the basis of future data systems. These services must be managed effectively in terms of cyber-security and privacy risk.
Data standards related to passenger

Managing passenger expectations involves providing customers with journey times and options available, particularly during disruptions. Aligning the message to customers across different communication channels, while preserving Intellectual Property, is currently a significant challenge for the industry.

To update the way in which the communications are being channelled to customers, the industry needs to identify and manage the balance between privacy and open access and look at solutions from the marketplace, as well as centrally controlled industry developments. Agreement is required to define how information is to be shared, captured and used, as well as how data will be transferred and what data will be secured.

New cloud-based software organisations provide the capabilities to integrate information. Rail innovation is often challenged by the industry’s legacy systems and it will be wise to align with current technology and data providers, whilst maintaining flexibility around changing technology solutions for the future.

Scope of work

Figure 3 shows initiative 2's linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into eight subthemes:

1. Cyber-security
2. Passenger data frameworks or standards
3. Relevant real-time information services
4. Market-based solutions
5. Journey planning - Link i3
6. New technology applications
7. Customer-based service
8. New training programs.

The further development of these ideas should be planned and qualified through relevant working groups.
Customised information services for passenger rail

PCE Objectives
- Safety
- Streamlined
- Value from data

Initial outcomes
1.3 Working group ownership of implementation plan and ready to execute
1.4 Industry engagement and government commitment

Starting Actions
1.1 Align or establish i2 working group, expand action list based on i2 and Smart Rail vision and scope and establish project management function
1.2 Identify key stakeholders and formulate value proposition accordingly

Implementation
2.1 Project controls
2.2 Project updates
2.3 Share lessons learnt

Timeline

Initiative i2

1. Cyber-security
   A form dedicated working group
   B meet government requirements
   C balance privacy and security

2. Passenger data standards
   D define data standards
   E implement standard

3. Relevant, real-time passenger information
   F real-time information requirements
   G identify customer expectations & preferences
   H predictive services
   I determine value-added information services

4. Market-based solutions
   J develop framework for digital marketplace
   K allow markets to develop customer-based services

5. Journey planning
   L Develop automated travel plans - Link i3

6. New technology applications
   M develop AR technology apps for customers
   N develop VR technology apps for customers

7. Customer-based services
   O design program of digital customer interaction

8. New training programs
   P data-skill training
   Q human-digital interface training

Additional themes and actions identified through revisions
Figure 3. Initiative 2 key actions or initial ideas for development.
Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Predictive journey planning methods will compare planned and actualised journeys and provide passengers with journey listing options for current and future travel. The options must include updates for any service disruption and a range of travel options for customer choice. Improved understanding of the relationship between systems and customer interaction points will support a safe and streamlined service offer.

Access to a reliable, multimodal transport service, with last mile connections, will be enabled via the simplification of journey planning through automation. An enhanced customer feedback system will permit journey planning to meet the practicalities of journey undertaking. The predictive journey planning not only includes relevant information provision but maintaining a transport system where mode interconnections are timely, accessible and reliable.

Real-time information will be required for full integration of the predictive capability of the journey planning apps, tools and techniques, to account for variability in the transport network.

Holistic journey planning

Journey planning is a key requirement for an improved customer experience and should be discussed beyond the rail experience to include what customers expect from the entire journey.

Customer satisfaction outcomes are not only a function of the rail operator but also the government and the broader transport industry. Services are provided within the broader context of city or regional planning, including the management of land development and urban design, which play a key role in community cohesion. In short, when planning new developments, consider the access to public transit system for area liveability and amenity.

Cyber-security risk associated with journey planning

Cyber-security and privacy data risks associated via inadvertent information release through journey planning techniques are expected to be a significant cause of concern for customers. Effective barriers against breaches require constant improvement, monitoring and contingency plans. Also, effective privacy methods must be used to limit inappropriate access to personal customer data.

Journey undertaking

The combination to data analytics and customised information services will allow the comparison between journey planning and undertaking. The data-derived information will be a useful tool for driving collaboration between multi-mode providers and the integration of holistic journey undertaking.

Scope of work

Figure 4 shows initiative 3’s linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into five subthemes:

1. Data standards and passenger identifiers for predictive capability
2. Cyber security for customer privacy
3. Journey planning tools - Link 12
4. Journey plan validation
5. Change management.

The further development of these ideas should be planned and qualified through relevant working groups.
### PCE Objectives

- Safety
- Streamlined
- Value from data

### Initial outcomes

1.3 Working group ownership of implementation plan and ready to execute

1.4 Industry engagement and government commitment

### Predictive journey planning techniques for passenger rail

#### Starting Actions

1.1 Align or establish i3 working group, expand action list based on i3 and Smart Rail vision and scope and establish project management function

1.2 Identify key stakeholders and formulate value proposition accordingly

### Implementation

2.1 Project controls

2.2 Project updates

2.3 Share lessons learnt

### Technology and Processes

1. Data standards & passenger identifiers for predictive capability
   - A required journey planning options
   - B location and service information from customers
   - C validate security with open data standards

2. Cyber-security for customer privacy
   - D determine how to best inform customers of journey plans

3. Journey planning tools
   - E use custom info services to directly inform passengers - Link i2
   - F predictive services for journey planning
   - G personalised journey planning options

4. Journey plan validation
   - H collate customised journey information
   - I compare journey plan with actualised journey - Link K

5. Change management
   - J program of change for customer-based communications
   - K use data analytics to drive better multimode transport integration - Link I

### Additional themes and actions identified through revisions
Figure 4. Initiative 3 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Real-time information for freight customers

Initiative vision and value

The development of real-time information flows will enable freight customers the ability to secure the on-time delivery of goods and track their location in real-time, facilitated by the physical internet and the Internet of Things (IoT).

In the future, real-time information will enable a self-organising system, based on the information uploaded by relevant stakeholders. Leveraged from the current body of work available on end-to-end supply chain visibility across transport, an automated supply chain management process will define: who are the customers; suppliers; the expectations from the end to end journey; and what information is required to connect the different parties.

Links from freight forwarder websites to other partners in the supply chain will help communicate status, location and prevent goods from becoming lost during the journey, thus reducing the security risk and potential escalation to forensic investigation.

Goods will be available at the agreed, and increasingly faster, delivery times. Customers will be notified on the status of the consignment, will know when the freight will be available at the destination, or the intermodal hub, and will locate the goods with accuracy during the journey - especially if there are concerns with the delivery time.

Key challenges in achieving the vision

People and speed of technology adoption

Transport businesses are at different stages of maturity in their data management and will have different capabilities to handle and respond to changes due to adoption of data and information sharing.

The time taken for mass adoption could be long. Large companies own significant freight assets and will drive the requirements for data automation in the supply chain. However, there is a long tail of smaller operators, especially when it comes to the last mile - where smaller businesses are needed to deliver.

Scope of work

Figure 5 shows initiative 4’s linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into six subthemes:

1. Data sharing platform across the supply chain - i5 is a pre-requisite
2. Physical internet strategy
3. Customised delivery information
4. Disruption management & return to plan
5. Change management
6. People.

The further development of these ideas should be planned and qualified through relevant working groups.
## Initial outcomes

**1.3** Working group ownership of implementation plan and ready to execute

**1.4** Industry engagement and government commitment

---

### Starting Actions

**1.1** Align or establish i4 working group, expand action list based on i4 and Smart Rail vision and scope and establish project management function

**1.2** Identify key stakeholders and formulate value proposition accordingly

### Implementation

**2.1** Project controls

**2.2** Project updates

**2.3** Share lessons learnt

### FCE Objectives

- **Cost effective**
- **On-time delivery**

---

### Technology and Processes

**1. Data sharing platform across the supply chain.** i5 pre-requisite

- Information and data distribution across supply chain

**2. Physical internet strategy**

- An automated supply chain model to optimise service delivery based on required service level
- A standardised freight API linking the freight forwarder info site to other supply chain partners
- Communication integration strategies of unique identifiers for each consignment
- Consignment aggregation and disaggregation techniques

**3. Customised delivery information**

- Develop a customer-centric approach to communication
- Goods and location tracing linked to supply chain customers

**4. Disruption management & return to plan**

- Updated information during disruptions

**5. Change management**

- Integration with national freight strategy
- Data and information consistency across the supply chain
- Improve collaboration & information sharing

**6. People**

- Define skills and training required
- Career development strategies
- Improve speed of adoption of new tech

---

### Additional themes and actions identified through revisions

- Industry engagement and government commitment
- Working group ownership of implementation plan and ready to execute
- Cost effective on-time delivery
Figure 5. Initiative 4 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Data management

To determine the requirements for data storage, privacy, retrieval and transfer, agreement on a viable industry model must be achieved. The data storage model could be a de-centralised model, where each freight forwarder is responsible for data coordination, or a central and neutral body, responsible for the collection and sharing of data across the supply chain. Either way, the repository service should provide information focused on freight performance and consignment tracking.

