Incentivising better capacity management in GB rail: Case study evidence from other industries and railways: ORR/CT/14-63

FINAL REPORT

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1 INTRODUCTION

1.1 Aims & Objectives

The ORR is currently in the early stages of preparing for the next periodic review in which it will determine Network Rail's charges, outputs and funding for April 2019 onwards. As part of these preparations the ORR is reviewing the way that capacity is managed on the rail network, including its approach to regulating Network Rail, to identify scope for improvement and to determine how these improvements could be realised. This follows from the ORR's commitments to define the role and benefits of effective performance of system operator functions – including actively managing capacity and creating flexibility on an increasingly diverse and busy network - which it set out as part of its Long Term Regulatory Statement. The ORR is also undertaking work to review the current structure of charges, a subject which is specifically excluded from this report.

1.2 Scope and Nature of Study

This piece of work is intended to collect evidence from case studies drawn from GB rail, international rail, and other regulated industries to illustrate best-practice approaches to capacity management. We began with a long-list of 30 potential case studies, and from this selected ten to take forward for further research (see: Figure 1). The shortlisted studies were chosen on the basis of their relevance (how well they exhibit an interesting or creative approach to capacity) and the directness of the analogy to GB Rail (i.e. the ease with which we may draw parallels between parties or processes in the studies and those in rail).

Further, our aim has been to provide a sample with both breadth and depth – i.e. covering a diverse range of scenarios, while exploring these in sufficient detail to get a strong understanding of the motivations of each of the parties concerned that led to an improvement in the management of capacity.

Figure 1: Case Studies featured in this report

GB Rail

Case Study	Comment
London Midland 110	• LM began operating additional and accelerated (110mph) services on the fast lines to/from London Euston
Greater Anglia / East Anglia routes	• Planning for CP6 is underway, and studies such as 'Improving Connectivity' are suggesting new approaches
Strategic Freight Network	• Providing appropriate routes to support industries reliant on freight and to promote use of rail over road or other haulage
Transport for London (Rail)	• TfL is responsible for implementing the Mayor of London's transport strategy. As such, it is continually adapting, enhancing, and upgrading its network

International Rail

Case Study	Comment
Vancouver SkyTrain (Automation)	• Vancouver runs a fully-automated metro system, mostly on elevated track, called the SkyTrain
Eurostar 'Gold'	• Eurostar designates a selection of 15 services to be its 'Gold Trains' - these are then given priority during unexpected disruptions
Kombiverkehr	• Kombiverkehr is a German intermodal freight operator owned by Deutsche Bahn (50%) and its customers (50%) which operates across mainland Europe

Other Industries

Case Study	Comment
Ofcom 4G Auction	• Ofcom ran a spectrum auction in early 2013 for the 800MHz and 2.6GHz bands of frequency to provide the necessary bandwidth for 4G technology to be rolled out
Heathrow Airport	• NATS provides Heathrow with a proprietary software platform for managing data and reacting to delays in real time
M25	• The M25 is a strategically important highway, with a programme of upgrade and improvement works in progress to enhance capacity

Rather than focusing on the capacity-enhancing approaches themselves (e.g. automated railways) we have looked beyond this to the supporting environment that led to the innovative approach being developed – i.e. are there particular measures, incentives, or motives in place that encourage a positive approach to identifying, allocating, or producing capacity?

While we have aimed to include best-practice examples, the studies selected are clearly not exhaustive of all possible techniques. However, they do provide a number of alternative perspectives that the ORR might compare and contrast with the situation in GB Rail.

It is worth noting that examples demonstrating both good management of capacity and an immediate relevance or applicability to GB Rail were not widespread. A number of cases that were not shortlisted have

nevertheless influenced our thinking. For example, we explored capacity management within French rail as a potential study and carried out some preliminary research with SNCF (both the passenger operator and now infrastructure manager), and ARAF (regulator). However, it became clear the French rail is in a period of transition – a major restructuring took place in January 2015 to reintegrate the IM and the passenger operator, such that both are now subsidiaries of SNCF. Interviewees suggested there is much progress to be made to improve treatment of capacity under the new regime. There were some positive approaches in place, such as those on the high-frequency, high-capacity RER lines in Ile-de-France, but these are in environments that are relatively simpler to control.

1.3 Methodology

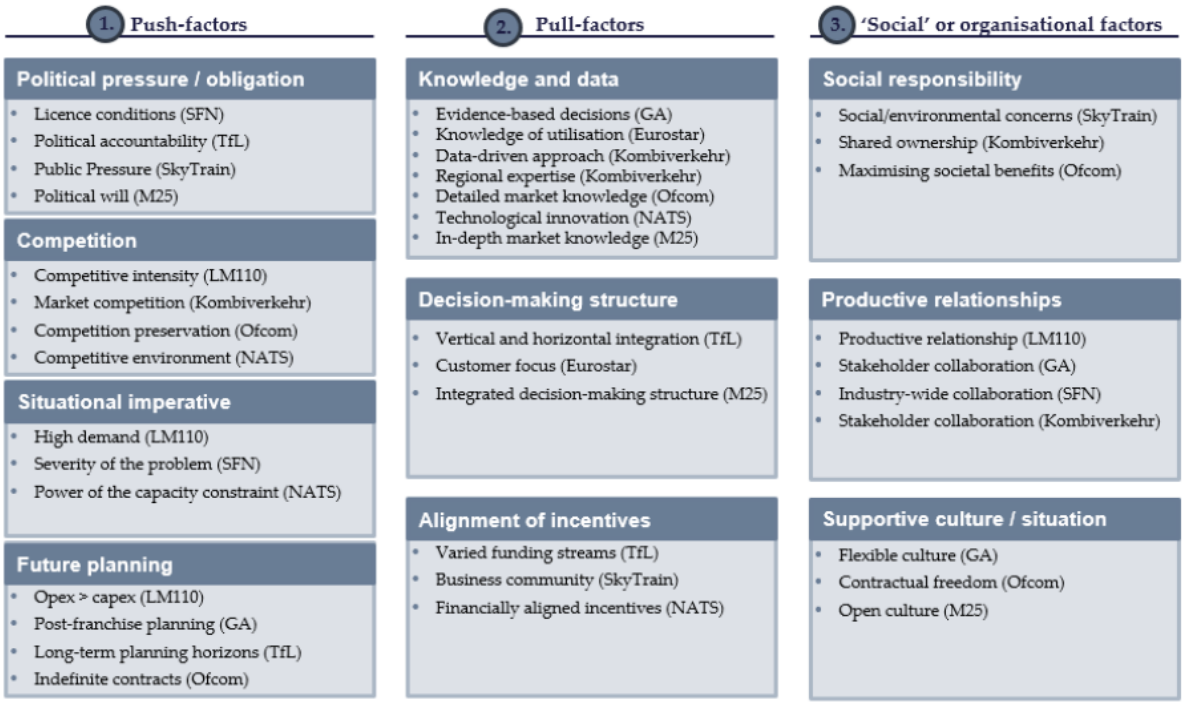
1.3.1 Approach

The evidence in this report is based on primary research undertaken by Credo in February and March, 2015. We have supplemented this primary research with data that was either provided by interviewees or available through secondary sources.

Our focus for interviews was to capture input from senior decision-makers within the appropriate industry stakeholders. Wherever possible, we have collected views from a range of parties – e.g. in the case study on aerospace we have spoken to NATS, Heathrow Airport Limited, and McLaren Applied Technologies to gather input from a number of perspectives. We aimed in all cases to speak with participants who are actively involved in setting the strategy behind the solutions employed, and with an appropriate visibility of how their organisation is motivated by incentives or structures present in the wider industry.

1.3.2 Framework for analysis

Figure 2: Overview of the enablers, themes, and pillars identified in this study



Within the individual case-studies, we have identified those elements of the supporting environment or industry structure that have made a strong contribution to the way that capacity is managed. These factors are specific to the case study in question, and are shown in Figure 2 as the bullet points within the grey boxes. We refer to these factors as **enablers**. For example, we identify the Network Rail's 'licence conditions' as one of the enablers of success in the SFN case study and 'political accountability' as one of the enablers in the TfL case study.

Considering all of the case studies, the enablers that encourage positive behaviours broadly fall into categories. For example, there are enablers relating to competition between parties that are identified in the case studies on London Midland, Kombiverkehr, Ofcom, and NATS. In this way, we have grouped enablers into ten key **themes**, which are shown as the grey boxes in Figure 2.

Finally, we notice differences in the nature of the themes themselves, in terms of directness with which they influence parties to take action on capacity. The themes align well into three '**pillars**':

- In some instances, these might be direct incentives, either financial or otherwise, which provide a motivation for parties to make better use of capacity, or which provide a reward for improvement. These are the **Push Factors**
- Further, there are a set of themes which act to *support* (rather than provoke) the delivery of a capacity project or strategy, such as availability of appropriate data to record utilisation or performance. These **Pull Factors** simplify or enable a solution to be implemented
- Often there are softer elements of organisational culture, or a directness of interaction with the public and wider environment, which motivate a capacity solution for social, environmental, or industry-wide benefit. These **Social or Organisational Factors** form the third pillar

The three pillars are shown as the vertical blocks in Figure 2.

1.3.3 Structure of report

This **written report** discusses each of the 'pillars' above in turn, and explains the nature of each of the themes contained within them. The discussion draws on specific findings from case studies, as well as commentary on how, in more generality, the theme itself is a useful part of a capacity incentive structure.

The **Appendices** to this report present detailed evidence on each of the case studies, describing the situation and background, the capacity constraints being addressed, an analysis of the incentive approach, and identification of the key enablers for the case.

2 Executive Summary

2.1 Key themes for successful capacity management

2.1.1 Summary of themes

We have analysed 10 case studies of best-practice in capacity management, drawn from UK rail, international rail, and selected other industries. In total, we have identified c. 40 separate factors (enablers) that contributed to the success of the approaches employed; these are discussed in detail within the Appendices to this report.

There are 10 broader themes that emerge from this analysis, relating to the incentives, motivations and cultures that prompt the development of successful approaches to capacity. These themes (shown in Figure 3) represent transferable 'lessons' from this study and are likely to be relevant across all industries.

Figure 3: Overview of themes identified in this report

	Theme	Description
Push-factors	Situational imperative	• Parties are forced to increase capacity due to the severity of the constraint – i.e. without capacity enhancements, the organisations' aims cannot be met • *Example*: Powerful capacity constraint at Heathrow, where the airport runs at 98% capacity – the most that can be accommodated while still allowing for resilience
	Competition	• Parties are pressured into improving capacity by the actions of their rivals. This is often translated in a commercial or financial sense • *Example*: Operators on West Coast Mainline compete to gain approval for track access proposals, where there is not capacity to accommodate all options
	Political pressure	• Direction or pressure from a political overseer compels parties to improve capacity management • *Example*: Accountability of TfL to the Mayor of London
	Future planning	• The extent to which parties are able, or obliged, to take a long-term view of capacity requirements affects the ability to put in place measures in the near-term • *Example*: TfL has an Infrastructure Plan for 2050, and has some certainty that it, or an equivalent body, will be responsible for infrastructure in the long-term
Pull-factors	Alignment of incentives	• Alignment of separate stakeholders' incentives benefits capacity management by encouraging cooperation (Note: these can often be commercial or financial motives) • *Example*: In the aviation case study, the airport, airlines and NATS are all incentivised (financially) to deliver the greatest possible capacity from the infrastructure
	Knowledge and data	• Improved understanding of a situation or market, underpinned by acquisition of knowledge and insight from data, leads to a more effective approach to capacity • *Example*: Eurostar uses data on the commercial value of its trains to make decisions on prioritisation during disruption
	Decision-making structure	• Organisational or industry structures influence the ease with which change can be enacted and the effectiveness of the solution • *Example*: Horizontal integration at TfL enables a holistic approach to capacity planning as part of overall urban development
Social & environmental factors	Social responsibility	• Where a relationship or other link is in place between an operator or Infrastructure Manager (IM) and the community it serves, this leads to a motivation to provide appropriate capacity • *Example*: Kombiverkehr's ownership structure promotes action in the best interests of its customers (who are also equal shareholders)
	Productive relationships	• Where solutions to capacity rely on the responsibilities of a number of parties, strong relationships are critical to identifying and delivering change • *Examples*: Network Rail is engaging TOCs on plans for the Anglia route during CP6 from the beginning of the process
	Supportive culture / situation	• An organisational or industry culture that promotes (or rewards) creativity and flexibility is important where capacity constraints cannot be overcome by accepted methodologies • *Example*: NR's 'Improving Connectivity' report challenges accepted conventions on timetable planning

2.1.2 Assigning relative importance

While all themes have a positive influence on stakeholders' approaches to capacity, there are some variations in the degree of influence or immediacy with which they act. On the basis of the evidence provided by our case studies, and taking into account feedback and discussion with ORR, we have aligned the 10 themes into a hierarchy as shown in Figure 4.

