IoT for Remote Rail Operations and Maintenance

DETAILS

SECTOR | Transport

STAGE | Operations and Maintenance

TECHNOLOGIES | Internet of Things (IoT), Sensors, Telecommunications Networks, Intelligent CCTV Cameras, Applications

SUMMARY

Internet of Things (IoT) is a term that describes a community of devices connected to the internet, with the ability to transfer and share data and information with each other. It has become a common term in recent years as technology has developed to allow for this advanced merging of physical and digital infrastructure. In 2005, alongside the increasing use of IoT, the rail industry started pursuing more technology-based projects that allowed for the major development of smart solutions that included automatic ticketing, rail analytics, dynamic route scheduling, and planning to name just a few.

For the operations and maintenance of railways, IoT are made up of connected solutions and transport infrastructure.

IoT are enablers of the following services:

1. Condition information on rail equipment
2. Freight delivery information systems
3. Train control systems, "Smart Infrastructure" (infrastructure and equipment embedded with sensor technology that enables them to interact with each other and communicate real time data to infrastructure owners on the structural health of assets); and
4. Predictive maintenance.

These IoT solutions require integrated software and wireless connectivity to allow for a high rate of data transfer, in order to optimise asset use and improve the service efficiency. IoT data collected from the above services are processed to improve the response time to maintenance needs. Furthermore, real-time information informs more intelligent and safer resource allocations and operations, thus improving the productivity of railway maintenance.

The desired outcome of IoT use in rail operations and maintenance systems, is to improve the efficiency of operations and minimise the time and effort originally employed for identifying malfunctions and alerting engineers. A fully automated system for maintenance would be ideal, where an issue is identified and communicated to the service provider and maintenance staff immediately, without human interference.

VALUE CREATED

Improving efficiency and reducing costs:

- Improve operational performance and decision-making as service providers can monitor and understand how their assets are performing over time and respond appropriately.
- Minimise operating costs through the increased efficiency of operational performance, as the frequency of rail services can be adapted (increased or decreased) to align with the actual network capacity, thus allowing operators to meet varying demand.
- Enable predictive maintenance, which means that renewals or new infrastructure requirements are better managed, or could be avoided, and asset life can be extended.

Enhancing economic, social and environmental value:

- Improve customer experience due to enhanced operations and more reliable transport services.
- Increase safety as authorities have access to information (train speeds and train conditions) from sensors and other technologies, and reduced response time to incidents due to access to real-time information.
- Reduce energy usage using real-time data to enable more efficient resource allocation and better response to traffic conditions.

POLICY TOOLS AND LEVERS

Legislation and regulation: Governments, and specifically the transport sector, need to determine the scale of the IoT system for railway operations and maintenance, considering whether it will be implemented as a national system, developed for each individual state or applied individually to each railway line or station. A larger scaled system will allow for a holistic view of the country's transport networks, however, could prove complicated for data processing without effective integration. Governments need to outline the requirements for security and safety, including the minimum standards that must be met by IoT systems. Additionally, they should provide a future goal for the system, to encourage continued development of the system, by the IoT providers and station operations.

Transition of workforce capabilities: Instead of monitoring operations and identifying areas that require maintenance, employees will now need to be trained in managing and maintaining the IoT system and solving malfunctions and security risks that may occur during operations. Furthermore, maintenance employees should be trained to use the digital services that are connected and communicated through the IoT system, allowing for their immediate response to technical maintenance requirements.

Funding and financing: A benefit realisation should be performed so that the government can understand the investment and funding they must provide to enable the IoT data to be transferred and used adequately by the rail operating and maintenance systems. The IoT technology and system costs should be costed in the operators offer as part of the provision of their managed services.

IMPLEMENTATION

Ease of Implementation

The implementation of IoT in railways requires the development of a connected Infrastructure with sensors and communication devices along the railway corridors as well as the development of applications enabling predictive maintenance systems. The implementation of both is essential to ensure the compliance and reliability of the data provided by IoT and the implementation should be validated/tested in order to meet the reliability requirements described for the service operations. Today the validation and testing procedures exist but need to be improved to be more robust and support an easier implementation.