A conversation between the various logistics and freight carrier industry associations with the ability to lobby political entities such as COAG or its transport committees is a suggested starting point. Priorities should be set as an industry to establish consistency among different associations in the transport sector.

The role of government may have to be adjusted and reviewed to stimulate change. There is a federal role to provide incentives and enforce requirements in terms of information hand over and reforming the current siloed system that breaks down at network boundaries. Having a framework that focuses more on incentives rather than further regulation could be a way to encourage both industry and governments to focus on the right reforms.

Data and information sharing and privacy

Setting the requirement for key information that protects the commercial confidentiality of suppliers and privacy of the customers is imperative to achieve well-integrated freight service outcomes.

Much of the above and below rail data is currently available but transport operators are reluctant to share information. The difficulty is the required collaboration from all parties and handing over the information at the boundaries between jurisdictions and between operators.

This situation limits the ability to guarantee delivery and security of goods. From the customer’s perspective, the freight forwarder is responsible for the delivery of goods across the supply chain. In the siloed driven transport environment, however, goods change hands from one provider to another, each to complete their individual tasks, and goods may often be lost through discrepancies at the service provider changeover.

Cyber-security

Threats that could put at risk the entire end to end freight network, or parts of it, could hinder the speed of technology adoption. This will increase the barriers in terms data sharing and diminish the ability to recover quickly from disruptions and retain system integrity.
Implementation of evolutionary cyber-security policies that balance privacy but allow open data protocols are needed not only to increase the protection against new and future threats, but also to maintain the confidence in new technology adoption.

People and data

The first key issue is the competency framework harmonisation, such that similar skills and competencies can be transferred across different jurisdictions within Australia and New Zealand. The general skills currently required are people skills in customer service, people management and interfacing between digital and real-world customers. The key technology skill requirements are communications technologies, data management, data analytics, predictive modelling, machine learning, deep learning and AI generally. These skill sets will be in high demand as digital disruptions gather pace beyond the rail sector and it is imperative that the rail sector provides a desirable workplace to attract new talent.

Further skill set requirements are general change management skills and methods for instilling an ethos of collaboration within the rail sector and across the broader freight transport sector.

Scope of work

Figure 6 shows initiative 5’s linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into six subthemes:

1. Data management
2. Real time information and consignment journey optimisation
3. On-time delivery
4. Cyber-security
5. Change management
6. People.

The further development of these ideas should be planned and qualified through relevant working groups.
1. Data management
   - alignment with global data standards for freight - Link F
   - collection of freight performance data
   - determine the best form of data storage, retrieval & transfer - Link K
   - protection of IP & other sensitivities
   - collection of customer and container-centric data

2. Real time information & consignment journey optimisation - Link i4
   - development of unique identifiers for each consignment - Link A

3. On-time delivery
   - goods and location tracking

4. Cyber-security
   - end to end system risks identification
   - end to end contingency & recovery plan

5. Change management
   - define data management model - Link C
   - integration with national freight strategy
   - leverage from current body of knowledge
   - establish consistency among the associations in the transport sector - Link O
   - data and information sharing collaboration along the supply chain - Link N
   - incentives to increase speed of technology adoption for data systems

6. People
   - define skills and training required
   - harmonise competency system
   - career development

Additional themes and actions identified through revisions
Figure 6. Initiative 5 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Identify key data requirements for Traffic and Network Management

Initiative vision and value

This initiative will define what information and knowledge can be developed from current and future data. It will also examine the potential opportunities and integration of cloud-based computing, analytics and other systems to enable automation of traffic and network management systems.

A well scoped, scaled and funded R&D project will provide high value outcomes via the understanding of how traffic management data and information will provide greater value to the business bottom line. The data will be used to monitor the health of the network, whilst the analytics will highlight the link between information, technology and business objectives.

The identification of key data will support the application of machine learning and progressing traffic management systems to become the central tool for bringing together all the aspects of other real-time systems that need to be coordinated on a regular basis.

Key challenges in achieving the vision

Skills and competencies

Improved decision making across the passenger and freight networks will require data and information processing, modelling, analytics and machine learning. There is a data analytics element in the future of traffic management systems and skills are needed to help industry visualise this future. Currently, these skill-sets are not common within the rail sector.

Change Management

Change management skills are required to transition towards automation and computer-based system control, employing humans with supervisory on-the-loop overview, which is described as part of the following initiative.

High value outcomes through R&D

Defining high value outcomes – how does an interconnected and automated network improve the bottom line for above and below rail operators, as well as improving customer service. Data frameworks don’t necessarily provide high value outcomes but provide the basis for automation and optimisation. Within this context, estimates of proposed performance improvement and value can be developed.

Scope of work

Figure 7 shows initiative 6’s linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into five subthemes:

1. Research and development
2. Data and information
3. Systems required
4. Change management
5. People.

The further development of these ideas should be planned and qualified through relevant working groups.
Identify key data requirements for T&NM

**T&NM Objectives**
- Automation

**Initial outcomes**
- **1.3** Working group ownership of implementation plan and ready to execute
- **1.4** Industry engagement and government commitment

**Starting Actions**
- **1.1** Align or establish i6 working group, expand action list based on i6 and Smart Rail vision and scope and establish project management function
- **1.2** Identify key stakeholders and formulate value proposition accordingly

**Implementation**
- **2.1** Project controls
- **2.2** Project updates
- **2.3** Share lessons learnt

**1. Research and development**
- Establish R&D project

**2. Data and information**
- Traffic management data collection and collation - Link B
- Identification and mining other key data
- Value creation from data
- Potential opportunities created from data

**3. Systems required**
- Cloud based systems
- Reporting systems

**4. Change management**
- Program to implement new network management
- Human-on-the-loop automation

**5. People**
- Design new network management programs
- Additional themes and actions identified through revisions

**Timeline**
- 2019 - Jan
- 2019 - Feb

**Revision 1**
Figure 7. Initiative 6 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Future systems will operate automatically through machine learning and algorithms that intervene, perform repetitive tasks and increase the level of control over the system management. Complex systems will be simplified through automation, balancing capacity and flexibility, while humans will maintain supervisory control of technology.

After having identified the key data requirements for traffic and network management (initiative 6), accelerating the application of machine learning will be achieved through an industry agreement for a standard data exchange and formatting.

An industry development platform will monitor where the industry is heading with regards to automation, why the direction is important and the priority tasks, helping the workforce visualise the opportunities and potential pathways to the future. This platform will generate the change management process required around leadership, behaviour, reskilling and repurposing of competencies.

### Initiative vision and value

Traffic management systems have always been managed with a human in the loop control philosophy and evolved as technology improved. Releasing control to machine learning and optimisation algorithms will have an impact on human factors.

New systems and practices will need to be developed to manage how the system will operate and where humans may need to intervene.

Mitigating potential transitional issues will require the development of change management programs based on the transition of traffic management from conflict resolution, find possible solutions, to predictability, i.e. what will happen in the near future.

### Key challenges in achieving the vision

#### People and skills

Skills and requirements for optimisation and AI/ML will be in high demand in the short to medium term, such that the rail industry requires a recruitment plan for highly-skilled professionals.

#### Change Management

Traffic management systems have always been managed with a human in the loop control philosophy and evolved as technology improved. Releasing control to machine learning and optimisation algorithms will have an impact on human factors.

New systems and practices will need to be developed to manage how the system will operate and where humans may need to intervene.

Mitigating potential transitional issues will require the development of change management programs based on the transition of traffic management from conflict resolution, find possible solutions, to predictability, i.e. what will happen in the near future.

### Development of R&D project

Data analytics in conjunction with the data framework developed in the previous initiative, will determine where greatest value for automation and network optimisation can be attained. From the previous initiative, the best optimisation and AI techniques would be tested to improve the overall system performance, based on the balance between capacity, safety, reliability and costs.

### Scope of work

Figure 8 shows initiative 7’s linked initiatives and action items for development and direction captured during industry engagement. These have been grouped into six subthemes:

1. Data requirements for traffic and network management automation - Link i6 & i8
2. Complex systems automation
3. Standards
4. High value outcomes through R&D
5. Change management
6. People.

The further development of these ideas should be planned and qualified through relevant working groups.
AI & automation for system management

T&NM Objectives
- Automation

Starting Actions

1.1 Align or establish i7 working group, expand action list based on i7 and Smart Rail vision and scope and establish project management function

1.2 Identify key stakeholders and formulate value proposition accordingly

Initial outcomes

1.3 Working group ownership of implementation plan and ready to execute

1.4 Industry engagement and government commitment

Implementation

2.1 Project controls

2.2 Project updates

2.3 Share lessons learnt

1. Data requirements for T&NM automation
   - Identify key data required for T&NM
   - Link i6

2. Complex systems automation
   - Standard data exchange and formatting to accelerate the application of machine learning
   - Link i8

3. Standards
   - Machine learning self-organising system

4. Complex systems automation
   - Industry agreement and adoption of a global approach for a standard data exchange and formatting

5. Change management
   - Industry agreement and adoption of a global approach for a standard data exchange and formatting

6. People
   - Develop change management program with regards to the transition of traffic management from conflict resolution to predictability

Additional themes and actions identified through revisions

- Link i6
- Link i7
Figure 8, Initiative 7 key actions or initial ideas for development.
Timeline provides commencement times for key actions arising through industry consultation.
Symbol for linked actions, themes or initiatives.
A new model for traffic management, especially a holistic network optimisation, will reflect the significant difference between the existing traffic planning and the operations of a digital railway in the next 20 years. This standard will be informed by high-value data for Traffic and Network management identified through initiative 6 and research into traffic management technologies containing significant legacy systems. Information and knowledge will be developed from data and exploration in other areas capable of stimulating new ideas, including:

- drones
- automated vehicles
- packages wrapping themselves through the network
- cloud-based computing, analytics and reporting.