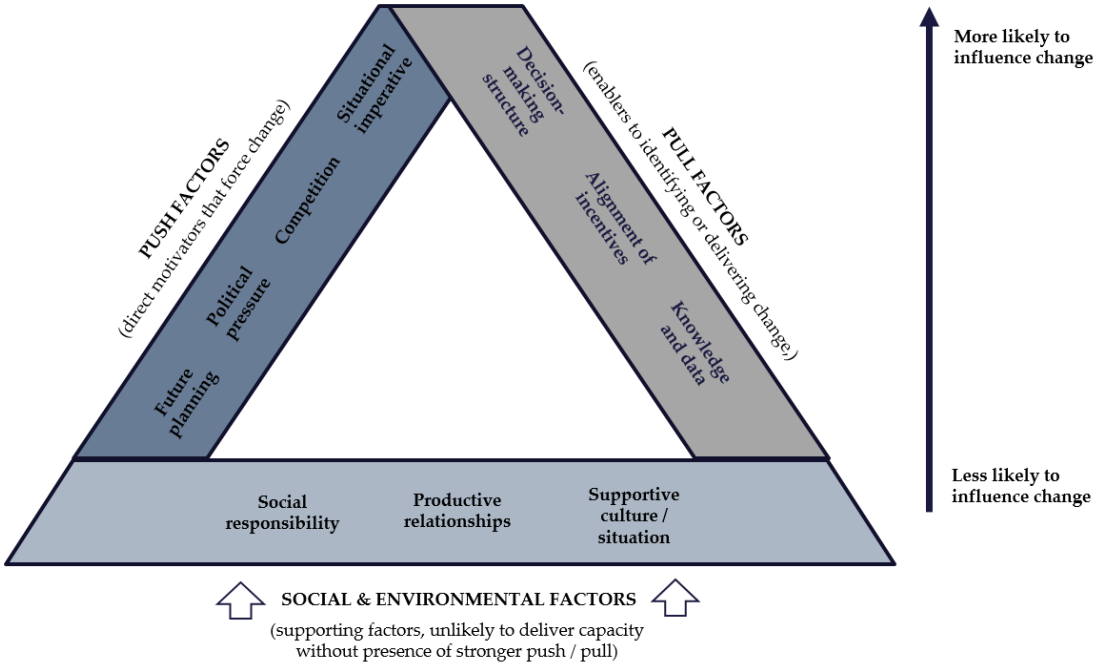
As Figure 4 shows, the Social & Environmental factors act in support of the stronger, or more direct, Push and Pull factors. It is not possible to test the impact that the Social & Environmental factors would have in isolation, though we hypothesise that this would be relatively minor unless also accompanied by a Push or Pull (or combination thereof).

Despite this, there is significant evidence that the *absence* of 'softer' cultural factors can act to undermine the overall capacity approach. This is clearly shown in French rail, for example, where perceptions that the IM has been insufficiently transparent have undermined the industry's confidence effectively[1].

> *"We know that the infrastructure manager occupies approximately 5% of all capacity on the network through possessions. This appears very high to the users of the infrastructure, but the IM has been unable to explain why this is the case. We are now trying to work with the IM to better understand and therefore help them to improve the situation."*
>
> Economist, ARAF (French regulator)

A further example of the importance of cultural factors can be seen in the Ofcom case study, where organisational flexibility towards the design of the auction was an important contributor to success, albeit alongside other themes such as competition (Pull) and market knowledge (Push).

Figure 4: Interrelationship (or hierarchy) of pillars and relative strength of themes identified[2]



Within the Push and Pull factors, we have assigned an indicative ordering of the individual themes according to their ability to influence change. Understanding that every situation will be influenced by these factors in a different way, it should be noted that we have assigned this ordering predominantly on the basis of the evidence presented by our case studies.

[1] France is currently undergoing a restructure of the IM, whereby the IM is now a part of SNCF (SNCF Réseau).

[2] Ordering of themes within each 'pillar' is intended to be indicative only, and is based on an overall assessment of the impact of each theme as evidenced in this study.

Considering first the Push factors, there is evidence, particularly at Heathrow (see: Appendix 9), to show that a strong situational imperative in place for many years can become ingrained within the decision-making of all parties and act as the single strongest motivator of change. Relatively less strong, perhaps, is the impetus provided by future planning – this effect may not be evident on a day-to-day basis, and so is arguably less immediate as an incentive for change.

We believe that the strength of the decision-making process, and in particular the way that integration is achieved across a given industry, is the strongest of the Pull factors. The TfL case study (Appendix 4) illustrates an approach to holistic planning, involving urban development and economics that is an intrinsic part of its perceived success in capacity approaches in place both now and for the future (this is discussed further in section 2.2.2 below).

The ordering assigned to themes therefore reflects our views as a result of this study. However, there are other factors that can be equally or more important in certain circumstances, and the influence of a given theme depends on its magnitude in any given situation – for example, all of the case studies exhibit some degree of situational imperative, though the severity of this at Heathrow (where the airport runs at a stated 98% of maximum capacity) is arguably greatest. As such, the relative impact of any two themes will be dependent on their 'magnitude' as well as their position in the hierarchy set out in Figure 4 – a weak situational imperative may have less influence than a strong competitive environment, say.

2.2 Lessons for GB Rail

This report provides the initial ideas and stimulus to assess the current position of GB Rail in terms of producing, optimising, allocating and planning for capacity. The themes above should now act as a framework by which to assess where there are 'gaps' in the way that Network Rail, train operators and others in the industry operate today. It is instructive to note that no single case study gave evidence of all of these themes, suggesting that an approach that selects and prioritises a subset of relevant ideas could be appropriate, and also that the appropriate ideas might depend significantly upon the context.

The scope of this study has not covered a detailed engagement process with Network Rail to undertake an analysis as described above. However, on the basis of available evidence, we suggest that there is scope for change within the formalised industry structures, where it appears the themes above could be enforced more strongly. It is less clear how well these themes are supported by the 'unwritten' or relationship-based elements of the industry – which should be an area for assessment alongside Network Rail in any subsequent analysis.

2.2.1 Competition

The theme of competition as a Push-factor is an important contributor to a number of case studies, including Heathrow. While there are elements of this present in the London Midland case, where an overlap of route with Virgin Trains led to competitive motivations, on the whole there is limited competition between operators as a result of the structure of franchises in GB Rail. Instead, the main form of competition is the franchising process itself, which is not set up with a clear emphasis on capacity management - indeed, the logistics of an engagement between Network Rail and bidders often precludes this. Direct competition is encouraged in some areas, e.g. by ORR, but this is seen as an inefficient use of capacity by others when it is given to Open Access operators. In general, our reflection is that competition could be better employed as a means to promote positive management of capacity.

2.2.2 Horizontal integration

A number of case studies illustrate how a robust decision-making structure actively supports a positive approach to capacity. One element of this is the need for high visibility of market knowledge and data, such as in the Ofcom and Eurostar cases, to provide a factual basis on which to make decisions. However, another important element is the way that industry structure supports integrated decision-making – horizontal integration at TfL is a very good example of this, where the structure of TfL supports transport planning as an integrated part of the long-term vision for urban development, and where the transport authority has appropriately leveraged third-party investment to support its development.

The ability of today's GB rail industry to undertake integrated decision-making appears more limited by comparison. While the Rail Delivery Group and other bodies have made progress on this recently, there still

appears a significant disconnect between the rail industry and the institutional users of that infrastructure. Furthermore, there is a need for a clear mechanism to channel private funding to drive increases in capacity.

2.2.3 Knowledge and data

The approach to data within the rail industry appears to be a key missing link. Whilst there is an accepted suite of industry-wide tools for some purposes (such as the LENNON revenue database, MOIRA demand model, and Network Rail's operational data feeds), there does not appears to be sufficient data, available sufficiently quickly, to inform a dynamic approach to capacity. This may be partly due to reluctance to collaborate or share data amongst TOCs – as evidenced by a reluctance to share vehicle braking characteristics as part of the ERTMS implementation, for fear this information could be commercially sensitive. The example of collaboration in the aviation case study is a useful comparison here.

Further, there is a reluctance to develop data-based decisions on capacity management given the imperfect (but adequate) information that does exist. As an example of this, there is no accepted means of assigning a 'maximum theoretical capacity' for a given section of the network. While this is indeed a complex problem, some simplifying assumptions (such as constant train length and acceleration) would allow an initial view of the problem and could inform decision-making.

2.2.4 Collective focus

Considering the industry as a whole, we hypothesise that the way to achieve significant change will be to make capacity management a major focus of the coming PR18 determination and thereby throughout Control Period 6.

The industry has seen the success of such a strategy with previous Control Periods, where the themes of safety and performance have been adopted as a key foci, leading to step-changes in approach. However, it is important to recognise that if today's focus is on performance, say, then the industry cannot expect a major step change in capacity. Objectives must be prioritised, and if capacity is to be the next major theme, it will require collective focus[3]. As an example of this, there is currently no explicit mention of capacity within Network Rail's vision statement – amending this would be the first step to embedding efficient capacity management as part of organisational mission and culture.

In addition to the themes set out here, the regime of charges and incentives is a key influence on the behaviour of stakeholders. As such, findings of the separate work being undertaken by ORR in this area should be taken into account alongside this report to inform subsequent options analysis.

[3] When delivering against this focus, there will clearly be trade-offs to be made between capacity, performance, safety and other important factors. A pragmatic approach will be required, but there should be appropriate recognition of the importance of capacity by those setting the industry's vision and objectives.

3 PUSH FACTORS

On the basis of the evidence in our case studies, the enablers of good capacity management appear to fall into a set of common themes, or 'pillars'. Of these, the first are the 'Push factors'. These are those conditions which, through coincidence or design, compel the various stakeholders to improve the quantity or use of capacity in order to avoid various negative consequence. They work in the opposite way to our second pillar – 'Pull factors' – which provide rewards or opportunities for capacity enhancements.

These enablers range from internal compulsions, such as legal obligations, to external conditions which promise the stakeholders undesirable outcomes for failure. In so doing, they drive improvement and innovation through necessity, producing solutions under circumstances where success is an organisational necessity.

These enablers often force or provoke a clear approach to be identified – and the inherent efficiency of pursuing a single view means capacity enhancements can be more swiftly realised[4]. This prioritisation leads to a concerted focusing of resources towards the problem. Consequently, the various parties involved often find themselves inclined to innovate and consider concepts which would otherwise likely be viewed as impossible.

3.1 Political/Contractual Pressure

Political/contractual pressure is an enabler common to many of the case studies we have investigated. It functions by compelling the stakeholders to push for capacity increases because of direction from some overseer, either political or regulatory. This either takes the formal shape of legal or contractual obligations or informal pressure through media statements and political oversight. Regardless, the result is often a drive towards improving capacity creation and management by the impacted party.

3.1.1 Contractual conditions

Contractual conditions work by imposing legislative terms upon the various stakeholders which force them to increase capacity and/or improve its management. This can either be by explicitly compelling them to search for capacity enhancements, or by requiring specific actions to be taken which produce the same results.

Network Rail's licence is illustrative of the former and its effects are present throughout those case studies which relate to UK rail. In particular, the Strategic Freight Network (SFN) highlights the manner in which these conditions enable the creation of additional capacity.

The SFN controls a pot of ring-fenced funding designated for improving rail freight in the UK and is defined as:

> *"A core network of trunk freight routes, capable of accommodating more and longer freight trains, with a selective ability to handle wagons with higher axle loads and greater loading gauge, integrated with and complementing the UK's existing mixed traffic network."*
>
> Department for Transport

As part of this, Network Rail aims to direct traffic away from major passenger centres by using targeted investments to create preferable diversionary freight routes. This is sometimes done in conjunction with private interests, but often projects are solely funded by Network Rail who act on recommendations from the SFN's steering group – a group of industry stakeholders that suggests potential investment-worthy projects.[5]

In funding these infrastructure improvements, Network Rail's formal role is to satisfy the conditions of its licence which requires the production of strategic documents on how to improve the UK freight network.

[4] Despite this, it remains important that within the decision-making process all available options are assessed before deciding the most appropriate course of action.

[5] Although the steering group is able to make recommendations, it is Network Rail's Investment Authority which makes the ultimate decision over whether or not a project is to be funded.

> *"We look at the network on an end-to-end basis over the period of many years to see how we can improve overall functionality. This is because the conditions of our licence (set out by the DfT) drive us to search for ways to improve the capacity and performance of the UK rail freight network."*
>
> Head of Freight Development, Network Rail

In this way, the legislative compulsion provided to Network Rail by its licence forces the creation of additional capacity. This process is strengthened by the DfT's desire to increase freight traffic as part of the government's desire to move traffic from the roads onto the rail network.

> *"The Government, through the DfT, want freight capacity increased in order to draw lorries off the roads. This is partly environmental as rail is considered the 'greener' option, and partly about road safety."*
>
> Senior Strategic Planner, Network Rail

3.1.2 Political pressure

The pressure placed on Network Rail by the government is indicative of the second, more informal (i.e. unwritten) strand of political/contractual pressure which can enable capacity improvements. Based less upon formal obligations, and more around oversight and political manoeuvring, this mechanism acts similarly by compelling the various stakeholders to focus on capacity increases.

The impacts of these pressures can be seen at Transport for London (TfL) where accountability to the office of the Mayor heavily impacts the approach to capacity management.

