Chapter 70
Blockchains:
A Distributed Data Ledger for the Rail Industry

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ABSTRACT

In recent years, the UK railway industry has struggled with the effects of poor integration of data across ICT systems, particularly when that data is being used across organizational boundaries. Technical progress is being made by the industry towards enabling data sharing, but an open issue remains around how the costs of gathering and maintaining pooled information can be fairly attributed across the stakeholders who draw on that shared resource. This issue is particularly significant in areas such as Remote Condition Monitoring, where the ability to analyse the network at a whole-systems level is being blocked by the business cases around the purchase of systems as silos. Blockchains are an emerging technology that have the potential to revolutionize the management of transactions in a number of industrial sectors. This chapter will address the outstanding issues around the fair attribution of costs and benefits of data sharing in the rail industry by proposing blockchains as a forth enabler of the rail data revolution, alongside ESB, ontology, and open data.

INTRODUCTION

In recent years, many railways worldwide have undergone a revival, with growth in passenger numbers driven by factors such as traffic congestion, and a desire to work during travel time. The United Kingdom's railway network is the oldest in the world, and has been steadily growing in popularity; between the years of 1991 and 2011 passenger numbers across the network rose by 67% (Office of Rail Regulation, 2011). This significant growth in demand for rail travel has put pressure on the industry to make better use of the available capacity on the rail network; however, with changes to the underlying physical infrastructure being both disruptive and hugely costly, the industry is being forced to consider alternative approaches to generating the additional capacity required.

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One option that is being actively pursued is the greater use of digital technologies in support of railway operations. It is hoped that through digitization of the railway, and the introduction of improved information-driven alternatives to current traffic management, signaling, and maintenance systems, the industry will be able to support up to one billion extra passenger journeys per year by 2030 (Digital Railway, 2017).

This chapter will examine the issues around the digital revolution in UK rail, with a particular focus on the dual challenges of poor integration of information, and the mechanisms by which costs may be equitably distributed around the various stakeholders in the industry for the collection, maintenance, and distribution of data used for the benefit of other parties. The chapter will begin by explaining the challenge facing the industry, before moving on to propose a solution in the form of blockchains, the distributed ledger technology that underpins the cryptocurrency Bitcoin. Finally, the chapter will conclude with a discussion of some of the outstanding issues posed by the work, and the enabling steps that will need to take place so that the industry is ready to take advantage of the technology when it reaches mainstream implementation, expected to be in around five to ten years' time (Gartner Inc., 2016).

Background

In recent years, the UK railway industry has struggled with the effects of poor integration of data across Information and Communications Technology (ICT) systems, particularly when that data is being used across organizational boundaries. The problem is far from unique to rail, and has been seen globally in many other infrastructure-led sectors; the National Institute of Science and Technology in the US has reported that in 2002 alone the US capital facilities industry could have saved around $15.8 billion (1% - 2% of annual revenue) through improved information interoperability (Gallaher, O'Conor, Dettbarn, & Gilday, 2004). Translated into the context of the UK railways this would amount to potential savings of between £82 million and £164 million for the financial year 2013 – 2014 (Tutcher, Easton, & Roberts, 2017).

To illustrate the scale of the problem facing the rail industry, consider Figure 1. Figure 1 shows the subset of shared information systems, not owned or operated by Network Rail (the infrastructure manager), used by stakeholders in the UK rail industry. The figure has been produced based on data from the 2015 update of the National Information Systems catalogue, originally released in 2011 by the Rail Safety and Standards Board (Brewer, 2011). In the figure individual ICT systems, represented by vertices, are divided into classes by function and labeled by color; crime and security related systems in green, customer / commercial systems in yellow, operational systems in red, planning in purple, rolling stock in grey, safety in orange, and supply chain and R&D systems in cyan. The arcs linking the systems denote data interfaces between them, and these are also colored; manual interfaces (requiring human data entry) are shown in red, interfaces based on the download and subsequent upload of a file are shown in blue, and fully automated interfaces are shown in green. The nature of interfaces shown in grey was unknown at time of preparation of the figure.

The complex web of interactions between systems shown in Figure 1 is typical of railway systems across Europe, and is an inevitable product of the business environment in which the systems developed. The nationalised railways of the 1960s, 70s, and 80s, meant that the very early ICT systems used to manage railway operations were, quite naturally, developed to work in the context of vertically-integrated railway systems. As the railways began to become privatised in the early 1990s, these vertically integrated architectural models persisted for legacy systems (and the updates to them), but newer ICT systems and