Risk Mitigation

One of the key issues is the upgrading of new technology into legacy systems without improving the operational processes that go along with said systems. The larger the number of different systems in practice, the greater the risk of equipment break-downs, operational conflicts and safety related incidents.

Integration of signalling systems

The integration of legacy and newer signalling systems must be managed to account for the differences in the system performance and operational practices, as well as interoperability.

Greenfield over existing infrastructure

New assets should be designed with newer technology, but the problem remains around integration of older legacy systems with up-to-date technologies. The development of standards and processes to do this would greatly speed up the adoption of newer technology and allow higher operational efficiencies.

Standards transition

Maintaining standards that cover all current and legacy systems, makes it difficult to manage the standards compliance for safety critical systems.
The standards systems must transition to the new technology systems as a priority.

**Effective business cases**

The use of data analytics *(initiative 6)* and a move towards automation systems *(initiative 7)* should be undertaken based on sound business models and good commercial practice. The development of the planning for technology redundancy is integral to development of new technologies with short lifecycles. This challenge is connected to the overall asset management strategy for the rail networks.

**Skills, training and competencies**

Training is required on new technology: design, installation and operation of the new systems. The implementation of new training systems must be developed with collaboration between network operators, suppliers and other key stakeholders.

**Change management**

The key areas for improving the management of legacy systems are, adopting where possible global and standards for faster uptake of technology systems, don't look for bespoke solutions. Planning for technology redundancy during the project design phase, so upgrades in technology can be implemented quickly across a larger part of the network.

**Scope of work**

*Figure 9* shows initiative 8's linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into six subthemes:

1. Digital railway and train control - Link i6
2. Interoperability
3. R&D
4. Business case for transition
5. Change management
6. People - Link i7, i9 & i10.

The further development of these ideas should be planned and qualified through relevant working groups.
1. Digital railway and train control
   - identify key data application for T&NM related to legacy systems - Link 16
   - develop a flexible standard for traffic management, especially data interchange between operators
   - progress T&NM to a role of train service optimisation
   - program to manage the choice, design and roll-out of the appropriate digital train control (DTC) system for each of the network providers (CBTC, LTE, ATMS, ETCS)

2. Interoperability
   - produce a consistent method for system boundary handover (API’s, process & data interchange) to manage the interoperability between different train control systems

3. R&D
   - need for technology change and how this will affect the industry
   - exploration in other areas worthy of study for integration in rail, including: drones, automated vehicles, packages wrapping themselves through the network, cloud-based computing, analytics and reporting

4. Business case for transition
   - the development of business cases for the need for change not just at the end of lifecycle for major assets
   - apply commercial models for both passenger and freight rail operators

5. Change management
   - implement new commercial models
   - improved arrangements for public/private partnerships and other companies involved with the rail supply chain
   - integration of the whole supply chain physical and digital processes
   - develop change management plans to integrate the new DTC with existing and legacy systems of train controls
   - employ change management tools during the transition in the system roll-outs, including the use of human factors expertise, to successfully achieve a significant shift in industry

6. People - Link 19 & 110
   - industry work practices, AI and Automation - Link 17
   - incentives for innovation

Additional themes and actions identified through revisions
Figure 9. Initiative 8 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
Harmonisation

There are difficulties in workforce planning and development within Australasia, due to the limited pool of skilled workers. Uniformity around common competencies and accreditation is a significant issue for the industry, such that workers can move seamlessly from one jurisdiction to another. This requires the harmonisation of standards and regulatory structures across different jurisdictions, including potentially the new skill-sets around digital, communications and automation technologies and systems.

Attracting talent

Finding people and training organisations that offer the right skills for innovative and forward-thinking projects, requires new entrants to adapt to the unique characteristics of the railway environment. Competing for skills that will be in high demand across many other sectors will require streamlining the rail industry conversion barriers that make the rail workforce environment different to other sectors. This will help attract highly skilled professionals to the industry.

Figure 10 shows initiative 9's linked initiatives and action items for development captured during industry engagement. The initiatives and actions have been grouped into four subthemes:

1. Training programs - Link i10
2. Competing for skills in high demand
3. Change management
4. People - Link i7, i8 & i10.

The further development of these ideas should be planned and qualified through relevant working groups.
### People and Management

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>i9</td>
<td>Up skill the industry</td>
</tr>
</tbody>
</table>

#### 1. Training programs
- align or establish i9 working group, expand action list based on i9 and Smart Rail vision and scope and establish project management function

#### 2. Competing for skills in high demand
- reducing barriers for new entrants
- programs for attracting talent

#### 3. Change management
- workforce planning and development as a nation
- uniformity around common competencies and accreditation
- collaboration programs across the industry, government, academia and other transport sectors
- develop incentives for innovation

#### 4. People
- systems change, AI and Automation - Link 17
- diversity program including age and gender mix - Link 18 & 110

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**Initial outcomes**

| 1.3 | Working group ownership of implementation plan and ready to execute |
| 1.4 | Industry engagement and government commitment |
Figure 10 Initiative 9 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
**Initiative vision and value**

Advanced technology dedicated to the monitoring and management of critical systems will be implemented to provide a greater level control and oversight of the myriad rail networks. This will enable a future with lower safety incidents and ensure improved reliability of passenger and freight services. Greater efficiency will be achieved, while continuing to provide the current or improved level of safety benefits to society.

Safety will be improved through the convergence of maintenance and operations, achieving self-healing networks that can bridge the gap for optimum running. These networks will balance the need to improve service reliability based on increased demand, whilst reducing asset degradation. New technology systems that facilitate early detection of safety threats and provide a timely response, will be in place for the monitoring of operational safety and business critical components.

Future high performing rail networks must provide greater accessibility and safety to the end user. Methods for better human safety through technology will be implemented, including better use of multi-modal hubs and using digital technologies/ AI to develop dynamic and flexible services such that safety is improved from the first to the last mile of journey.

**Key challenges in achieving the vision**

**Harmonisation and regulation**

Productivity and innovation are inhibited by the different regulatory structures in relation to safety and standards across jurisdiction with transformative rail projects.

Achieving balance and success in the adoption process for the harmonisation of equipment, product design, standards, procurement practices and safety performance, while providing innovation incentives, will enable efficiency to advance at a rapid pace in rail. *Ref: deloitte p62, Senate report*

**Change management**

Recognition is needed for the dependency on the technology systems, to better manage infrastructure and rolling stock, and that technology itself needs to be better managed and balanced in relation to safety. A secondary system is required to manage the technology-based systems.

**Scope of work**

*Figure 11 shows initiative 10’s linked initiatives and action items for development captured during industry engagement. These have been grouped into five subthemes:*

1. Legacy issues - Link i8
2. Critical systems - Link i9
3. Maintenance and operations
4. Change management
5. People - Link i8 & i9.

The further development of these ideas should be planned and qualified through relevant working groups.
### Improve safety through advanced technology

#### Initial outcomes

1. **1.3 Working group ownership of implementation plan and ready to execute**

2. **1.4 Industry engagement and government commitment**

#### Starting Actions

1. **1.1 Align or establish i10 working group, expand action list based on i10 and Smart Rail vision and scope and establish project management function**

2. **1.2 Identify key stakeholders and formulate value proposition accordingly**

#### Implementation

1. **2.1 Project controls**

2. **2.2 Project updates**

3. **2.3 Share lessons learnt**

#### Timeline

- **2019 - Jan**
- **Revision 1 2019 - Feb**

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### People and Management

#### HPR Objectives

- **Reliability**

### Technology and Processes

1. **1. Legacy Issues - Link i8**
   - Establish a business case to develop incentives for harmonisation, to reduce inefficiencies related to non-mandatory safety standards

2. **2. Critical systems**
   - Implementation of i-TRACE for assets and asset component traceability - Link i-TRACE
   - Build capabilities in data storage and transfer
   - Build capabilities in data analytics, information and knowledge development - Link i9

3. **3. Maintenance and operations**
   - Requirements for operation and maintenance, and balance the need to improve service reliability based on changes in demand and expectations
   - Develop self-healing networks that can bridge the gap for optimum running and prevent degradation

4. **4. Change management**
   - Technology solutions for reduction of inefficiencies in safety standards
   - Cross network decision making alignment with the Rural and Regional Affairs and Transport References Committee recommendation 4 for the development of a National Rail Procurement Strategy

5. **5. People**
   - Upgrade safety standards based on new and proposed technology
   - Diversity program including age and gender mix - Link i8 & i9

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Additional themes and actions identified through revisions
Initiative 10 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.