> *"On the simplest level, we are incentivised to increase demand and capacity because that is part of the Mayor's plan."*
>
> Director, London Underground & London Rail, TfL

TfL is responsible for enacting the transport strategy set by London's directly elected mayor. For a Mayor overseeing a city with an often overcrowded transport network, increasing capacity is a major recurring election issue and therefore a political imperative. As such, this priority trickles down to TfL whose responsibility it is to find solutions that will satisfy London's voters.

> *"For the Mayor, who is unusual in that he is directly politically accountable and directly in charge of TfL, transport is his biggest electoral strength (or potential weakness). As a result, the Mayor will push very strongly for a transport system that can serve all the demands of the electorate and does so in a manner which is desirable (i.e. regular, reliable, and resilient)."*
>
> Director, London Underground & London Rail, TfL

A particularly pertinent example of this can be seen in the upcoming extension of the Northern Line to Battersea. This project was a result of the Mayor's desire to regenerate brownfield sites and deprived areas within London such as Nine Elms and the Battersea Power Station, providing extra housing and commercial space. To make such a project attractive, improved transport links are considered an imperative, hence the pressure on TfL to expand the Underground network to accommodate it.

> *"We attempt to create additional capacity in order to drive growth in line with the Mayor's plans for the city – the theory is that with increased transport links, an area will become more attractive from a residential and commercial point of view, thus creating the demand for capacity. One good example of this is the Battersea development which is going to be connected to an extension of the Northern Line."*
>
> Director, London Underground & London Rail, TfL

Along with providing an incentive to focus and act upon capacity, these political interactions also function to provide ideas and solutions. Without the Mayoral influence, planning may be a somewhat insular process, but his oversight and the related transport planning his office devises provides an additional viewpoint, thus widening the intellectual scope for tackling the capacity constraints on London's transport network. The objectives are delivered through a clear and, largely, shared objective between the Mayor and TfL.

> *"One of the important concepts for us is how our work interacts with the overall objectives of the Mayor and his vision for London. We are very much part of the long-term planning that sets our vision for London as far as 2030 and 2050."*
>
> Director, London Underground & London Rail, TfL

The presence of such plans helps to counter some of the difficulties in creation of new capacity. Often individual councils and individuals have different views on where new lines should go – but an overarching Infrastructure Plan around where and how additional capacity can be delivered (as in place at TfL) helps to guide these conversations. When combined with the imperative to act which results from TfL's direct accountability, one can see how this informal political pressure enables improved capacity management.

Figure 5: Summary of case studies - Political / Contractual Pressure

Case study & Enabler	Description
• **Strategic Freight Network**: Licence conditions	*Network Rail's licence, issued by the DfT, requires it to produce strategic documents around improving capacity and to act upon them. This obligation compels it to create additional freight capacity, partially through the use of ring-fenced funding provided as part of the Strategic Freight Network.*
• **Transport for London**: Political accountability	*Transport for London is directly accountable to the Mayor of London and is responsible for implementing his transport plan. Given its importance as an election issue, and broad consensus around the benefits of better use of the current network, increasing capacity is therefore prioritised by the Mayor, thus compelling TfL to find ways of achieving this goal.*
• **Vancouver SkyTrain**: Public pressure	*The pubic of Vancouver expects a high-quality service. When these expectations were not met in July 2014, it cost the CEO's job. Given that maintaining service quality as demand increases requires improvements to be made around capacity management, this pressure encourages SkyTrain to find solutions.*
• **M25**: Political action in response to public pressure and licence conditions	*Investment decisions regarding which parts of the Motorway or wider road network to upgrade are made based on which areas have the necessary political support and therefore have supporting business cases produced. This political support is based upon public pressure to improve visible choke points. Additionally, the Highways Agency is compelled to increase capacity because of its government mandate to improve the strategic road network. Equally, Connect Plus (the PFI consortium contracted to deliver a specified suite of upgrades to the M25) acts to implement the Highways Agency's plans because of its Design, Build, Finance, and Operate (DBFO) agreement.*

3.2 Competition

Capacity improvements are also enabled by competition. In intensely-competed markets, stakeholders are pressured into improving capacity by the prospect of their rivals' actions. This competition often takes a commercial form, especially in the private sector where firms battle for the same market. In situations where customer demand exceeds the capacity an operator can provide, they are forced to act, less they surrender business to a competitor.[6] As a result, stakeholders push to improve capacity in order to outcompete each other.

[6] Indeed, one could argue that until the available capacity exceeds the total market's demand, there exists an incentive to improve. However, often the business case may not be sufficiently compelling to justify the necessary investment with little prospect of achieving a total monopoly. This may be because of the realities of the market (i.e. customers will never all choose the same operator), or because legislative circumstances may deny the operator the chance to achieve such an anti-competitive position.

3.2.1 Market competition

Market competition drives innovation by forcing firms to maximise the value of their available capacity in order to maintain their position. Equally, additional capacity is sought in order to grow a firm's revenue base. The Heathrow Airport case study is a particularly strong example of this, because it contains two competitive markets – airports and airlines – interacting with each other.

The aviation market is well competed, with airports vying with one another for customers. In Heathrow's case, its major rivals would appear to be other domestic airports, most notably Gatwick, with whom it competes for the domestic market (i.e. British residents traveling out of the UK) and international visitors.

However, a particular concern for Heathrow is its international competition, especially Amsterdam Schiphol and Paris Charles de Gaulle. Its overall aim is to be not just Britain's leading airport, but the 'hub' of choice for European travel.[7] This produces a particularly pressing demand for capacity because without it, airlines are incapable of acquiring sufficient runway time to run all the necessary flights for Heathrow to make sense as their hub. As such, failing to provide the additional capacity could result in a competitor airport usurping Heathrow's desired position.

> *"We (Heathrow Airport) very much want to be the European hub and if airlines are incapable of operating sufficient flights out of us, they may move to other hubs."*
>
> Senior Manager, Air Traffic Management, Heathrow Airport

Equally, competition between airlines further prompts enhancements in Heathrow's approach to capacity management given that routes in aviation are heavily competed. With airlines looking to attract passengers by providing high-quality, reliable services, capacity management at airports is vital to them because it improves network resilience and, by extension, service reliability.[8] It also incentivises cooperation between airlines and the airport, which aids Heathrow's ability to implement the data-driven solutions it has adopted.

This imperative to provide airlines with sufficient capacity to operate, as well as a high-quality, reliable standard of service (i.e. limited delays/cancelations) continues to drive Heathrow's work with NATS on the use of data analytics to optimise their dynamic management of capacity. Doing this has not only already increased network resilience, but even identified sufficient additional capacity to provide an extra pair of 'slots' (i.e. allow an extra flight in and out each day).

> *"[NATS] just found [Heathrow] a new pair (of slots) – incidentally, the first new pair since 1996 (through the use of our data-driven solution to improving capacity management).*
>
> Senior Consultant, NATS

3.2.2 Maintaining competition

However, outcompeting rivals is not the only way competition was shown to enable capacity enhancements during our research. In the case of the Ofcom 4G Auction, we also found evidence of a regulator's desire to improve capacity management.

As part of its auction process for allocating the necessary spectrum for the rollout of 4G mobile broadband, Ofcom went to great lengths to manipulate the allocation of capacity in such a way as to avoid a competitive decline in the UK telecoms market. This was because Ofcom deemed competition to be in the customers' best interests and protecting customer interests is Ofcom's primary purpose.

> *"We conducted a significant competition analysis before the auction was held and, deeming competition to be crucial to the efficient operation of the market and in the best interest of the public, implemented three measures to ensure its survival."*
>
> Director, Ofcom

[7] A 'hub' airport is one which airlines use to transfer passengers between flights during journeys that are not completed directly. This is part of a 'hub and spoke' model whereby the airline will deliver a passenger to the hub before flying them out to their final destination or spoke.

[8] Poor capacity management can result in delays which will harm the passenger experience, thus incentivising them to use alternate airlines.

In order to achieve this, Ofcom imposed a number of caveats on the auction in order to avoid the three biggest national wholesalers – Vodafone, EE, and O2 –denying anyone else entering the marketplace. These were as follows:

1. **The spectrum reservation** – A small portion of spectrum was reserved for a fourth national wholesaler. This was eventually bought by H3G.
2. **Overall bandwidth cap** – This capped the total capacity a wholesaler could acquire to avoid any single provider from controlling too large a portion of the market.
3. **Low bandwidth cap** – This capped the amount of the most desirable capacity any operator could hold in order to avoid domination of the premier capacity by a single company.

Of these three, the spectrum reservation was most important for maintaining market competition as it was the caveat which guaranteed competitive plurality and which was therefore most directly impacted by Ofcom's desire to maintain competitive intensity in the telecoms market.

> *"Ofcom was concerned with maintaining the competitive intensity of the UK telecoms market. It aimed to achieve this by ensuring a fourth national operator – in this case H3G – won sufficient spectrum to provide a full set of services. This was primarily achieved through the spectrum reservation."*
>
> Director, National Audit Office

Clearly competition is capable of enabling capacity improvements in a variety of related ways. In the private sector, competition between rivals spurs innovation in attempts to leverage continually greater rewards from the available infrastructure. Equally, public sector regulators can look to promote competition, aware of this process and the benefits it can bring. In this way, even organisations which are not direct market participants can, with the right tools at their disposal, direct and magnify a market's competitive intensity such that it enables the creation of additional capacity and/or greater efficiency in its usage.

Ofcom's objectives to promote competition and increase benefits to consumers also lead it to consider the best use of the entire range of available spectrum over the long-term. Parts of the 800Mhz spectrum being auctioned for 4G were previously used for television within London, meaning Ofcom was required to reorganise the allocation. A separate body (at800) was set up to mitigate any interference to television signals received by the public. As such, the 4G auction can be viewed as a particular event within a wider strategy to make most efficient use of the total available spectrum.

Figure 6: Summary of case studies - Competition

Case study	Description
• **London Midland 110**: Competitive intensity	*Competition on WCML flows between LM and other operators, including new entrants, was one driver for submitting plans for new services. In another sense, operators viewed the end of the restrictions placed upon new services under Moderation of Competition as an opportunity to suggest new services and hold position (or gain advantage) over their competition – 'There was something of a horse race' (Head of Revenue Development, London Midland)*
• **Kombiverkehr**: Market competition	*Kombiverkehr is committed to maintaining its position as the market leader despite substantial competition. As such, it is forced to strive for efficiency improvements and capacity increases.*
• **Ofcom 4G Auction**: Competition preservation	*Ofcom strongly believes that the competitive environment in the UK telecoms industry ensures the efficient allocation of capacity because it places strong costs on failure. This compelled it to preserve competitive plurality through the imposition of various auction conditions, whilst also managing spectrum over time in a way that allows it to release capacity for new uses, as technology and demand changes.*

• **NATS**: Competitive environment	*The intense competition present across the aviation industry (between airports and between airlines) pushes everyone to find additional capacity and improve efficiency.*

3.3 Situational Imperative

At times, the circumstances surrounding a network or the conditions under which stakeholders must operate can enable capacity enhancements. These situational imperatives force the party or parties involved to increase capacity and/or improve its management by making it integral to success. Such circumstances are often severe enough as to offer no alternative solution (i.e. without capacity enhancements, the stakeholders' aims cannot be met). In this way, situational imperatives can force an increase in the resources directed towards tackling problems related to capacity, as well as remove any intellectual/cultural barriers which are preventing an otherwise viable solution from being implemented.

3.3.1 Severity of the constraint

The most common situational imperative is an extremely high level of demand, one which not only surpasses current capabilities, but also the network's theoretical maximum. This gives the stakeholder(s) no choice but to find ways of improving the situation and is a prominent issue at Heathrow Airport.

Heathrow is currently operating at around 98% of its theoretical maximum, meaning additional capacity cannot realistically be created despite extremely high levels of excess customer demand.[9] To further strengthen this constraint, the number of flights in and out are legislatively capped.

> *"Heathrow has been hugely constrained for a long time. It currently operates at 98% capacity and is capped at 480,000 'movements' per year. This means it can have 480,000 unique take-off/landing events a year, or 240,000 full take-off-landing cycles."*
>
> Senior Consultant, NATS

> *"At Heathrow, we like to say that we are 99.x% full. This constraint absolutely drives our approach to capacity management."*
>
> Senior Manager, Air Traffic Management, Heathrow Airport

These severe constraints created an imperative that is so strong that it can be used to support business cases for developing and investing in capacity solutions. In doing so, they enable new, potentially innovative approaches to the challenges posed by limited capacity which would not make financial/commercial sense under other circumstances.

> *"[Heathrow's] work (improving capacity) is very much based around need – other airports may understand it, but if they aren't capacity constrained it makes it very hard to create a compelling business case for investment… You can effectively afford to be inefficient if you have spare capacity whilst the scarcity of capacity drives up the need for investment."*
>
> Senior Manager, Air Traffic Management, Heathrow Airport

The Strategic Airport Capacity Management (ACM) platform which NATS developed for Heathrow to improve the dynamic management of its network is a direct result of this enabler. The desire to find a solution was sufficiently strong that common barriers which had been seen elsewhere – most notably executive scepticism around the use of 'Big Data' – failed to materialise.