Cost 	The cost of developing an IoT-based system varies from industry to industry according to the requirements of the application and services. For infrastructure management and the transport industry, an IoT application is estimated to cost approximately USD 25,000[1]. However, there are additional costs involved in the process including the implementation of sensor systems and CCTV Cameras for infrastructure monitoring services, including the rail crossing sensor, rail friction sensor and obstacle detecting sensor. The cost of sensor systems also varies according to the schematic layout of the system, but a simple individual sensor would cost around AUD 1.17, with an entire network of temperature sensors would cost anywhere from AUD 10,000 to AUD 3,500,000[2].
Country Readiness 	For the implementation of IoT on a national scale, country readiness is lacking as most IoT operations and maintenance services are only applied to single rail lines at present. High income countries will find implementation easier, as the cost of sensors and other devices required, as well as the production of a system and IoT network are a significant expense. Physical construction for IoT implementation is limited and therefore does not impact existing infrastructure, proving an enabler for both high- and low-income countries.
Technological Maturity 	An example of an existing IoT system is the collaboration between the Italian high-speed train and SAP, for the development of a Dynamic Maintenance Management System (DMMS). The DMMS utilises real-time sensor information from sliding doors in trains, to notify engineers when repairs are needed and build Predictive Models using machine learning, to allow for more efficient and responsive maintenance systems. This main aspect of IoT for railways that needs development, is the IoT network of devices considering containment for security purposes and big data processing capabilities.

RISKS AND MITIGATIONS

Implementation risk

Risk: With the use of many devices within one system, the system network and integration of services will become complex as organisations attempt to manage multiple Internet Protocol (IP) addresses, process large volumes of data, and manage complicated IP infrastructure. Additionally, as automated controls and workflows are added to the system, IoT data outputs will increase, which for a static system could cause a disturbance and imbalance. IoT systems also consist of thousands of sensors and devices that can be hard to manage.

Mitigation: Network infrastructure will need to be developed to allow for this complex system integration and data processing, and networks should be able to scale to accommodate the addition of workflows and controls. Automatic onboarding needs to be implemented in order to allocate devices to the appropriate networks and enable governance and visibility during the device lifecycle.

Social risk

Risk: The implementation of IoT for maintenance and operations will replace jobs that would otherwise be undertaken by railway service employees. This will of course have an impact for the individuals affected but may also prove to be broadly unpopular within the wider community.

[1] "Cost of IoT Apps of Trending Industries", Business of Apps, Accessed 13 May 2020.

[2] "How much for an IoT Sensor?", Newie Ventures, Accessed 13 May 2020.

Mitigation: To avoid the public rejection of the new system, existing employees should be re-trained in other tasks such as using the IoT operating systems, maintaining the devices used such as sensors, CCTV and the data output programs.

Safety and (Cyber)security risk

Risk: The integration of numerous sensors and devices provides an opportunity for hackers to break into the system and steal important information, such as private government and transport information. This is especially prevalent for IoT systems as the "network attack surface"[3] is increased drastically due to the abundance of devices creating numerous vectors or pathways for entry. Furthermore, the individual devices are generally manufactured by companies without relevant security requirements considered.

Mitigation: Service providers must ensure that processes to protect sensitive information are implemented, and that all IoT devices used are compliant with the general security properties implemented.

EXAMPLES

Example	Implementation	Cost	Timeframe
East Japan Railway Company	JR East transitioned to a condition-based maintenance program utilizing predictive analytics technology.		Collaboration with PARC began in 2013 and 20+ fleets were planned to be running by March 2018.
VicTrack, Australia	VicTrack embed fibre optic sensors into rail bridges and utilized optical radar and analytics to make sense of the resulting data.	AUD 70 million for the IoT and the system development	The testing and project start date was in 2018.
Dutch Railway Network	IoT sensors are being used to identify and communicate rail conditions, that humans couldn't otherwise identify.		

CONTACT INFORMATION

Devina Hassanaly	Systra	dhassanaly@systra.com	Director, Mobility and Future Cities

[3] "The Internet of Things in Transportation", Alcatel – Lucent Enterprise, Accessed 12 May 2020.