---

**Figure 11** Initiative 10 key actions or initial ideas for development.

Timeline provides commencement times for key actions arising through industry consultation.

Symbol for linked actions, themes or initiatives.
ANNEXE

Annexe 1. Goals, Objectives and Initiatives
Annexe 2. Reach versus importance scatter plot
Annexe 3. Methodology
Goals, Objectives and Initiatives
SMART RAIL Route Map Development

Below is a series of Goals, Focus Area Objectives and Initiatives for the next 30 years from which the Smart Rail programs will be developed.

Smart Rail Route Map – Industry Goals

<table>
<thead>
<tr>
<th>OUTCOMES</th>
<th>GOAL No.</th>
<th>RAIL INDUSTRY GOALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td>G1.1</td>
<td>To reduce costs for passenger and freight transit, while maintaining an optimal balance of the safety, security, capacity and service requirements across each of the main railway networks</td>
</tr>
<tr>
<td></td>
<td>G1.2</td>
<td>To increase revenue from higher frequency and value-added services, through technology use</td>
</tr>
<tr>
<td></td>
<td>G1.3</td>
<td>To increase the market share of passenger and freight transport services, using new technology</td>
</tr>
<tr>
<td>Customer Experience and Expectations</td>
<td>G2.1</td>
<td>Freight: To ensure rail becomes the preferred transport mode for long-distance freight by achieving a fast, reliable, secure, efficient and cost-effective freight service</td>
</tr>
<tr>
<td></td>
<td>G2.2</td>
<td>Passenger: To make rail the preferred mode for mass transit in cities and regional travel by increasing customer satisfaction in journey experience</td>
</tr>
<tr>
<td>Efficiency</td>
<td>G3.1</td>
<td>To establish a self-organising system capable of performing high quality maintenance whilst maintaining high operational efficiencies, using new technologies</td>
</tr>
<tr>
<td></td>
<td>G3.2</td>
<td>To improve economies of scale, whilst improving interoperability and harmonisation, through technology use</td>
</tr>
<tr>
<td>Talent and retention</td>
<td>G4.1</td>
<td>To access the required pool of technology-based skills for the future and to make rail an attractive technology-based career option</td>
</tr>
<tr>
<td>Social and environmental value</td>
<td>G5.1</td>
<td>To make rail a more inclusive environment</td>
</tr>
<tr>
<td></td>
<td>G5.2</td>
<td>To achieve viable energy efficiency outcomes and CO2 reductions through design and technology implementation</td>
</tr>
<tr>
<td>Safety</td>
<td>G6.1</td>
<td>To decrease safety incidents and injuries for both employees and customers via new technology</td>
</tr>
<tr>
<td>Capacity</td>
<td>G7.1</td>
<td>To ensure the capability to support the doubling of passenger and freight journey undertakings, through technology use</td>
</tr>
<tr>
<td>Innovation</td>
<td>G8.1</td>
<td>To identify, analyse, develop, implement and market viable business cases for technology opportunities in the Australian rail sector and encourage knowledge transfer to/from other industries</td>
</tr>
<tr>
<td></td>
<td>G8.2</td>
<td>To develop an industry that has the agility to evolve and respond to changing markets and technology</td>
</tr>
<tr>
<td>Key Performance Measures</td>
<td>G9.1</td>
<td>To increase on-time deliveries for freight, through new technology use</td>
</tr>
<tr>
<td></td>
<td>G9.2</td>
<td>To decrease overall travel duration for passenger and freight services, using technology</td>
</tr>
<tr>
<td></td>
<td>G9.3</td>
<td>To decrease the number and duration of service interruptions, through technology use</td>
</tr>
<tr>
<td></td>
<td>G9.4</td>
<td>To increase service availability for both passenger and freight services through use of technology</td>
</tr>
<tr>
<td>Industry structure and management</td>
<td>G10.1</td>
<td>To promote a national approach and establish a common set of priorities around three focus areas: High Performing Railways, Traffic Network and Management, Passenger and Freight Customer Experience</td>
</tr>
<tr>
<td></td>
<td>G10.2</td>
<td>To effectively manage change and transition of the new technology implementation</td>
</tr>
<tr>
<td></td>
<td>G10.3</td>
<td>To improve the industry model and develop industry, state and federal government collaboration to ensure successful growth and technological innovation.</td>
</tr>
</tbody>
</table>
Focus Area Objectives and Initiatives

1. Passenger Customer Experience

Focus Area Objectives

<table>
<thead>
<tr>
<th>Related Industry Goals</th>
<th>Objective No.</th>
<th>Passenger Customer Experience – HIGH LEVEL OBJECTIVES</th>
</tr>
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<tbody>
<tr>
<td>G1.1, G2.2</td>
<td>o1.1</td>
<td>To provide value for money through high asset utilisation and efficient service provision</td>
</tr>
<tr>
<td>G1.3 G2.2, G9.4</td>
<td>o1.2</td>
<td>Increase passenger comfort through the reduction in overcrowding and carriage monitoring</td>
</tr>
<tr>
<td>G2.2, G9.2 G9.3</td>
<td>o1.3</td>
<td>To reduce the overall journey time for both the rail and wider transport network (modal interchanges)</td>
</tr>
<tr>
<td>G2.2, G6.1</td>
<td>o1.4</td>
<td>To maintain and improve passenger safety through higher automation levels and improved passenger monitoring</td>
</tr>
<tr>
<td>G2.2, G9.3</td>
<td>o1.5</td>
<td>To provide access to reliable, end to end and well interconnected multimode transport services (last mile connections)</td>
</tr>
<tr>
<td>G2.2</td>
<td>o1.6</td>
<td>To improve convenience through payment systems for passengers across the whole of journey undertaking, with the overall goal to implement invisible ticketing</td>
</tr>
<tr>
<td>G2.2, G4.1</td>
<td>o1.7</td>
<td>To develop and maintain the skills to effectively manage customer interaction points, customer service and data analytics</td>
</tr>
<tr>
<td>G1.2, G1.3, G2.2, G8.1</td>
<td>o1.8</td>
<td>To improve the service offering through a better understanding of the data, information and knowledge nexus, while maintaining cyber security</td>
</tr>
<tr>
<td>G2.2</td>
<td>o1.9</td>
<td>To develop accessibility programs for disadvantaged groups, through a host of physical and information programs</td>
</tr>
</tbody>
</table>

Focus Area Initiatives and Actions to support objectives

<table>
<thead>
<tr>
<th>ITEM No.</th>
<th>Passenger Customer Experience – INITIATIVES AND ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i1.1</td>
<td>Customer experience – Data and Information</td>
</tr>
<tr>
<td>i1.1A</td>
<td>Rail industry data standard related to passengers</td>
</tr>
<tr>
<td></td>
<td>To set up an industry data framework related to passenger customers, including:</td>
</tr>
<tr>
<td>i1.1A1</td>
<td>a data sharing interchange for journey planning extending upon GTFS and GTFS-RT</td>
</tr>
<tr>
<td>i1.1B</td>
<td>Customised information services</td>
</tr>
<tr>
<td></td>
<td>To design and develop customised information services, digital media and content strategies, including:</td>
</tr>
<tr>
<td>i1.1B1</td>
<td>define and capture the data around customer expectations and preferences</td>
</tr>
<tr>
<td>i1.1B2</td>
<td>predictive services</td>
</tr>
<tr>
<td>i1.1B3</td>
<td>automated travel plans</td>
</tr>
<tr>
<td>i1.1B4</td>
<td>apps, websites and social media information</td>
</tr>
<tr>
<td>i1.1B5</td>
<td>relevant, customised, real-time passenger information</td>
</tr>
<tr>
<td>i1.1B6</td>
<td>open and accessible data standards for data interchange (non-proprietary)</td>
</tr>
<tr>
<td>i1.1B7</td>
<td>look at solutions from the marketplace rather than government developed</td>
</tr>
</tbody>
</table>
i1.1B8 identify and manage the balance between privacy and open access
i1.1B9 VR and AR customer information visualisation and customer engagement
i1.1B10 Lesson learnt techniques and other information services imported from other sectors, e.g. aviation
i1.1B11 further value-added customer information leading to higher revenues

1.1C Develop accessibility programs
To develop accessibility physical and information programs, including:
1.1C1 wayfinding
1.1C2 augmented reality
1.1C3 micro-navigation
1.1C4 hearing-impaired information direct to phones
1.1C5 sight impaired voices to phone

1.1D Enhance cyber security
To control cyber security issues arising from transport automation and cloud-based computing. Activities include:
1.1D1 enhancing cyber security in conjunction with open data standards
1.1D2 ensuring cyber security requirements meet state and federal government requirements