> *"Getting people to sign off on the use of 'Big Data' is often quite challenging. At Heathrow, this was not the case (because their team was purely interested in finding a solution)."*
>
> Senior Consultant, NATS

[9] The Department for Transport estimates that, by 2020, there will be 11 million potential Heathrow passengers who will go unserved because of the capacity constraints. Additionally, 86% of airlines have indicated a desire to increase the number of flights they operate in and out of Heathrow. See: Appendix 9.

In this way, situational imperatives such as the strength of the capacity constraints present at Heathrow can enable consideration and implementation of solutions which may otherwise make no commercial sense. Equally, necessity can allow ideas which clash with an entrenched corporate culture to overcome this barrier.

Figure 7: Summary of case studies – Situational Imperative

Case study	Description
• **London Midland 110**: High demand	*Crowding on existing services at peak times was amongst the worst in the country, prompting action to be taken to provide more seating capacity (especially during peak hours).*
• **Strategic Freight Network**: Severity of the problem	*Where freight shares track with passenger services, performance risk and opportunity cost is high. As such, there exists a clear rationale for Network Rail to influence movement of freight traffic off the core network. This acts as an incentive to provide appropriate capacity elsewhere and may also avoid financial dis-benefits in the form of performance fines.*
• **Heathrow Airport**: Power of the capacity constraint	*Although demand far exceeds supply, Heathrow's 98% utilisation rate makes providing additional capacity effectively impossible. It is therefore incentivised to work on maximising its efficiency instead.*

3.4 Future Planning

An organisation's ability or obligation to look forwards can have a profound impact on its approach to capacity management and, if circumstances align appropriately, strongly enable improvements. Most capacity enhancements require substantial investment in infrastructure, something which usually requires a strong business case to support it. If a stakeholder's planning horizons are sufficiently long-term, these are easier to construct because a return can be calculated over many more years, in so doing enabling them to push forwards with the investments.

Equally, if a stakeholder expects to remain actively involved for a long time, future demand projections can impact its decision-making process. If one expects a substantial increase in the demands placed on the network, a stakeholder who will have to manage this growth may begin preparing early, thus driving it to search for ways to improve capacity before the problem occurs.

3.4.1 Long-term horizons

Transport for London is notable for working to long-term planning horizons and planning decades into the future. This allows it to cost out infrastructure improvements over many years, thus creating justifications for capacity-enhancing projects that would not make sense if a return was required in the short-to-medium term. This makes it very different from most rail operators whose franchises typically run for less than ten years, but similar in nature to Network Rail.

> *"One thing we have, and this makes us quite different from TOCs etc., is that we are financially incentivised to invest for the future because TfL and its successors are going to be around in perpetuity, whereas TOCs know their franchises will end after a fixed number of years. They therefore think financially in terms of a few years, whereas we can cost things over decades meaning a very different set of upgrades makes financial sense to us."*
>
> Director, London Underground & London Rail, TfL

This mechanism can be seen particularly strongly in the letting of the LOROL concessions. During this process, TfL took on the vast majority of the revenue risk and funded the infrastructure upgrades and was able to specify clearly what it wanted from LOROL to meet its own long-term objectives. Doing this meant the operator was left to focus entirely on providing a reliable service in order to meet TfL's objective of increasing demand for, and utilisation of, the London Overground network. TfL believes its ability to think in the long-term played an important part in permitting such an arrangement.

> *"When we were letting the LOROL concession, our long-term considerations meant that we were able to offer the operator conditions that required them to focus purely on operating a reliable and attractive service which would drive demand. We took on all the revenue risks etc. and offered bonus payments for maintaining a reliable service."*
>
> Director, London Underground & London Rail, TfL

In and of itself, this horizon may not seem to be pushing the operator to improve capacity as much as a financial incentive might. However, the inherent corollary of thinking in such timescales is the need to plan for future demand. In TfL's case, this means for increases in London's population which are projected to be substantial. As such, its horizons do not just allow it to invest for the long term, but compel it to do so.

> *"In considering network upgrades, we (TfL) take into account expected population changes, not just in terms of growth, but in terms of density as well. Providing for these changes is crucial to our medium-to-long term (10-50 years) plan."*
>
> Director, London Underground & London Rail, TfL

3.4.2 Short-term horizons

The history of the London Overground network prior to TfL taking it over in November 2007 stands in direct contrast to the current situation and illustrates the problems with short-term planning horizons.

From February 1997 until TfL took over responsibility, the London inner suburban railway was operated by Silverlink Metro on a nine-year franchise.[10] During this time, it was renowned for under-utilisation, operational failings, and social problems.

> *"When we (TfL) took over operational control of the London Overground network, it was known for being unreliable and undesirable with the fare evasion rate exceeding 30%. Indeed, its reputation was so poor that it was commonly referred to as 'the muggers' railway' because of the problems associated with it. For example, the lights at many of the stations didn't even function at night."*
>
> Director, London Underground & London Rail, TfL

These problems were, at least in part, a result of substantial underinvestment on a network which was let in short-term franchises, with limited freedom for Silverlink to radically alter the service proposition and, coupled with this, an absence of any obvious incentives on the franchisee or Network Rail to take a radically different approach. In this way, the absence of a long-term horizon negatively impacted capacity management by pushing the relevant parties away from the necessary solutions by making them commercially unviable. This directly contrasts with the approach TfL has been able to take and the successes this has achieved, albeit with significantly more financial support.[11]

Figure 8: Summary of case studies - Financial/Future Imperative

Case study	Description
• **London Midland 110**: Opex focus over capex	*Given the typical seven-year franchise term, TOCs incentives align to achieving a return over relatively short investment horizons. As such, solutions that do not require significant capex are most attractive and prompt innovation.*
• **Greater Anglia**: Post-franchise planning/continuity of personnel	*Discussions on infrastructure upgrades for CP6 are being attended by staff of the current franchise – although the owning group may change, personnel are likely to carry over, and so hold a keen interest in negotiating*

[10] The franchise was originally due to end in October, 2006, but Silverlink was granted an extension in August of that year which took it up until November, 2007.

[11] Ridership has increased dramatically since TfL took charge. For example, between 2007 and 2013, the North London lines saw like-for-like growth of 160%.

	longer-term solutions (though this is not, in general, from a commercial perspective).
• **Transport for London**: Long-term planning horizons	*TfL has some certainty that it will exist/manage the infrastructure in perpetuity (though structures may change, transport is likely to be controlled by a body resembling TfL in future) which allows for a long-term investment horizon* *The structure of the London Overground involves a concessionaire operating the service, while TfL procures rolling stock, controls stations, and takes 90% of the revenue risk. This takes advantage of TfL's ability to commit funding over the longer term.* *Taken together, these factors suggest that TfL has the appropriate means to enact change, and is close enough to passengers to identify the appropriate solution and to push it through.*
• **Ofcom 4G Auction**: Indefinite licences	*The length of the licences being sold – indefinite with the price covering the first 20 years of operational fees – meant bidders could view their costs and potential returns over a very long timeframe, thus enabling greater infrastructure spending.*

4 PULL FACTORS

The second thematic group of enablers we observed during our research for this project was the 'Pull factors.' These complement the previously identified 'Push factors' despite working very differently; instead of compelling the parties to pursue capacity enhancements, they lure them by offering opportunities and/or positive consequences.

Creating opportunities is achieved by enabling the parties involved with managing capacity to do so more effectively than would otherwise be possible. This is done through the creation of a tool or structure which simplifies the process or makes previously impossible options possible.

Meanwhile, the positive consequences work as a reward structure, usually by offering financial gain to the stakeholders in charge of capacity for achieving significant gains. Where multiple stakeholders are present, it is also often the case that their incentives are aligned within this structure such that everyone accrues benefits from any improvements.

4.1 Knowledge and data

The acquisition of knowledge and the manipulation of data is a prominent enabler. By improving the understanding of the situation/market, this group of enablers helps to identify key pinch points in the network which are disproportionately responsible for the capacity constraints. As a result, it allows for targeted investment aimed at improving the situation.

4.1.1 Knowledge

The first of these strands, knowledge, is based upon a deep understanding of the market one operates in, particularly where the needs of the market are complex or might change over time. This is often qualitative and relies upon gathering together the opinions of a wide range of other stakeholders, from customers to well-informed experts. During our research, Kombiverkehr provided a particularly strong example of this being put into action effectively.

Kombiverkehr, a German intermodal freight operator, works closely with two groups when designing new solutions to capacity constraints: its customers and regional market experts.[12] Each is relied upon to identify possible opportunities for creating additional capacity, with customers identifying current demand whilst the market experts highlight likely future trends.

> *"Most new projects and improvements are driven by client engagement/them asking us why things are not a certain way or requesting a new service. This will start us thinking and push us to research firstly whether change would be welcomed by our customers, and then secondly to see if we can find a way to make it possible."*
>
> Head of Marketing, Kombiverkehr

> *"When it comes to identifying opportunities for providing additional capacity, especially predictive opportunities, we rely heavily on teams of specialists in each country/region… One of the functions of departments such as mine is to act as experts in their region who can identify new opportunities. This is done, in part, through maintaining a strong network of regional contacts by attending conferences etc. By doing so, we can gain access to information before it reaches the newspapers, and generally gain information from a wide range of experts which can inform our decisions going forwards."*
>
> Manager, Northern European Traffic, Kombiverkehr

These processes, and the deep market knowledge they provide, profoundly influence Kombiverkehr's strategic decisions. For example, they are currently investigating a new line in Denmark, partly as a result of expert knowledge they have acquired which is used to predict future demand trends.

[12] It is worth noting that, due to Kombiverkehr's ownership structure, its customers are also its shareholders (see: Appendix 7).

4.1.2 Data

Along with the qualitative understanding gathered by organisations such as Kombiverkehr, quantitative data has also shown itself to be valuable during our research. A good example of this is Eurostar which has proven particularly successful in leveraging data to improve its capacity management techniques through its 'Gold Train' initiative.

By leveraging its status as a full-reservation railway, Eurostar is able to gather very accurate data regarding utilisation of each service. It then aggregates this across a six-month period to identify which ones are most commonly carrying the highest amount of revenue.[13]

> *"We track the value of all of our trains – the amount of revenue they are carrying – over 6-month periods so that we can work out which services are particularly popular and generate the most revenue for us."*
>
> Route Director & Former Head of Customer Proposition

The top segment are then given 'Gold' status for the next half year and subsequently receive preferential treatment in the event of a need to prioritise among Eurostar services. This manifests itself both in terms of track access during delays and service quality (where possible, the 'Gold Trains' are run using a consistent crew and newer rolling stock).

> *"We designate 45 of our ~400 services as 'Gold Trains' which we give priority when there are problems. What this means is, we send those through the tunnel ahead of the non-Gold trains regardless of the schedule (i.e. they will be allowed to go ahead of other trains if necessary)."*
>
> Route Director & Former Head of Customer Proposition

This process is clearly enabled by Eurostar's collection and manipulation of very accurate customer utilisation data. Without it, the objective ability to work out which services were most important would not exist which would hinder the efficiency of the 'Gold Trains' initiative.

4.1.3 Technology

A complementary enabler to data is the advances in the technology used to process, analyse, and understand it. Although technology alone is unlikely to force capacity enhancement, it often works effectively in the presence of other, stronger, factors as a tool to facilitate action. It allows parties to better identify pinch points where improvements are necessary, as well as to refine current processes in order to improve the efficient allocation and/or use of the available capacity.

Nowhere was this more present than at Heathrow where NATS's Strategic Airport Capacity Management (ACM) platform is heavily reliant upon technological innovation.

The ACM tool is dynamic, analysing data in real-time and allowing decisions to be made regarding capacity management during operations in order to mitigate delays. This requires a substantially more complex/powerful computing system.

> *"It is important to note that technology is absolutely an enabler of the solution we employ (ACM). We didn't create it because technology exists, but without those advances it would not be possible to produce such an ambitious tool."*
>
> Senior Consultant, NATS

This example highlights the value of technological advances and their importance in enabling capacity management improvements. Although its existence may not have compelled Heathrow and NATS to improve capacity, it created the opportunity to produce a powerful, data-driven system which leverages 'Big Data' in innovative, not to mention highly successful ways.

Indeed, if knowledge and data are key to helping organisations understand the capacity challenges they face, then technology may be equally key in enabling them to tackle said challenges.

[13] Contrary to Network Rail, Eurostar considers capacity in terms of revenue carried, not people.

Figure 9: Summary of case studies - Knowledge and Data

Case study	Description
• **Greater Anglia**: Evidence-based decision making	*Given updated knowledge of demand for Stansted Airport flows, new rolling stock could be diverted and put into productive use elsewhere on the network. This reliance on evidence to inform the decision-making process is also integral to the planning for CP6.*
• **Eurostar 'Gold Trains'**: Knowledge of high-value passengers	*Partly because Eurostar operates a full-reservation railway (i.e. no walk-on passengers), it is able to gather far more accurate data about the usage of its services and the population traveling on them. This is then used to objectively select its priority 'Gold Trains.'*
• **Kombiverkehr**: Data-driven approach and regional expertise	*Paths will not be operated unless there is confidence that utilisation will be high. Kombiverkehr collects data regarding customer demand and the amount of freight loaded onto each train, and builds an appreciation of the costs incurred for running each service.* *Paths currently operated that fall below the breakeven benchmarks are usually relinquished. Meanwhile, communication with heavily engaged parties across its network allows Kombiverkehr to identify potential areas in which capacity could be grown to meet future demand patterns.*
• **Ofcom 4G Auction**: Detailed market knowledge	*Ofcom's in-depth knowledge of the UK telecoms market meant it was able to design an auction to satisfy its various desires (including the creation and allocation of capacity), and also systematically work through the existing spectrum to identify and release capacity for auction. This was particularly true of the clause reserving a portion of spectrum for a fourth national wholesaler – H3G.*
• **NATS**: Technological innovation	*In order to act on the various situational enablers, a solution utilising 'Big Data' was required. The software provided by NATS to enable collaborative decision making in response to flight delays is a highly technical, data-driven solution that relies heavily on technological innovation.*
• **M25**: In-depth market knowledge	*Possession of in depth market knowledge, gained through research and modelling, provides a detailed picture of expected demand going forwards. This picture allows for a more sophisticated understanding of where capacity is needed and allows for it to be created much more efficiently.*

4.2 Decision-Making Structure

Whilst data can improve an organisation's understanding of its market and ability to objectively tackle the problems, so too can its decision-making structure offer opportunities to improve capacity. This is achieved by providing the various internal stakeholders with greater spheres of influence and the subsequent ability to approach the problems caused by capacity from angles which would otherwise be inaccessible.

There is a decision to be made in this sense on whether it is most appropriate or beneficial to the system as a whole to arrange decision-making within an organisation or between organisations[14]. In the case of an integrated organisation, contracts will be informal, whereas external relationships naturally lead to more formalised, contractual relationships.

Transport for London's organisational decision-making structure illustrates elements of both vertical and horizontal integration.

[14] Similar concepts are explored in The Nature of the Firm, Coase (1937)

4.2.1 Vertical integration

Of TfL's two structural factors which provide direct benefits for capacity management, the first is vertical integration between the rail infrastructure management and operator (i.e. on the Underground, TfL is both the infrastructure manager and the operator). While TfL states this as a clear advantage, the benefits of this vertical integration may in part be linked to the nature of the TfL network – it is a single-use network with a relatively simple service pattern, and a passenger base which has relatively similar demands from the network.

TfL's control of both the infrastructure and train operations gives it a level of control over the overall system which it would not otherwise possess. This removes some of the barriers associated with multi-organisation systems which can hinder the production of capacity as everyone pursues different objectives. In particular, the speed with which ideas can be formulated and agreed means that planning and implementation can be more fully integrated. This allows for an improved approach to capacity management without the need for protracted negotiations between stakeholders.

On those lines where vertical integration is not present and TfL works as one of a number of stakeholders, there is a view that its ability to manage capacity is reduced. This primarily occurs on some of the services which are not part of the London Underground network where Network Rail is the infrastructure operator.

> *"In situations where we (TfL) need to engage with Network Rail, other TOCs etc., the processes to negotiate capacity improvements is more complicated (than when we are working on lines over which we have total control) because the number of individual stakeholders is greater and each tends to have different objective. An example of this would include the DC lines from London Euston to Watford, where we have a compelling business case for upgrades, but there is a lot of 'conversation' required to get a solution delivered"*
>
> Director, London Underground & London Rail, TfL

The absence of similar problems on those lines which are fully vertically integrated highlights some of the benefits of having a single body controlling an entire process. In particular, the ability to make quick decisions which are purely focused on improving the network (as opposed to which satisfy a far broader set of objectives) enables a more responsive and arguably better, approach to managing capacity. Albeit that such approaches might have potential downsides in different contexts, such as when there are complex and conflicting demands being placed on a network. In this case, it might be relevant to consider how vertical integration can be mimicked through alternative financial incentives[15].

4.2.2 Horizontal integration

Perhaps of even greater value to TfL than vertical integration is its horizontal integration with functions such as city planning. Unlike many rail examples, TfL exists effectively as a branch of the Mayor's Office which means it is partially involved in decision-making processes which pertain to its geographical space, but which are not transport-centric; the Battersea development and associated Northern Line extension is a good example of this (see Appendix 4). As such, it has far greater influence over the entire environment in which its network exists, allowing it to take a more holistic approach to capacity management. However, this horizontal integration is made more straightforward by a contained geographic scope, relatively less complex demands being placed on the network and more aligned views about the needs of the network when compared with wider GB rail situation. The approach described can be seen to work well as a means of integrating decision-making at a local level – allowing for an informed perspective on the basis of local knowledge, and providing the tools to implement appropriate solutions.

As a result of this integration, a cross-disciplinary team has been created which contains a selection of transport and urban planners, as well as a wide range of other personnel. This means that TfL is able to impact the overall strategy for London going forwards and to position transport as a part of that.

> *"One of the important concepts for us is how our work interacts with the overall objectives of the Mayor and his vision for London. A lot of this has to do with city planning (next areas for growth/regeneration etc.) and, as a*

[15] An example of this might be the Paris RER's migration away from a PPM-style measure to one weighted according to customer volumes carried (in a similar way to TfL's Lost Customer Hours metric.

result, we are a big part of these conversations. They are very iterative and we are very much part of the group that drives the long-term planning around things like the vision for London in 2030 and 2050."

Director, London Underground & London Rail, TfL

The Battersea development is a particularly good example of this in action as TfL was heavily involved in the planning process. This allowed it to secure agreements with the developer to ensure that the space is used for a mixture of residential and commercial purposes.

"Part of this includes lock-step agreements between ourselves and the developers to ensure that they are incentivised to complete their project in accordance with the pre-agreed plans.

Director, London Underground & London Rail, TfL

This enables TfL to project future demand much more accurately by understanding likely population trends. It is then capable of planning capacity improvements such that they will be well utilised whilst also not becoming overwhelmed going forwards. As such, the horizontal integration enjoyed by TfL allows it to plan capacity in a way that ensures upgrades are far more targeted and the additional capacity created is done so in a maximally efficient manner. Even in the absence of horizontal integration within an organisation, this example serves to highlight the importance of integrated decision-making, particularly at regional levels.

Figure 10: Summary of case studies - Decision-Making Structure

Case study	Description
• **Transport for London**: Vertical and horizontal integration	*Strategic planning within TfL is intrinsically linked to urban development – for example, the business case for the Northern Line extension is tied into the Mayor's intended Opportunity Zone developments, and is aligned to overall city planning objectives. Through an in-house cross-disciplinary team of experts, TfL is able to influence this process. It also benefits from owning the network infrastructure whilst also operating the rolling stock service on top giving it total control of the London Underground.*
• **Eurostar 'Gold Trains'**: Customer focus	*Eurostar views itself similarly to an airline and subsequently places the greatest value on the customer experience. By contrast, operational planners in GB Rail are more likely to think in terms of trains than people when assessing performance.*
• **M25**: Integrated decision-making structure	*Connect Plus M25 believes an integrated decision-making system, although currently not in place, would better facilitate the flow of knowledge and capability (particularly from the perspective of the contractor) in order to inform capacity planning..*

4.3 Alignment of Incentives

Aligning separate stakeholders' incentives can benefit capacity management by encouraging cooperation which functions to remove many of the barriers which hinder progress. If the various stakeholders are all working towards the same objective because it is in everyone's best interests, resources can be pooled making finding solutions easier. This is true regardless of whether the stakeholders are all directly involved with running the network, or if external stakeholders are also included.

4.3.1 Internal alignment

Of the case studies we looked at, Heathrow Airport provided the clearest example of capacity management being improved when the entire market was incentivised to work together.

As previously mentioned, the capacity constraints at Heathrow mean that it is effectively impossible for additional slots to be created without additional investment in runway infrastructure (see Appendix 9). This is despite both airlines and the airport having strong financial incentives to increase the number of daily flights.

For the airlines, capturing the excess customer demand and converting it into revenue is a hugely attractive prospect. Indeed, the rewards on offer for doing so can be seen in the prices the airlines are willing to pay for acquiring new slots – up to £30m for a single pair (see Appendix 9). The high price capacity commands amongst airlines is indicative of its commercial value from their perspectives.

Equally, Heathrow is also able to monetise its runway capacity, charging airlines multi-million-pound fees for the right to use its tarmac. To give an example, when NATS recently identified a new pair of slots, Heathrow received multiple bids, with Vietnam Airlines eventually winning them.

> *"Each aircraft 'slot' is a commercial entity for an airport and they are therefore able to charge for its use. In this particular instance, the new slots were taken by Vietnam Airlines."*
>
> Senior Consultant, NATS

Furthermore, NATS, the air navigation service provider, also accrues financial rewards from increased capacity. Its fees are partly based upon the number of 'movements' it facilitates each year meaning any additional capacity will provide it with direct revenue benefits.

> *"As for us (NATS), our fees are based on the number of movements we can facilitate per year, as well as the amount of fuel we save people (by avoiding them circling Heathrow waiting to land for example) so we are directly incentivised to improve efficiency and capacity."*
>
> Senior Consultant, NATS

Additionally, all three parties gain further from improved efficiency through better capacity management. Heathrow's reputation is enhanced, key to its ability to compete with other international hubs, the airlines' service quality is improved, driving customer choice, and NATS reduces fuel consumption and cancellations which boost its fees.

> *"For us, minimising delays absolutely has financial incentives by allowing us to outcompete other airports. The same is true for airlines who want to provide passengers with the best possible service."*
>
> Senior Manager, Air Traffic Management, Heathrow Airport

The degree to which incentives are aligned in this case has significant implications for the ability to improve capacity management. Although the prospects for creating additional slots are severely limited, the fact that everyone is also interested in increasing network efficiency and improving resilience has enabled a complete overhaul of the season planning process.

NATS and Heathrow worked very closely together on streamlining the process of analysing data from the previous six months to optimise the schedule. Previously, this procedure took around three months, but by digging down into the 'grass roots' of airport operations – passengers, planes, and baggage – NATS and Heathrow were able to cut this down to a one-week task.

> *"We started with the seasonal schedules and re-designed the entire process. Working collaboratively with Heathrow Airport we managed to streamline the process down from three months to one week."*
>
> Senior Consultant, NATS

They were also able to bring together a variety of stakeholders, notably including the airlines, which allowed everyone to have input into the revision process. This improved the overall collaboration between parties which has had positive knock-on effects including the cooperative approach now taken to periods of major disruption.

> *"The airlines have really bought into [the cancellation process used during major disruption]… The level of maturity displayed by all parties and the collaboration we are seeing has been a culture change that is not present across all airports, but has certainly been achieved here at Heathrow."*
>
> Strategic Partnership Leader, Airside Operations, Heathrow Airport

Overall, Heathrow Airport stands testament to the ways in which aligned incentives are able to enable a best-practice approach to capacity management.

> *"I think it would be fair to say that the alignment of incentives present at Heathrow is hugely effective at driving the efficient use of capacity."*
>
> Head of Information, NATS

4.3.2 External alignment

Whilst Heathrow shows what can be achieved when all the parties responsible for running a network have financial incentives to work towards a common goal, the Vancouver SkyTrain case study illustrates that external stakeholders can also make a positive impact.

One of the major challenges facing SkyTrain is access to funding following the financial crisis. Prior to this, a large amount of public funding had been earmarked for two programmes: the construction of a new line and a major series of upgrades. However, the recession caused the second of these to become defunded, thus reducing SkyTrain's ability to better utilise its existing capacity.

> *"When this funding package collapsed, a choice had to be made and the political consensus opted to continue the Evergreen Line project but halt much of the related upgrade programme."*
>
> Manager, Operations Planning, Vancouver SkyTrain

However, recently a proposal has been made to raise sales taxes by 0.5% in order to pay for these defunded improvements. This is due to go to a public referendum later this year. One of the prominent lobbying groups supporting this tax increase is the Vancouver business community which is heavily invested in the metro system continuing to provide a high-quality service because a high (and ever-increasing) proportion of its workforce commutes on SkyTrain. It is therefore economically important to them that capacity continues to meet demand.

> *"The business community began to take a much greater interest in our service around 2010 (when workers began using it in greater numbers) and are currently in the process of lobbying for a 'Yes' vote (in the upcoming referendum)."*
>
> Manager, Operations Planning, Vancouver SkyTrain

Although the result of this referendum is yet to be determined, the publicity generated by the lobbying group is evidence of the value its support provides. As such, the Vancouver case study offers an insight into how a transport system can, through benefitting external stakeholders, achieve a productive relationship which may provide benefits when searching for the funding necessary to improve capacity.