1.1E Increase passenger comfort
To improve passenger comfort, depending upon length of travel; regional, heavy rail, metro, light rail:
1.1E1 increase in capacity leading to higher service frequency
1.1E2 information on seating availability
1.1E3 monitoring systems for carriage conditions
1.1E4 Real-time cabin loading and smart car parking availability

1.2 Journey planning
1.2A Predictive journey planning techniques
To implement predictive journey planning techniques, including:
1.2A1 journey listing options for current and future travel, including updates for any service disruptions
1.2A2 Include data augmentation from smart cards and other identification techniques
1.2A3 a feedback system such that journey planning meets practicalities of journey undertaking

1.3 Payments Systems
1.3A Requirements for payment systems
To develop system requirements for planning and payment
1.3B Technologies to achieve invisible ticketing
To explore new technologies to achieve card less and paperless payments, including:
1.3B1 facial recognition
1.3B2 financial systems
1.3B3 deep learning
1.3B4 device (phone or similar technology) tracking, assuming such tracking can be developed within privacy laws

1.4 Disruption Management
1.4 **Disruption Management**
To implement automated disruption management to successfully return to schedule or plan. This will require:

1.4A1 analysis of disruption causes
1.4A2 modelling and techniques to return from disruption to timetable
1.4A3 feedback systems and communication techniques for informing customers

1.5 **Customer Segmentation**

1.5A **Improve rail offer while balancing usage**
To identify gaps and opportunities to improve the rail service offer while balancing service usage. Activities include:

1.5A1 information for effective segmentation and targeting to support value added services and opportunities to cross sell more services and products
1.5A2 developing methods and incentives to time-shift demand such that the peak loading is smoothed
1.5A3 analytic approaches should target the millennials, as they will be the prime driver of customer expectations in the future, using augmented technologies and data sharing
1.5A4 survey and/or forum of other economic sectors to leverage the targeted information services already undertaken and align with all the industry organisations

1.6 **Skills and Competencies**

1.6A **Develop a skills map and gap analysis**
To develop a skills map and gap analysis, such that technology skill sets, and competencies are transferable across the nation

1.6B **Increase focus on customer service and soft skills**
To increase focus on technology supported customer service and interpersonal skills for key staff

1.7 **Last Mile Services**

1.7A **Digital and AI programs to ensure better last mile services**
Use digital technologies and AI to develop dynamic and flexible services such that the last mile of journeys is convenient and timely. Make better use of multi-modal hubs

1.8 **Physical passenger safety**

1.8A **Determine methods for better customer safety through technology**

---

2. **Freight Customer Experience**

**Focus Area Objectives**

<table>
<thead>
<tr>
<th>Related Industry Goals</th>
<th>Objective No.</th>
<th>Freight Customer Experience – HIGH LEVEL OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1.1</td>
<td>o2.1</td>
<td>To achieve a significant cost reduction (35%) in unit rail freight costs (per tonne kilometre)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost</td>
</tr>
<tr>
<td>G1.3, G7.1</td>
<td>o2.2</td>
<td>To increase the volume of rail freight (&gt;100%) on the key corridors, leading to improved revenues for the below and above rail operators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume</td>
</tr>
</tbody>
</table>
Focus Area Initiatives and Actions to support objectives

<table>
<thead>
<tr>
<th>ITEM No.</th>
<th>Freight Customer Experience – INITIATIVES AND ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i2.1 A</td>
<td><strong>Transfer freight from road to rail</strong></td>
</tr>
<tr>
<td></td>
<td>To determine where digital and communications technology is best applied, i.e. key corridors, for the transfer of freight from road to rail for long-distance goods movements</td>
</tr>
<tr>
<td>i2.1 B</td>
<td><strong>Customer centric framework</strong></td>
</tr>
<tr>
<td></td>
<td>To develop a strategy based on a customer centric framework:</td>
</tr>
<tr>
<td></td>
<td><strong>i2.1B1</strong>  this can be converted into a container view of freight travel, where the customer specifies the delivery date and times of goods and the cost is based on priority and delivery times</td>
</tr>
<tr>
<td></td>
<td><strong>i2.1B2</strong>  develop systems that allow flexibility to move goods between containers and between different services, based on dynamic delivery date and times (changing at short notice for a premium price)</td>
</tr>
<tr>
<td>i2.1 C</td>
<td><strong>Real-time information</strong></td>
</tr>
<tr>
<td></td>
<td>To develop capabilities for tracking the location of the goods in real time – facilitated by the physical internet and internet of things. Developments in this area fit into the priorities for the National Freight Strategy through Global Data Standards (GDS) and will include:</td>
</tr>
<tr>
<td></td>
<td><strong>i2.1C1</strong>  data/information sharing and collaboration along the supply chain</td>
</tr>
<tr>
<td></td>
<td><strong>i2.1C2</strong>  a standardised freight API linking the freight forwarder information site (website or app) to other supply chain partners, including above and below rail operators, to help with goods location and tracking</td>
</tr>
<tr>
<td></td>
<td><strong>i2.1C3</strong>  develop the strategy to become a physical Internet type approach, through the development of unique identifiers for each consignment</td>
</tr>
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<tr>
<td><strong>2.1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>C4</strong></td>
<td>an automated supply chain model to optimise service delivery based on required service level (customer centric).</td>
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<tr>
<td><strong>2.1D</strong></td>
<td>Multi-modal efficiency</td>
</tr>
<tr>
<td></td>
<td>To develop strategies for higher multi-modal efficiencies and flexibility, including:</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.1D1</strong></td>
<td>improved movement and planning for mode transfers</td>
</tr>
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<tr>
<td><strong>2.1D2</strong></td>
<td>flexibility to realign container priorities at each hub</td>
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<td></td>
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<tr>
<td><strong>2.1D3</strong></td>
<td>ability to break-down containers into consignments for re-direction or changing priorities</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>2.2</strong></td>
<td>Supply chain collaboration - Data and Information</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>2.2A</strong></td>
<td>Data sharing framework across the supply chain</td>
</tr>
<tr>
<td></td>
<td>To establish a taskforce on the development of a data-sharing framework across the supply chain. Tasks will include:</td>
</tr>
<tr>
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<tr>
<td><strong>2.2A1</strong></td>
<td>collection of customer and container-centric data, including goods description, delivery date and times, priority and other relevant customer information</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.2A2</strong></td>
<td>setting the requirement for key information that protects the commercial confidentiality of suppliers and privacy of the customers</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.2A3</strong></td>
<td>implementation of cyber security policies that balance privacy, but allow open data protocols</td>
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<td></td>
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<tr>
<td><strong>2.2A4</strong></td>
<td>to determine the best form of data storage and retrieval/transfer, options include:</td>
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<td></td>
<td>• a de-centralised model, where each freight forwarder is responsible for data coordination</td>
</tr>
<tr>
<td></td>
<td>• a centralised (government?) body that manages the data storage, privacy and transfer/retrieval</td>
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<tr>
<td><strong>2.2B</strong></td>
<td>Predictive information services</td>
</tr>
<tr>
<td></td>
<td>To provide predictive information services, managed by exception or query, including:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.2B1</strong></td>
<td>delivery dates and times</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.2B2</strong></td>
<td>return to plan during significant disruptions</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.2B3</strong></td>
<td>proactive management of disruptions and alerting customers to alternative options during significant delays, based on query or exception, including</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i2.2B3.1 - current causes and time durations of disruptions</td>
</tr>
<tr>
<td></td>
<td>i2.2B3.2 - expected effect upon delivery of freight to multi-model centres</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.2C</strong></td>
<td>Knowledge transfer from other sectors</td>
</tr>
<tr>
<td></td>
<td>To conduct surveys and studies of information collaboration in other sectors, including:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.2C1</strong></td>
<td>aircraft traffic control, examining priority systems and disruption management</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.2C2</strong></td>
<td>grocery, health and defence sectors, examining information transfer for supply chain management</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.2C3</strong></td>
<td>implement ongoing improvements in disruption and supply chain management based on collaboration</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>2.3</strong></td>
<td>Disruption management</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>2.3A</strong></td>
<td>Automated disruption management</td>
</tr>
<tr>
<td></td>
<td>To develop automated disruption management techniques, including:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.3A1</strong></td>
<td>to develop categorisation methods for the overall disruption system into planned and unplanned events</td>
</tr>
</tbody>
</table>
2.3A2 to systemically undertake root cause analysis for disruptions, including:

- 2.3A2.1 - the introduction of improved condition monitoring will lead to reduced equipment failures
- 2.3A2.2 - mitigating further disruption due to weather and track obstacles

2.3A3 mathematical optimisation or AI based tools for the management of the disruptions and the return to planned operations

2.4 Role of government and interventions (ties into other focus areas)

2.4A Drive collaboration between State and Federal governments

ARA to drive better collaboration between state and federal governments for freight movements

2.4B Drive Innovation

To obtain a balance between government regulation and private sector to drive innovation

2.4C Incentives for investment and productivity

To determine the best methods for incentives to maximise investment and productivity

2.4D Government intervention to benefit freight customer

To determine what other forms of government intervention (apart from laws) can benefit the freight customer