Figure 11: Summary of case studies - Alignment of Incentives

Case study	Description
• **Transport for London**: Varied funding streams	*The importance of London's transport network to a variety of stakeholders means that TfL is able to access substantial funding for infrastructure improvements from three separate streams:* 1. *Public sector – Money provided by government.* 2. *Farebox revenue – Money earned through ticketing.* 3. *Private sector – Money provided by business interests with vested interests in expanding/upgrading the network.*
• **Vancouver SkyTrain**: Business community engagement	*As the percentage of people commuting by metro has increased, the local business community has become increasingly aware of the importance of SkyTrain. Subsequently, support for SkyTrain improvements has come from influential groups including the Vancouver Board of Trade who have since begun advocating very strongly in favour of increased funding for service improvements. This has included lobbying for a "Yes" vote in an upcoming referendum on increasing property taxes by 0.5% to pay for upgrades to SkyTrain.*
• **Heathrow Airport**: Financially aligned incentives	*Heathrow and the airlines are all incentivised to improve the quality and availability of capacity because of its financial value to them. This alignment of incentives enables collaborative solutions to be sought out.*

5 Social & Environmental Factors

The final thematic pillar which we uncovered through our research are the 'Social and Environmental factors'. These are considerations which related to the stakeholders' organisational cultures, which allow some of the barriers to improved capacity management to be circumvented. Owing to their cultural nature, these factors are generally less concrete that the others we have discussed (i.e. the compulsions and/or rewards are less tangible).

In most cases, the Social & Environmental factors act in *support* of the stronger, or more direct, Push and Pull factors. It is not possible to test the impact that Social & Environmental factors would have in isolation, though we hypothesise that this would be relatively minor unless also accompanied by a Push or Pull (or combination thereof).

It is worth being aware that the themes described below may be the most difficult to implement from a regulatory perspective. It is difficult, if not impossible, to *enforce* a philosophical motivation to do something which can make directly implementing these challenging. However, in some areas we have identified a structure in place that supports or furthers a pre-existing social objective.

There are sometimes links between cultural factors and economic ones. For example, external incentives can cause a shift in cultural factors within an organisation by affecting the behaviour of staff within a company. Conversely, cultural factors may prohibit external incentives from having the desired effect.

5.1 Social responsibility

Perhaps the clearest overlap between social responsibility and capacity management comes where a player feels a relationship or link to the community it is serving. This feeling of service, or obligation, is typically shown through interactions with the public and communities (e.g. through passenger rail operations), though it can also be shown in a 'corporate' sense, by supporting the interests of customers within the same industry (e.g. in a freight setting).

5.1.1 Acting in the best interests of customers

In the case of Kombiverkehr, the German freight operator shown in Appendix 7, the 'community' concerned is that of its customer-shareholders. The firm describes itself as '*the German intermodal society for combined transport*', which itself is an indication of social responsibility. Further, the company operates a shared-ownership structure – Deutsche Bahn owns 50%, with the remaining 50% split equally amongst c. 230 companies who are customers of Kombiverkehr. Typically these customer-shareholders are freight forwarders (distribution specialists) or transport companies.

Kombiverkehr works on the principle that by providing an appropriate amount of capacity, and achieving the optimal utilisation of its assets, it will be better able to serve the needs of its customer-shareholders. This is a strong motivation for how the organisation is run.

> *"First and foremost, new capacity is added because customers ask for it. We exist to provide them with the best service, so if they are requesting a service, it is something we will of course look to provide."*
>
> Manager, Northern European Traffic, Kombiverkehr

This focus on serving stakeholders appears to be felt more strongly by management than any financial incentives. While Kombiverkehr aims not to be loss-making, the incentive for the business to generate profit is less strong than that to provide a beneficial service to its customers.

> *"Our remit is not to maximise profits, but rather to provide the best intermodal freight service in Europe to our [customer-]shareholders."*
>
> Manager, Northern European Traffic, Kombiverkehr

This case provides an insight to how a variation of the typical corporate structure can be used to promote community benefits. It provides a good example of a mechanism through which 'softer' motivations (acting in the best interests of the broader community) can be formalised in order to better influence actions.

5.1.2 Regionalisation

Where there is a close relationship between a transport provider and the community it serves, this is often accompanied by a sense of social responsibility. Two of our case study examples illustrate such an effect: Vancouver SkyTrain and TfL.

Taking SkyTrain first (see Appendix 5), we clearly see the means by which social and environmental aims have influenced decision-making. SkyTrain's owning group, TransLink, is a subsidiary of the South Coast British Columbia Transportation Authority – the public sector body responsible for transport in the region. The SkyTrain case illustrates two 'philosophical' motivations, firstly towards appropriately serving the travelling public and commuters of Vancouver, and secondly an imperative towards environmental stewardship and sustainability.

> *"There is a huge environmental benefit to maintaining a reliable rail network with the capacity to serve everyone. It is a far 'greener' option than driving so encouraging people to use our service, and increasing capacity to the extent that we can, is very important to us."*
>
> Manager, Operations Planning, Vancouver SkyTrain

Altruistic motivations such as these are clearly to be encouraged for their ability to enable capacity improvements, but it is often difficult to identify why organisations behave in this way unless there are other, more formal, incentives in place. In the case of SkyTrain, our analysis suggests it is the company culture and sense of purpose that drives a social motivation. This is enforced and formalised through its mission statement:

> *"Together, we connect the region and enhance its liveability by providing a sustainable transportation network, embraced by our communities and our people."*
>
> TransLink Mission Statement

As described in the case study, this culture has influenced decision-making on the construction of the 'Evergreen' line extension – the SkyTrain proposal was a preferred option over freeways which are seen as a less sustainable option, with a greater carbon impact per passenger.

TfL exhibits a similar sense of social responsibility, perceiving itself as working towards London's betterment. It is partially able to achieve this because of its devolved responsibility – its decision-making has been localised and disentangled from national policy. The public displays a high level of engagement with the transport network in terms of patronage and involvement, holding it accountable for a service that is used frequently. In turn, TfL has a strong reputation for developing the right capacity schemes to meet the requirements of its customers. We postulate that there is a sense of social responsibility behind this; that TfL is London's transport executive, with a remit not only to improve the level of service, but to drive socio-economic outcomes for the city. There are a number of factors that support this:

- As a devolved authority, TfL is focused on London and can develop localised knowledge and expertise (an example of this might be the Railplan demand modelling tool for Greater London)
- The Mayor is in charge of devolved powers, and is politically motivated to drive economic growth and social outcomes specifically for the Greater London region
    - Overseen by the Mayor, there is integration between transport and broader urban and infrastructure planning – social regeneration is often a specific objective here, e.g. the new communities provided in the Vauxhall, Nine Elms and Battersea (VNEB) Opportunity Area, which are linked to the provision of Underground capacity to Battersea
- It is also apparent that the level of engagement between London residents and the transport network is stronger than elsewhere: TfL is often prominently featured in local media (e.g. *Evening Standard*); capacity upgrades and other major projects tend to capture imagination, are a topic of discussion, and feature prominently in Mayoral and Assembly elections.

For these reasons, we may interpret that TfL is in place to 'serve' the London population, and there are a number of processes and bodies in place that support and extend this concept. This is backed by clear accountability and the fact that the electorate put significant weight on transport issues.

Within GB rail, we already have a situation where a subset of train operators is regionally focused – for example the Northern and Wales & Borders franchises are 'regional' railways – though despite this, franchising and legislative oversight is still centralised by the Department of Transport (or by Transport

Scotland). Much publicity has been made over the introduction of further devolved transport administrations such as Transport for Greater Manchester and Transport for the North, which will be conduits for local decision-making in the manner described here. A key consideration will be how to establish a clear sense of responsibility for the regions concerned, and how to implement processes that deliver integrated planning in a different, and perhaps more complex, context to that of TfL.

Figure 12: Summary of case studies - Social Responsibility

Case study	Description
• **Vancouver SkyTrain**: Social and environmental concerns	*SkyTrain is committed to providing socio-economic benefits to the city of Vancouver through the provision of a high-quality metro system. It therefore needs to create sufficient capacity to meet public demand. SkyTrain also has a desire to reduce carbon emissions which means it is committed to drawing traffic from the roads onto its network. To do this, it must provide and high-quality service and secure sufficient capacity to accommodate the additional passengers.*
• **Kombiverkehr**: Shared ownership model	*Kombiverkehr's relationship with its shareholders means that it prioritises the provision of desired services over revenue accrual. As such, it is strongly incentivised to boost capacity to meet demand whilst also ceasing low-demand services, thus leaving those paths open for more efficient uses.*
• **Ofcom 4G Auction**: Desire to maximise societal benefits	*Ofcom's mandate does not allow it to chase revenue. Instead, it compels it to attempt to maximise the benefits to society provided by the allocation and use of its infrastructure. As such, it was able to pursue a capacity-enhancing solution without concern for increasing the price.*

5.2 Productive relationships

A critical requirement of successful management of capacity within organisations and between them is an effective mechanism for decision-making. When this operates across company boundaries, decision-making takes a particular form. This is particularly relevant to the relationships between operators (both passenger and freight) and Network Rail, where decisions on capacity are often long-term considerations that require collaborative working and sharing of information between these two parties. There are also relationships to be nurtured within Network Rail itself – as a large organisation of 34,000 employees, there are real issues around how best to ensure joined-up decision-making.

We have explored three case studies from within GB Rail, which illustrate some variations in the relationship between operator and Network Rail, which we summarise below.

London Midland 110: The initial suggestion for the capacity upgrade was provided by LM, which was then submitted to ORR and taken forward for Network Rail approval. While there were some initial difficulties with the performance impact of the proposal, overall this was a productive relationship:

> *"I think one of the things that allowed a project like Project 110 to work was the way in which we at Network Rail work closely with the TOCs on long-term planning. It is very much a joint process and this dialogue was helpful in implementing the speed upgrades necessary for 110 to be the success it has been."*
>
> Project Manager, Network Rail

The timing of this proposal, towards the middle of an 8-year franchise (with possible extensions in future), and the relatively low capital investment required to achieve the solution, both allowed LM to undertake this project despite the short investment horizon that TOCs typically operate within.

Also noted was a supportive approach to assessing the solution in the first place:

> *"The solution, on paper, was a neat one which was easy to convince people was worthy of further investigation. The challenges were therefore far more on the technical side of things than around convincing sceptical parties within Network Rail to buy into the idea of increasing train speeds."*
>
> Project Manager, Network Rail

Greater Anglia: This example showed a positive approach to collaboration where the goals were medium- to long-term in nature. Planning for major infrastructure works during CP6 (2019-2024) is being approached in an inclusive manner, led by Network Rail:

> *"Unlike previous approaches, the TOCs are now being engaged in the CP6 plans for the Anglia route from the very beginning and being asked exactly what it is we would want to improve the service… Another big benefit of the CP6 approach is that [Network Rail] is starting out with a clear goal – having something to work towards from the start should enable clearer, more focused decision-making to occur."*
>
> Director, Abellio Greater Anglia

Strategic Freight Network: In this case, industry engagement is a critical means by which the infrastructure manager can influence behaviour. While the franchising process in passenger rail allows a degree of control over TOCs (as shown above with the timetable approval process for LM), freight is harder to influence. This is particularly true given the lack of a strong charging mechanism.

> *"We lack the mechanisms to impose a financial cost on FOCs to operate more efficiently and increase capacity. Although there are the track access charges, as far as a percentage of the operating costs go, they are very low. As such, they can't really be used as leverage by us."*
>
> Senior Strategic Planner, Network Rail

As such, the SFN aims to consult with the industry to provide appropriate capacity (e.g. lines that are gauge-cleared, capable of carrying long and heavy trains) where this is most needed, and where this will have a positive effect on the efficiency of operating the network as a whole.

The mechanism for this is a representative steering group drawn from FOCs, the transport executive, and Freight Groups that oversees the progress of delivering the SFN enhancements.

> *"The SFN Steering Group is remitted to oversee the prioritisation of schemes and allocation of funding for development and delivery. NR's obligation is to work with stakeholders to identify the best use of available funds."*
>
> SFN Governance & Deliverability Review

By ensuring effective and appropriate provision of capacity, the aim is to encourage use of the SFN over busier core routes (e.g. those around London), thereby improving allocation of capacity on the infrastructure from a holistic perspective. The mechanism above by which stakeholders' requirements and input can be captured is central to this.

> *"We utilise a 'carrot' mechanism by creating potential service improvements through route upgrades which would benefit the operators. Given they are very cost-focused and this is mainly based upon operational efficiency, service improvements are often attractive to them."*
>
> Senior Strategic Planner, Network Rail

In summary, the presence of a productive industry relationship, and one where capacity management is prioritised, facilitates an approach to capacity management that is flexible to change (LM), able to overcome short-term motivations and consider the overall most efficient approach (GA), and able to influence behaviour in situations where this is not necessarily a contractual obligation (SFN).

Figure 13: Summary of case studies - Productive Relationships

Case study	Description
• **London Midland 110**: Productive relationship with Network Rail	*Constructive industry relationships allowed London Midland to approach Network Rail with an idea, and to receive support in developing and implementing it.*
• **Greater Anglia**: Collaboration between all stakeholders	*Interaction between the GA route director and the operations team within the operating company enabled discussions that led to improvements in the solutions deployed. Equally, discussions between Network Rail and*

	TfL have informed the CP6 planning process whilst TOC/FOC conversations allow paths to be allocated more efficiently.
• **Strategic Freight Network**: Industry-wide collaboration	*Unlike franchised passenger operators, there is little means of directly influencing freight operators on choice of route. As a result, a mechanism which convinces operators to switch is required; this takes the form of improvements to the network that influence the operators' choice route. Industry-wide engagement through the SFN steering group, and the resulting understanding of relationships this brings, is an important factor.*
• **Kombiverkehr**: Stakeholder collaboration	*Kombiverkehr has close working relationships with external stakeholders such as the ports. By collaborating with stakeholders who impact the rail network, Kombiverkehr opens the possibility of discovering alternative choke points which need addressing.*

5.3 Supportive culture/situation

The final group of enablers is based around the decision-making bodies' individual situations and their internal cultures. To tackle some of the more difficult challenges posed by capacity constraints, it is often important to innovate as the accepted methodologies have failed (hence the difficulty of the challenges). However, this creativity is often stifled by insular corporate cultures or burdensome legislation. As such, their absence enables innovative approaches to capacity management by allowing for a situation and/or culture which promotes flexibility.

5.3.1 Supportive culture

Of these two strands, a culture which promotes intellectual creativity and innovative approaches to capacity management can be seen most clearly in the Greater Anglia case study. Specifically, the production of the Improving Capacity report by a group of Network Rail signallers is indicative of both institutional flexibility and the output this can produce.

The report's major focus was on vastly increasing the use of interchanges – a practice typically assigned significant dis-benefits in Network Rail's modelling processes – in order to dramatically decrease journey times. It worked on the premise that there is an over-reliance on the core trunk routes and that, through improving the under-utilised portions of the network, pressure could be eased on the lines suffering from excess demand.

As such, its recommendations (such as the creation of a "Core Timetable" which could be reverted to during periods of disruption) could reasonably be expected to cause some controversy and receive a degree of pushback. However, thanks to the atypical culture it was produced within, the report has managed to gain a level of traction and is beginning to be seriously discussed.

> *"[Improving Connectivity] was driven by our culture of continually looking at new ideas and new ways of doing things… Many of the recommendations it makes would have major impacts on some of our traditional services so we need to evaluate them properly, but it is certainly an interesting project worthy of serious consideration."*
>
> Lead Strategic Planner for London & the South East, Network Rail

Consequently, it is clear that the existence of a corporate culture which is open to reconsidering accepted conventions and supports intellectual creativity can result in innovative approaches to capacity management coming to the fore. By promoting such approaches, these conditions undoubtedly enable the output required for improving capacity, especially in hugely constrained environments where traditional approaches are not feasible.

5.3.2 Supportive situation

Similar to culture which promotes creativity, the conditions under which a party operates can have a profound impact on its ability to maximally improve capacity. This was a particularly prevalent theme during our research around the Ofcom 4G Auction. During the design process, Ofcom was able to include a number of conditions and caveats aimed at achieving its aims (increased rural coverage and preserved market competition) which relied heavily on a flexibility to adapt its processes to achieve outcomes in line with its statutory duties.

Along with the three caveats included to protect competition discussed earlier (see Section 3.2.2), Ofcom also attached a spectrum obligation to part of the capacity it was auctioning. This mandated the winner of one of the most desirable lots to provide indoor mobile broadband service to 98% of the UK population by 2017. By doing this, Ofcom was ensuring capacity was available to more people than ever before.

> *"A particular feature of the 4G auction, of interest from a capacity perspective, was the use of a coverage obligation. Ofcom wanted to ensure a minimum level of indoor 4G coverage (98% of households) so made this a condition of one of the more desirable packages of spectrum in the 800MHz band."*
>
> Director, Ofcom

This condition, undoubtedly successful in increasing customer access to mobile broadband services, was enabled by the supportive situation Ofcom found itself in, as were the caveats which ensured competition in the market did not contract to three players.

> *"It is worth noting that Ofcom is a relatively powerful regulator with a number of powers available to it – it could, for example, have chosen to block mergers between the big three, or to have regulated the types of contracts which can be sold to customers. Instead, it opted to ensure the marketplace had space for an extra competitor."*
>
> Director, National Audit Office

Had Ofcom been less able to act in the best interests of the network, it may not have been able to design an auction which was as specifically tailored to increasing capacity and benefitting the British public. That Ofcom had the authority to use these conditions to achieve its goals is evidence of the ability of a supportive situation to enable capacity improvements.

Figure 14: Summary of case studies - Supportive Culture/Situation

Case study	Description
• **Greater Anglia**: Flexible culture	*Capacity is a variable resource. In the case of the Class 379 deployment, a willingness to change plans led to better utilisation of resources to provide capacity where it was needed most. Equally, the Improving Connectivity report was enabled by a culture of intellectual flexibility.*
• **Ofcom 4G Auction**: Contractual freedom	*It was possible to tie the coverage obligation to a lot of 800MHz spectrum because Ofcom possessed sufficient legal freedom in writing the licences. It was also permitted to run an outcome-based auction.*
• **M25**: Open culture / willingness to challenge convention	*The M25's openness to accepting the use of new technological solutions was integral to its capacity enhancements. Equally, the willingness of the various stakeholders to alter their thinking around what may be possible within the confines of running a safe motorway, in particular the conversion of the hard shoulder, was a key feature in their success.*

APPENDICES

1 Appendix 1 – London Midland Project 110

1.1 Situation and Background

1.1.1 Description of scenario

- London Midland (LM), a member of the Govia group of TOCs, has been the operator of the West Midlands franchise since 2007.
- There are a number of different service types within this franchise, including cross-city flows in Birmingham, West Midlands 'regional' services, and mainline flows between London Euston and Crewe on the West Coast Main Line (WCML).
    - Mainline services into London Euston are among the most strategically important and constitute a major portion of revenues for the operator.
- A number of major stations on the WCML are served by both London Midland and Virgin Trains (VT) which is the operator of InterCity West Coast franchise. These include, for example, Birmingham New Street, Coventry, and Rugby.
    - Broadly, VT operates 'fast' services whilst LM operates stopping services. As such, the fastest London-Birmingham journey at peak times might take 1h22m with VT but 2h04m with LM.[1]
- Where origin and destination stations are served by more than one operator, revenue is allocated through the ORCATS system. Tickets sold for 'Any Permitted' route between two major stations are allocated according to the typical proportion of customers using each option.
    - For example, due to the difference in journey time, it is assumed that customers travelling on 'Any Permitted' tickets would choose VT for a direct journey between Birmingham New Street and London Euston as this is the quickest option.
    - However, in many cases there are specific LM-only ticket types sold that are cheaper than the equivalent 'Any Permitted' tickets for the route. When one of these is used, revenue is allocated solely to LM.
- As a franchised TOC, LM has the ability to influence some, but not all, of the factors relevant to the provision of capacity.
    - For example, timetabling, fares policy, light train maintenance and modifications, and some element of rolling stock choice would fall within the TOC's remit, subject to the requirement to meet their franchise commitments and the train service requirement specified by the DfT.
    - Other factors such as infrastructure upgrades, heavy rolling stock maintenance, and major procurement of new stock are generally led or supported by other parties.
- For all TOCs, an important consideration when making investment in the franchise is the likelihood of achieving a return over the course of the allotted franchise term.
    - Most franchises last for c. 7-8 years (with options for extension). Major investment is perhaps most likely early in the term to allow maximum time for benefits to be realised.
    - This is not always the case – for example, if funding is provided or matched by the DfT or other stakeholders, this may change the viability of particular projects.

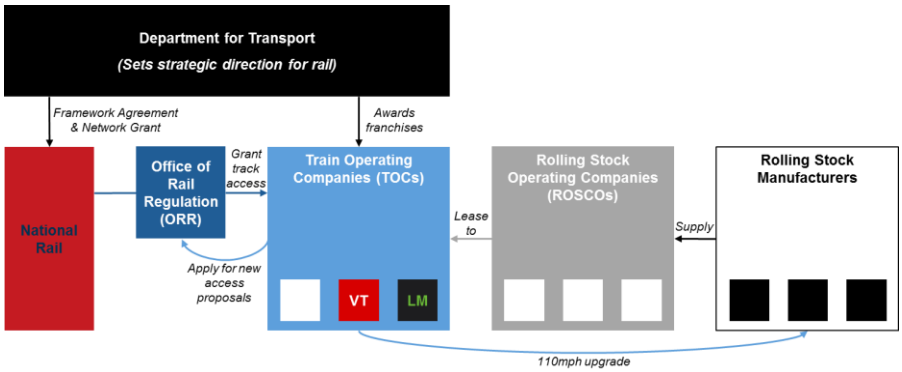


Figure 1: Stakeholder diagram

[1] Journey times correct as at 10th March 2015, for fastest services in the (am) peak 7am-10am out of EUS.

London Midland offers a range of semi-fast and stopping services on the WCML. As a TOC, it is able to influence timetabling and some elements of rolling stock choice

1.1.2 Measurement/quantification of capacity

- Track Access rights applications are decided by ORR, in consultation with Network Rail, which awards rights to operators (both passenger and freight) in the form of train paths.
- There are many constraints to consider when allocating train paths, but for the purposes of this case study the most appropriate is train speed.
    - Where trains travel at different average speeds on the same line, faster services will inevitably catch slower ones. These may vary because of stopping patterns or because of differences in maximum running speed.
- On the WCML:
    - VT Class 390 'Pendolino' (and some 'Super Voyager') trains run at up to 125mph and use a 'tilt' to achieve this.
    - LM Class 350 'Desiro' stock was originally run at 100mph.
    - Freight operating on the WCML is slower, typically between 60mph (coal) and 75mph (intermodal).[2]
- The WCML is quadruple-tracked as far as Crewe, and so the constraints on train speed are partially overcome by separation of 'fast' and 'slow' lines in each direction.
- However, where the 'slow' lines accommodate stopping services, more direct 100mph services need to share the 'fast' line with 125mph services – leading to potential for interference as faster trains catch slower trains.

Available train paths are the key measure of capacity in this case, and these paths operate over segregated 'fast' and 'slow' lines

1.1.3 Capacity challenge

a. Limited infrastructure capacity

- The West Coast Route Modernisation (WCRM) was a major project undertaken during CP3 to unlock additional capacity on the route.
    - Delivered by December, 2008, these works included:
        - Re-signalling and remodelling works at Rugby, Northampton, Nuneaton and Milton Keynes.
        - Installation of new track on the Trent Valley section to upgrade a 12-mile section of double track to quadruple track.
        - Overhead line works.
- As such, the context for LM's plans was one in which infrastructure upgrades had recently been completed, with further major capacity enhancements unlikely for the immediate future.
- The WCML continues to be heavily used by a large number of freight and passenger operators.
    - In total, 11 passenger operators use at least part of the WCML. It is also a very important freight route for distribution from the south (e.g. Channel Tunnel) to terminals in Daventry, Coventry, and Hams Hall (near Birmingham).

[2] Network Rail, West Coast Main Line Capacity Report (October 2010)

"The complex mix of services represents a major challenge in terms of maintaining performance levels and pathing of services."

Network Rail WCML Capacity Report, 2010

b. Contractual restrictions

- Until 2012, WCML operators (other than VT) were restricted in their ability to add new services due to legal measures imposed by the DfT through Moderation of Competition (MoC).
    - The premium payments to government agreed in VT's initial Franchise Agreement were intended to partly recoup the government's expenditure on the WCRM project.
    - To protect these premiums, MoC was introduced.
    - The MoC protection meant that some of the uncertainty around VT's revenues could be alleviated by not allowing other operators to directly compete with its services.
    - Other operators were therefore to be restricted from adding services or routes where it could be demonstrated that this would abstract revenue from VT.
    - MoC ended in March, 2012, at which point a number of options were submitted to ORR by Open Access and Franchised TOCs for the introduction of new services or variations on existing ones. LM submitted a proposal for an amendment to their existing track access contract as part of this.
    - These submissions were then assessed by ORR as part of an options process, including stakeholder consultation, engagement with Network Rail and an independent performance model of the impacts.
        - Schemes from Open Access operators were still required to demonstrate that they would attract a material amount of new business to the railway (rather than abstracting from franchisees), and this prevented acceptance of a number of the proposals

c. Strength of customer demand

- At the time of making a proposal for 'Project 110', it was clear there was customer demand.

"In the three-hour peak, 14,486 seats were provided with 15,437 passengers travelling. Of these, 2,300 were standing [given uneven loadings]. Further, in the high peak, all services were at the maximum length for the infrastructure. This prompted the question: How we can create more capacity?"

Head of Revenue Development, London Midland

- This view was supported by ORR.

"In the evening peak, which would be the main beneficiary from the proposed changes, sixteen trains load in excess of seating capacity. Going out of London, one train loads in excess of 145% of seats to Cheddington, and another to Harrow & Wealdstone, and standing is common as far as Bletchley. Growth in excess of 30% is anticipated on these services over the next fifteen years, which indicates the potential scale of the problem."

ORR's 'Minded to' response to London Midland on 30th SA

- However, consideration of potential solutions is a complex process involving the Operator, Network Rail, and consulting with other operators and stakeholders on the route.
- In particular, with the introduction of additional services comes performance impacts and reduced resilience, the understanding of which is a key part of the timetable approval process with Network Rail.