2.4E ARA lifecycle costing

ARA to continue developing life-cycle costing to highlight the benefit of rail transport compared to road. The differences between road and rail should be captured, including:

- 2.4E1 externalities and associated costs that should be measured include greenhouse emissions, safety, noise, fatalities, injuries, property damage, land use, congestion, etc
- 2.4E2 to demonstrate how the outcomes from the route map fit into the national rail plan and the national freight strategy
- 2.4E3 linking Smart Rail with National Freight Strategy goals and objectives

3. Traffic and Network Management

Focus Area Objectives

<table>
<thead>
<tr>
<th>Related Industry Goals</th>
<th>Objective No.</th>
<th>Traffic and Network Management – HIGH LEVEL OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1.1, G3.1</td>
<td>o3.1</td>
<td>To achieve improved control and prediction of trains and traffic management across the network</td>
</tr>
<tr>
<td>G3.2</td>
<td>o3.2</td>
<td>To integrate the train network holistically through improved physical and process interoperability</td>
</tr>
<tr>
<td>G1.1, G3.1</td>
<td>o3.3</td>
<td>To implement Automated Train Control and Automated Train Protection based on international best practise</td>
</tr>
<tr>
<td>G1.1, G3.1</td>
<td>o3.4</td>
<td>To transition traffic management to dynamically perform the role of train service optimisation</td>
</tr>
</tbody>
</table>
### Focus Area Initiatives and Actions to support objectives

<table>
<thead>
<tr>
<th>ITEM No.</th>
<th>Traffic and Network management – INITIATIVES AND ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i3.1</td>
<td>Traffic Management</td>
</tr>
<tr>
<td>i3.1A</td>
<td>Identify key data requirements for T&amp;NM</td>
</tr>
<tr>
<td></td>
<td>To develop a program to identify key data and information requirements for traffic management and how this will add value to the service providers. This data will be required to monitor current and near future network states, as well as providing the base for decision support processes.</td>
</tr>
<tr>
<td>i3.1B</td>
<td>Integration plan for TMS into other transport modes</td>
</tr>
<tr>
<td></td>
<td>To develop integration plans for the traffic management system into other transport modes. This will improve the interoperability of the service with other transport providers. Plans will cover:</td>
</tr>
<tr>
<td>i3.1B1</td>
<td>integration of train control centres with bus and road control centres, processing power and higher capacity computers, as well as information provision for customer interaction through open data frameworks</td>
</tr>
<tr>
<td>i3.1B2</td>
<td>development of tools and techniques for network management self-organisation and optimisation</td>
</tr>
<tr>
<td>i3.1C</td>
<td>AI and automation for system management</td>
</tr>
<tr>
<td></td>
<td>To allow automation, machine learning and algorithms to have an increasing level of control over the system management in the next 20 years. Activities will include:</td>
</tr>
<tr>
<td>i3.1C1</td>
<td>industry agreement and adoption of a global approach for a standard data exchange and formatting to accelerate the application of machine learning</td>
</tr>
<tr>
<td>i3.1C2</td>
<td>develop strategies for humans to maintain supervisory control of technology, through the escalation to humans when the system requires assistance</td>
</tr>
<tr>
<td>i3.1C3</td>
<td>develop a technology program to simplify complex systems through automation</td>
</tr>
<tr>
<td>i3.1C4</td>
<td>develop change management programs with regards to the transition of traffic management from conflict resolution (find possible solutions) to predictability (what will happen in the near future) to avoid potential issues</td>
</tr>
<tr>
<td>i3.1D</td>
<td>Develop a flexible standard for traffic management</td>
</tr>
<tr>
<td></td>
<td>To develop a standard for traffic management, especially the data interchange between operators, to reflect the significant difference between the existing traffic planning and the operations of a digital railway in the next 20 years</td>
</tr>
</tbody>
</table>
### i3.2 Train Control

**i3.2A** Develop a management plan for digital train control

To initiate a program to manage the choice, design and roll-out of the appropriate digital train control (DTC) system for each of the network providers (CBTC, LTE, ATMS, ETCS)

- **i3.2A1** To develop change management plans to integrate the new DTC with existing and legacy systems of train control
- **i3.2A2** To produce an consistent method for system boundary handover (API’s, process & data interchange) to manage the interoperability between different train control systems
- **i3.2A3** To employ change management tools during the transition in the system roll-outs, including the use of human factors expertise, to successfully achieve a significant shift in industry culture around DTC

### i3.3 System Interoperability

**i3.3A** Develop a management plan for interconnected rail systems

To initiate a program to address the interconnections with other train networks in terms of:

- **i3.3A1** data and information exchange formats
- **i3.3A2** process and working assurance systems to manage the interoperability
- **i3.3A3** safe working systems across network boundaries
- **i3.3A4** writing of outcome-based standards that promote innovation and change management
- **i3.3A5** to ideate new methods to integrate the different network systems, such that the silo mentality is removed across network boundaries to allow for holistic system management
- **i3.3A6** continuation of the role of the ARA in promoting better interoperability across the network
- **i3.3A7** to produce a communication package to clearly identify and articulate the benefits of new train control and traffic management technologies. This will involve:
  - establishing an ongoing dialogue with industry and government stakeholders
  - measuring the opportunity costs of not implementing the new technologies

### i3.4 Change management for automation systems

**i3.4A** Develop a change management program for automation transition

To implement a change management program to support work practices that will transition from traffic management and train control performed via humans, toward automation

- **i3.4A1** change management techniques to enable new control and automation regimes on network integration with other transport modes

**i3.4B** Management of technology legacy systems

The management of legacy systems will require initiatives to manage the following:

- **i3.4B1** the need for technology change and how this will affect the industry
- **i3.4B2** the development of business cases for the need for change, related to integration and transition for new technology, not just at the end of lifecycle for major assets
- **i3.4B3** improved arrangements for public/private partnerships and other companies involved with the rail supply change
- **i3.4B4** better integration of the whole supply chain should enable improved economies of scale and better planning
- **i3.4B5** better commercial models for both passenger and freight rail operators
3.5 Research and Development

i3.5A To pursue high-value outcomes through R&D

To scope, scale and fund of projects correctly to achieve high-value research outcomes through R&D, including the adoption to Australia of existing sophisticated systems

i3.5A1 to examine other complex systems that require traffic management technologies to develop new ideas and technologies for the rail industry. Case studies include:
i3.5A1.1 - the logistics involved with transport for on-line based systems, e.g. Amazon

i3.5A1.2 - air traffic control and utilities operation

i3.5A2 to explore areas worthy of study for stimulating new ideas, including:
i3.5A2.1 - drones
i3.5A2.2 - automated vehicles
i3.5A2.3 - packages wrapping themselves through the network

i3.5A2.4 – cloud-based computing, analytics and reporting

i3.5A3 to initiate a research project to answer how to make the most of the data collected and collated, what information and knowledge can be developed from current and future data. Further the data should be used to investigate a move towards more contemporary technology standards for rail safety, similar to the automotive industry approach

4. High Performing Railways

Focus Area Objectives

<table>
<thead>
<tr>
<th>Related Industry Goals</th>
<th>Objective No.</th>
<th>High Performing Railways–HIGH LEVEL OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>G2.1, G2.2</td>
<td>o4.1</td>
<td>To ensure reliability of current and future services according to freight and passenger customer experience focus area objectives</td>
</tr>
<tr>
<td>G1.1, G2.1, G10.3, G5.2</td>
<td>o4.2</td>
<td>To ensure an efficient method of high volume transport based on current and future customer service requirements, whilst maximising energy efficiency and asset utilisation.</td>
</tr>
<tr>
<td>G2.1, G2.2</td>
<td>o4.3</td>
<td>To ensure a convenient method of transport for people and goods with timely interconnection with other transport modes</td>
</tr>
<tr>
<td>G1.1, G3.2</td>
<td>o4.4</td>
<td>To maintain a system based on measured need, rather than scheduled timelines</td>
</tr>
<tr>
<td>G7.1</td>
<td>o4.5</td>
<td>To significantly increase the capacity of existing train networks, through new traffic management systems and targeted infrastructure investment</td>
</tr>
<tr>
<td>G3.2</td>
<td>o4.6</td>
<td>To achieve effective interconnectivity in terms of data, information, systems and work processes, while protecting the entire system from cybersecurity threats</td>
</tr>
<tr>
<td>G6.1, G8.1</td>
<td>o4.7</td>
<td>To develop more agile and innovative methods for managing the overall networks, while maintaining high level of safety</td>
</tr>
<tr>
<td>G8.2</td>
<td>o4.8</td>
<td>To monitor, test and communicate the progress of emerging technologies and capabilities that have the potential to affect logistics and services or provide business opportunities for rail</td>
</tr>
<tr>
<td>G1.1, G1.2</td>
<td>o4.9</td>
<td>Develop the compelling business case for rail, such that new technology projects and initiatives are viable from a budget or risk perspective</td>
</tr>
</tbody>
</table>
Focus Area Initiatives and Actions to support objectives

<table>
<thead>
<tr>
<th>ITEM No.</th>
<th>High Performing Railways – INITIATIVES AND ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i4.1</td>
<td>Asset Management</td>
</tr>
<tr>
<td></td>
<td>i4.1A A digital &amp; communications technology upgrade strategy</td>
</tr>
<tr>
<td></td>
<td>To develop a strategy for upgrading rapidly evolving digital and communications technologies into existing assets and infrastructure, requiring an obsolescence and upgrade strategy</td>
</tr>
<tr>
<td></td>
<td>i4.1B Asset traceability</td>
</tr>
<tr>
<td></td>
<td>The development and roll-out of traceability for assets and asset components. Currently, the implementation of i-TRACE will supply most of assets and asset components traceability, over the next decade. Asset traceability will require programs based on:</td>
</tr>
<tr>
<td></td>
<td>i4.1B1 data storage and transfer</td>
</tr>
<tr>
<td></td>
<td>i4.1B2 data analytics and information and knowledge development</td>
</tr>
<tr>
<td></td>
<td>i4.1B3 replacement and procurement procedures</td>
</tr>
<tr>
<td></td>
<td>i4.1C Optimum lifecycle management of assets</td>
</tr>
<tr>
<td></td>
<td>To develop a strategy with clear lines of responsibilities between the operation and ownership of assets for optimum lifecycle management. An interface mechanism should allow for the optimisation of access, resources, speed and equipment</td>
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<tr>
<td></td>
<td>i4.1D Technologies to extend asset life</td>
</tr>
<tr>
<td></td>
<td>To develop a strategy to extend the life of existing assets through new technologies including remote condition monitoring and improved axle-bearing loadings, whilst considering asset cost, asset economic opportunity and interoperability</td>
</tr>
<tr>
<td></td>
<td>i4.1E Employ a consistent approach to asset management</td>
</tr>
<tr>
<td></td>
<td>To employ a consistent approach to asset management, including:</td>
</tr>
<tr>
<td></td>
<td>i4.1E1 all users’ system requirements</td>
</tr>
<tr>
<td></td>
<td>i4.1E2 knowledge sharing</td>
</tr>
<tr>
<td></td>
<td>i4.1E3 development of standard interfaces and systems</td>
</tr>
<tr>
<td></td>
<td>i4.1E4 Understanding the requirements and objectives of asset stakeholders</td>
</tr>
<tr>
<td>i4.2</td>
<td>Remote Condition Monitoring</td>
</tr>
<tr>
<td></td>
<td>i4.2A Rollout condition monitoring systems</td>
</tr>
<tr>
<td></td>
<td>To rollout condition monitoring systems for both rolling stock and infrastructure on an as-needs basis, with the aim to have most operationally critical systems monitored within 15 years</td>
</tr>
<tr>
<td></td>
<td>i4.2A1 establish synergies between the above-rail assets and below rail assets</td>
</tr>
<tr>
<td></td>
<td>i4.2B Managing condition monitoring data</td>
</tr>
<tr>
<td></td>
<td>To combine data and sensor to manage the large quantity of condition monitoring data, particularly video feeds. Management will involve:</td>
</tr>
<tr>
<td></td>
<td>i4.2B1 aggregating, summarising, prioritising and storing data, dependent upon application</td>
</tr>
<tr>
<td>i4.3</td>
<td>Cyber Security</td>
</tr>
<tr>
<td></td>
<td>i4.3A Cyber Security</td>
</tr>
<tr>
<td></td>
<td>To incorporate a federation of systems methodology, to validate and verify system security</td>
</tr>
<tr>
<td></td>
<td>i4.3A1 align cyber security to Australian standards and requirements from governments</td>
</tr>
</tbody>
</table>
### Data Integration and Deriving Value

#### i4.4A Management of asset performance data across rail

To develop a program for the effective management of asset performance data across the whole rail industry. Activities will include:

- **i4.4A1** for each key technology area, a forum of participants from across the industry is needed to set the data and information requirements, the expected outcomes and data storage and maintenance. The EU smart mobility marketplace is a good reference point

- **i4.4A2** Define the expected outcomes from data analytics, AI or machine learning algorithms. Determine extent a self-organising model be applied here

- **i4.4A3** maintain a knowledge bank

- **i4.4A4** Document and share lessons learnt

- **i4.4A5** Seek methodologies from other sectors and industries to determine ways for making data and information work for the rail industry, such as the finance sector

#### i4.4B Data Standards

To determine what a data standard(s) will be best for the industry:

- **i4.4B1** data integration and synchronisation will be key base principles for the standard(s)

- **i4.4B2** ARA will facilitate the industry wide response to the data standards

### Change Management for high performance

#### i4.5A Innovative culture

A program to educate and inform rail stakeholders on the benefits of innovation and change, making it open to new technologies and operating methodologies, rather than fitting to existing modes of operation

#### i4.5B Condition monitoring for maintenance scheduling

To develop a transition plan from manual scheduled maintenance systems to a system of automated condition monitoring. Use scheduled maintenance initially as an audit of the automated system but apply CM as a combination of fixed infrastructure and mobile monitoring.

#### i4.5C Enable human on the loop automation

To develop change management systems that enable network operators, maintainers and owners to move to an automated operations system, where supervisory humans are on-the-loop rather than in the loop

### Skills and Competencies

#### i4.6A Up skill the industry

To implement new skills and up skills staged programs. The new key skills and competencies requirements will be:

- **i4.6A1** data management, storage and transfer

- **i4.6A2** data analytics, AI technologies, knowledge capture and the ability to explain and sell the benefits of these new technologies, i.e. soft skills and communication

- **i4.6A3** telecommunications-based information flows and control procedures

- **i4.6A4** to implement a management program for the upskilling of the industry

- **i4.6A5** focus on the safety and operationally critical systems to value-adding data analytics and machine learning knowledge development
<table>
<thead>
<tr>
<th>i4.7</th>
<th>Research and Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>i4.7A</strong></td>
<td>Establish innovation hubs</td>
</tr>
<tr>
<td>To establish innovation hubs as required across the rail sector. One example is the TfNSW innovation Hub. Uses and projects include:</td>
<td></td>
</tr>
<tr>
<td><strong>i4.7A1</strong></td>
<td>the use of innovation hubs and sandboxes for the development of new technologies and systems/processes before going live on the networks</td>
</tr>
<tr>
<td><strong>i4.7A2</strong></td>
<td>a program to utilise simulation and modelling more widely across the rail sector</td>
</tr>
<tr>
<td><strong>i4.7B</strong></td>
<td>Initiate research programs for VR/AR and advanced manufacturing</td>
</tr>
<tr>
<td>To initiate research programs for Virtual/Augmented Reality and advanced manufacturing technologies:</td>
<td></td>
</tr>
<tr>
<td><strong>i4.7B1</strong></td>
<td>information visualisation and customer engagement</td>
</tr>
<tr>
<td><strong>i4.7B2</strong></td>
<td>employee visualisation and training and skills for maintenance, design and build</td>
</tr>
<tr>
<td><strong>i4.7B3</strong></td>
<td>strategic planning, project development and modelling</td>
</tr>
<tr>
<td><strong>i4.7B4</strong></td>
<td>robotics</td>
</tr>
<tr>
<td><strong>i4.7B5</strong></td>
<td>additive manufacture</td>
</tr>
<tr>
<td><strong>i4.7B6</strong></td>
<td>nanotechnology</td>
</tr>
<tr>
<td><strong>i4.7C</strong></td>
<td>Examine the impact of Unmanned Aerial Vehicle’s (UAV’s) and autonomous technologies</td>
</tr>
<tr>
<td>To develop a series of discussion groups examining the impact of UAV’s, Connected Autonomous Vehicles (CAV’s) and autonomous technologies upon the rail sector, looking at:</td>
<td></td>
</tr>
<tr>
<td><strong>i4.7C1</strong></td>
<td>what sectors of rail will be affected by these technologies, e.g. network maintenance</td>
</tr>
<tr>
<td><strong>i4.7C2</strong></td>
<td>how rail can integrate these new technologies</td>
</tr>
<tr>
<td><strong>i4.7C3</strong></td>
<td>Determine how rail will be active, not reactive, to these new technologies</td>
</tr>
<tr>
<td><strong>i4.7C4</strong></td>
<td>what type of relationships need to be established from a collaboration and business perspective?</td>
</tr>
<tr>
<td><strong>i4.7D</strong></td>
<td>Development of over the horizon surveillance functionality</td>
</tr>
<tr>
<td><strong>i4.7D1</strong></td>
<td>The development of a continual surveillance program for over-the-horizon threats and opportunities for the benefit of the whole rail sector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>i4.8</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>i4.8A</strong></td>
<td>Improve safety through advanced technology</td>
</tr>
<tr>
<td>To improve the monitoring and management of critical systems to avoid future incidents. New models facilitate early detection of threats and fast response</td>
<td></td>
</tr>
<tr>
<td><strong>i4.8B</strong></td>
<td>Dynamic risk assessment</td>
</tr>
<tr>
<td>To develop dynamic risk assessments, including visualisation of the current risk profiles, for both asset and operational risks</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>i4.9</th>
<th>Openness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>i4.9A</strong></td>
<td>Openness of Rail</td>
</tr>
<tr>
<td>To assess industry willingness and preparedness to encourage the sharing of data and information outside of rail</td>
<td></td>
</tr>
</tbody>
</table>
ANNEXE 2
Reach versus importance scatter plot
SMART RAIL Route Map Development

PRIORITY INITIATIVES

The prioritisation method ranked the focus area objectives in importance, and then ranked how important each defined initiative was at meeting the stated objectives for each focus area. The method therefore produced a pairwise ranking for each focus area initiative against each focus area objective, allowing for a ranking on the importance of each initiative for each focus area.

Priority initiatives were selected by mapping initiative importance versus initiative reach (Figure 1); The top initiatives were shortlisted based on their ability to meet the highest rated focus area objectives that could help the rail industry be/remain competitive over the next 30 years (importance) and their ability to reach a higher number of industry wide goals (reach).
ANNEXE 3

Methodology
Industry engagement

The development phase actively sought input from rail industry representatives with relevant domain knowledge.

Knowledge elicitation and industry involvement in the systems mapping of the current and future state of the rail industry in Australia was also intended to facilitate active participation and ownership of the Smart Rail outputs such as the final Smart Rail Route Map report.

Three large and four smaller focused workshops were undertaken along with a series of individual and group discussions:

- **Steering Committee Workshop 0** focused on the structure for the development of the Route Map, which considered initially three focus areas as a reference framework to be most likely impacted by the introduction of new technologies, these being: Customer Experience (CE), Traffic and Network Management (T&NM) and High Performing Railways (HPR). The objective of this workshop was also to gain a baseline understanding of the preferred process and participation, along with a discussion to build fundamental input to the complex modelling;

- **Rail Industry Workshop 1** involved a discussion on the key themes per focus area. After Workshop 1, the Customer Experience focus area was split into Passenger Customer Experience (PCE) and Freight Customer Experience (FCE) sub focuses, due to the differences in the customer expectations and undertakings;

- Four smaller video-conference discussions were then conducted to further develop the understanding of the focus areas and identify goals, objectives, initiatives and action items to facilitate the first draft of the Route Map;

- **Workshop 2** was scheduled to review and confirm the requirements for technology over the next 30 years resulting from a series of Goals, Objectives and Initiatives syntheitised from the previous workshops. During this session, participants prioritised the objectives and assessed the importance of each initiative against the focus area.

- Individual and group discussions were programmed to capture feedback and further details around key conclusions after workshops. These included individual meetings with industry representatives as well as group discussions future leaders, steering committee, attending events such as the TTF 2018 and other relevant forums.

Deakin provided the modelling and analytic tools, which facilitated visualisation and storyboarding to support the industry stakeholders and decision makers in understanding the complexity due to interdependencies between four focus areas. The visualisation tools allowed a systems level view when building the route map, with a common view of priorities, themes, timelines and actions.

The route map development process (figure 12) combined:

1. industry engagement
2. system mapping for technology
3. identification of key industry requirements to shape a competitive future including goals, objectives and initiatives
4. a matrix-based rating methodology
5. the establishment of a pathway for continuation – from planning to implementation.
Figure 12, Outline of methodology for identifying and prioritising key initiatives and action items
Prioritisation methodology

Many technology and telecommunications relevant initiatives were generated through the systems mapping process, the next logical step was prioritisation.

The start of the prioritisation method was the development of goals, objectives and initiatives document (Annexe 1), which included:

1. 10 broad industry goals (21 when detailed into specific goals), which were the overall aims for the industry
2. Specific focus area objectives for each of the four focus areas (a total of 36 objectives), which formed the aims for each of the focus areas and have been linked directly to one or more industry goals
3. The initiatives, which allow for a series of programs and actions undertaken over a period to achieve the focus area objectives.

Thus, the document allows for the development of initiatives, programs and action items aimed at meeting a series of focus area objectives and thereby broad industry goals within the next 30 years.

The development of the strategic pathways documents allowed for the application of a prioritisation method, which took place during workshop 2, where each participant was provided with a systems and planning information package and a prioritisation matrix. Participants evaluated each objective and initiative providing individual scores, while socialising any ideas, opinions and concerns within their working groups.

The prioritisation method ranked the focus area objectives in importance, and then ranked how important each defined initiative was at meeting the stated objectives for each focus area. The method therefore produced a pairwise ranking for each focus area initiative against each focus area objective, allowing for a ranking on the importance of each initiative for each focus area.

Priority initiatives were selected by mapping initiative importance versus initiative reach (Annexe 2); The top initiatives were shortlisted based on their ability to meet the highest rated focus area objectives that could help the rail industry be/remain competitive over the next 30 years (importance) and their ability to reach a higher number of industry wide goals (reach).

Timeline

An initial timeline for the Route Map was also possible through workshop 2 and individual consultation. Participants were asked to provide a high-level starting time and the duration estimate for each initiative as well as potential conflicts and precedence.

Smart Rail Route Map Outcomes

This Interim Report was planned to communicate the priority telecommunications and technology initiatives, as outcomes of the development phase; allow the space for adjustments; and capture ideas for effective adoption and deployment of the proposed Smart Rail initiatives. This process is currently being undertaken through the wide distribution of the Interim report and the subsequent discussions undertaken during the 2018 Telecommunications and Technology Forum (TTF). Further updates to the Interim Report will be canvased at AusRail 2018.

A final report will be completed by December 2018 based on the feedback captured during and after AusRail.
Systems mapping and identification of key requirements for technology

For increasingly integrated and complex infrastructure systems, Deakin has developed systems mapping methods and the online technology platform (StickE) to support conversation between diverse stakeholders; development of shared understanding (convergence) of systems and complexity; and explore implications of decisions (business, policy, etc.)

The information collected through industry consultation, considering rail operations on current infrastructure around the four focus areas, was used to progressively build a rail industry complex model to map variables and relationships for digital and telecommunications technologies using the StickE platform (figure 13).

Captured industry contributions were grouped into number of themes that were later synthesised into a series of strategic pathways including 21 industry wide goals for the next 30 years, 36 objectives across the four focus areas, and 120 initiatives and action items which provided directed ideas, from the present day to the future goals (Annexe 1).

Focus areas systems maps generated through this process, assisted in identifying the relationships between the desired outcomes and technical and non-technical variables, enablers, barriers and disruptors for each initiative. The system maps also helped in identifying precedence, impacts and relationship between initiatives, which contributed to the way in which initiatives have been structured and presented in the StickE maps and this document.

<table>
<thead>
<tr>
<th>FOCUS AREA</th>
<th>OBJECTIVES</th>
<th>INDUSTRY INITIATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>o4.1 Reliable</td>
<td>o4.2 Efficient</td>
<td>i4.1A A digital &amp; comms technology upgrade strategy</td>
</tr>
<tr>
<td>o4.3 Convenient</td>
<td>o4.4 Adaptive</td>
<td>i4.1B Asset traceability</td>
</tr>
<tr>
<td>o4.5 Capacity</td>
<td>o4.6 Connected</td>
<td>i4.1C Optimum lifecycle management of assets</td>
</tr>
<tr>
<td>o4.7 Innovation</td>
<td>o4.8 Technology</td>
<td>i4.1D Technologies to extend asset life</td>
</tr>
<tr>
<td>High Performing Railways</td>
<td></td>
<td>i4.1E Employ a consistent approach to asset management</td>
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<td></td>
<td></td>
<td>i4.2A Rollout condition monitoring systems</td>
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<tr>
<td></td>
<td></td>
<td>i4.2B Managing condition monitoring data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i4.3A Cyber security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i4.4A Management of asset performance data across rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i4.4B Data standards</td>
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<tr>
<td></td>
<td></td>
<td>i4.5A Condition monitoring for maintenance scheduling</td>
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<tr>
<td></td>
<td></td>
<td>i4.6A Enable human on the loop automation</td>
</tr>
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<td></td>
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<td>i4.6B Initialize research programs for VR/AR and advanced manufacturing</td>
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<td></td>
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<td>i4.7A Establish innovation hubs</td>
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<td></td>
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<td>i4.7B Examine the impact of UAVs and autonomous technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i4.8A Improve safety through advanced technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i4.8B Dynamic risk assessment</td>
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</tbody>
</table>
Figure 13, Sample StickE map for the High Performing Railways focus area, used for identifying interdependencies and socialising the key ideas.
Smart Rail Route Map

Australasian Railway Association
Duncan Sheppard
General Manager - Freight & Contractors
T +61 2 6270 4531
M +61 412 340 934
E dsheppard@ara.net.au
W ara.net.au

Deakin University
Prof. Doug Creighton
Deputy Director – Institute for Intelligent Systems
Research and Innovation (IISRI)
T +61 3 5227 2179
M +61 411 273 213
E dougc@deakin.edu.au
W deakin.edu.au/IISRI

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