The capacity challenge was due to finite infrastructure, a (temporary) restriction on flexibility in services, and strong customer demand

1.1.4 Solution employed

- LM procured its original fleet of Siemens 'Desiro' Class 350s in stages between 2004-5 (350/1) and 2008-9 (350/2) – these made up the operating fleet at the time the solution was proposed
    - Operating speed for the stock was originally 100mph despite the fleet being technically capable of 110mph.
- A project team at LM was tasked with reviewing timetable options for the period after MoC came to an end.
    - It was suggested that if running speed could be enhanced from 100mph to 110mph, there was potential to operate two services into the current path (see Figure 2).
    - This could be delivered by upgrading the operating speed of the Class 350 stock, a programme of upgrades that could be carried out by the OEM, Siemens.
- Service changes would be split into two packages for peak and off-peak times, with the off-peak changes introduced in December, 2012, followed by the Peak changes in December, 2014.
- Following successful testing, Siemens carried out the upgrades during 2012, allowing the Off-Peak timetable change to take place.
    - The pre-existing timetable operated two services per hour (xx.13 and xx.46) on the fast lines out of Euston.
    - The path of the xx.46 was 'split': an additional service was added into each off-peak hour (xx.49) as a stopping service, and the xx.46 service was adjusted to run fast (non-stop) between Milton Keynes and Rugby.
    - The xx.13 service remained unchanged.
- The off-peak changes could be delivered by using the 'spare' trains within the existing fleet that were previously only diagrammed at peak times.
- In order to deliver the enhancements for the Peak service, additional rolling stock was required
    - LM, in collaboration with DfT, procured 10 new Class 350/3 sets. The cost of these was included in the business case for the proposal.
    - At the time, TransPennine Express also had a requirement for similar units, so a buying arrangement was put in place whereby LM would negotiate for all the units at once to secure best value for the Department.

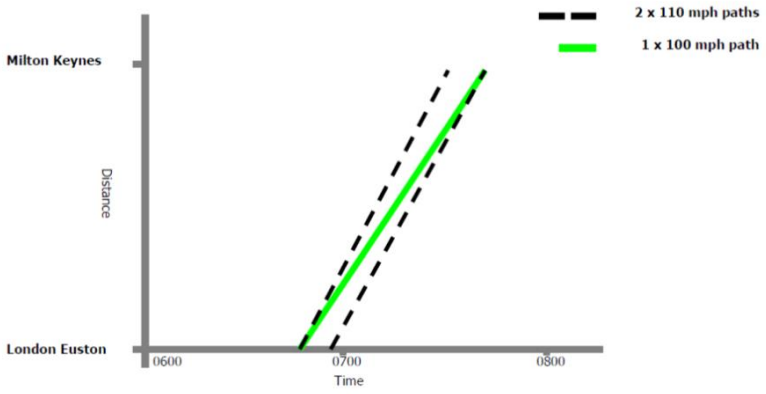
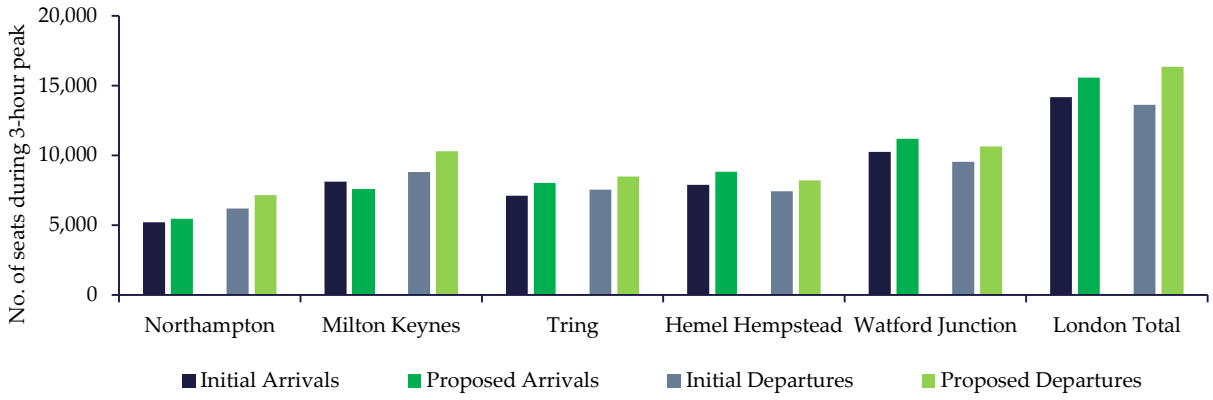


Figure 2: Diagram showing how two 110mph faster paths fit within the 'shadow' left by one 100mph slower path (Source: London Midland)

- The full peak timetable came into effect in December, 2014, significantly altering the 'fast' services ('slow' services remained unchanged).
- As a result, an additional two morning peak services and five evening peak services were added, including non-stop journeys between London and Northampton.
    - These cut the minimum journey time between the two from 57 minutes to 48.
    - The overall increase in capacity works out at 3,922 in the mornings (~7.5%) and 8,060 in the evenings (~15%).

Figure 3: Change in Peak passenger seats arriving/departing London Euston as a result of Project 110[3]



LM's solution involved acceleration of services and, as a result of the capacity unlocked, the addition of new services. This led to a material increase in passenger seats into and out of the key London terminus

1.1.5 Relevance of study

- This is a directly relevant study from within GB Rail, particularly when considering the capacity issues faced on lines into the key London terminal at Euston. The situation has a strong analogy to the East Coast, for example, where a number of operators run services to and from Kings Cross
- This study demonstrates a successful collaboration between the infrastructure manager and the TOC to improve performance when using measures within the TOC's control.
    - As such, the approach taken may hold lessons for other franchised operators in the UK market.

The collaboration and creativity in this study is directly relevant to other UK TOCs and Network Rail

Figure 4: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Competitive intensity on the WCML, and strong customer demand for existing services, incentivised creative thinking around a capacity solution* • *Given the restriction on elements controllable by the TOC, LM's solution centred on rolling stock modification and timetable change* • *This was based on existing infrastructure and (largely) existing assets (i.e. stock)*	✓
b. Performance optimisation	• *A restriction on capital available to be employed, allied to TOCs' short-term investment horizons,*	✓

[3] Source: 'Project 110 – Faster, more frequent, more seats', London Midland. Note: seats departing Milton Keynes fall slightly under the proposals due to changes in stopping patterns, however this is offset by the fact that trains which do stop under Project 110 will be more lightly loaded (i.e. more chance of getting a seat). London Total reflects the total number of seats into/out of London Euston.

		led to a solution requiring a relatively inexpensive performance enhancement of existing stock • *Overall network performance (PPM) was predicted to see a minor negative impact due to reduced resilience, though Network Rail's judgement (after stakeholder consultation) was that this was outweighed by capacity benefits*	
c.	Efficient allocation of capacity	• *Competitive forces between WCML TOCs led to a keen interest in retaining additional paths within LM*	✓
d.	Planning for future capacity in response to demand	• *N/A*	×

1.2 Analysis of incentive approach

1.2.1 Incentive to improve capacity

a. Competitive pressures

- Given that a number of flows on the WCML are offered both by LM and by Virgin (as well as some competition by Chiltern Railways), competition is an influence on this railway in a way that is not the case elsewhere in the UK.
    - Thus, the ability to gain advantage, or protect ground, against a competitor is a strong motivation.
- Virgin Trains, as the operator of the InterCity West Coast franchise, had a Moderation of Competition clause written into its Franchise Agreement.
    - The timing of the initial LM 'off-peak' proposal coincides with the end of Virgin Trains' Moderation of Competition clause in 2012 and was only made possible by the lifting of restrictions.
- LM was not the only operator to review creative options.

> *"In the run up to the end of Moderation of Competition, there was something of a horse-race with a lot of operators, including new open-access operators not already active on the West Coast such as Alliance which suggested a Blackpool-London service."*
>
> Head of Revenue Development, London Midland

- There was a total of 18 expressions of interest in anticipation of the end of MoC.
    - The DfT submitted a set of applications on behalf of the future franchisee.
    - London Midland contributed two proposals (off-peak and peak 110mph services).
    - Grand Central proposed a 110mph service from London to Blackpool.
    - Alliance Trains proposed services to Blackpool North, Bradford Interchange, Hebdon Bridge and Leeds.
- The ORR commissioned a programme of work to review, and performance-model, the feasibility of these suggestions.
- From LM's perspective, the competitive imperative to participate in this process lay in two factors:
    - Actively pursuing opportunities to enhance its own service relative to competitors.
    - Limiting the opportunity for scarce paths to be consumed by competitor activity as this would limit the potential for LM, or moreover the West Midlands franchise itself, to expand or diversify in future.

> *"While the Open Access propositions served new destinations, there would still be a noticeable impact on London Midland because the Blackpool services, for example, would call at intermediate stations on the way. ORCATS would therefore allocate a share of revenue to that activity."*
>
> Head of Revenue Development, London Midland

- It is therefore evident that competition has a strong role to play – when the suppression of competition was removed, a number of parties were keen to add capacity.
- Competition was a factor in two distinct ways:
    - There was pre-existing competition on the route between operators, which is a form of market competition limited elsewhere in rail
    - During the options process, there was completion to agree the best solution and be granted access rights - there was not the capacity to accommodate all proposals. This bears a resemblance to the franchise process as currently applies elsewhere in UK rail.
        - Whilst their plans were eventually rejected, Open Access Operators contributed to the competitive forces felt in this case.

b. Willingness to explore factors within TOC control

- TOCs are constrained by Franchise Agreements which tend to lend themselves to a short-term investment horizon.
- In this example, LM was keen to explore those factors within its direct control in search of a capacity solution.
    - In the face of growing demand from passengers (these were among the most crowded services in the country) LM reviewed options where it could feasibly, and commercially, act to improve the customer experience.
- The chosen solution minimised the requirement for new rolling stock by focusing on a modification to existing units.
    - Some new stock was still required (10x Class 350/3 sets), though these were economically procured in a joint arrangement with the DfT and TPE franchisee.
    - Whilst new stock would be purchased by the Rolling Stock Owning Company (ROSCO), the cost of this would have been passed on to LM through increased rental rates for new units.
- Therefore, in partnership with the train manufacturer Siemens, proposals were developed to perform the required traction upgrades to the Class 350 stock.

c. Relationship with Infrastructure Manager

- This solution was dependent on involvement from Network Rail in order to sign off the necessary timetable amendments.
- Records of the approval process show there were some issues to be resolved from the initial proposal:

> *"One of the reasons that Network Rail has not agreed to this [initial stage] application is that two of the proposed peak services do not fit within the timetable, as they breach the timetable planning rules ("TPR"), although work is being done to see if this can be resolved. However, performance modelling has shown that these are technical breaches of the TPR, and that, practically, there would be little or no effect on other services, because the TPR do not reflect the actual capability of the network."*
>
> ORR 'Minded-to' decision on LM 30th Supplemental Agreement, 15 December 2011

- In particular, an engineering assessment was required of the impact of running long, 110mph sets under the overhead lines. Collaboration between Network Rail, LM, and Siemens allowed for testing to take place of a new pantograph design to ascertain no negative impact on infrastructure or other services.

> *"The Class 350/1 fleet will be fitted with either the modified Brecknell Willis or the new European pantograph following testing and the acceptance criteria have been agreed and documented with Network Rail. Both pantographs have exhibited significantly improved performance compared to the existing Brecknell Willis pantograph in simulations undertaken with the assistance of Network Rail."*
>
> London Midland letter to ORR, 1 May 2012

- Overall, however, there is evidence that this was a successful cooperative process.

"Project 110 was initially driven by London Midland. They approached us with the initial idea which we then worked closely with them on the technical requirements to getting it implemented. Basically, it was a collaborative project where the conceptual idea came from the TOC."

Project Manager, Network Rail

LM was incentivised by the potential competitive response of other operators, and its action was supported ('pushed') by a supportive relationship with the IM and a flexibility to explore factors within LM's control

1.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 5: Enablers identified within study

Enabler	Corresponding element of case study
1. Opex focus over capex	*Given the typical 7-year franchise term, TOCs' incentives align to achieving a return over relatively short investment horizons. As such, solutions that do not require significant capex are most attractive and prompt innovation.*
2. Competitive intensity	*There is active competition with Virgin services on a number of routes into London Euston. The constraint on possible paths meant there was a strong incentive to ensure no paths were surrendered to the competition and that any additional paths created could be operated by LM.*
3. Customer demand	*Crowding on existing services at peak times was amongst the worst in the country, prompting action to be taken to provide more seating capacity (especially during peak hours).*
4. Productive relationship with infrastructure manager	*Constructive industry relationships allowed LM to approach Network Rail with an idea and to receive support in developing and implementing it.*

1.4 Conclusion

- London Midland's solution to the capacity constraints on the WCML was to accelerate key Euston flows from 100mph to 110mph through rolling stock modifications and a small procurement to fulfil the additional stock requirement at peak times.
    - This produced an additional c. 4,000 seats in the morning peak and c. 8,000 in the evening peak.
- This approach was incentivised by competitive activity (or the threat thereof), and enabled by a positive relationship with Network Rail (and ORR) to satisfy the necessary requirements and testing for the new timetable to be introduced.
- Further, the case evidences the positive steps that can be taken by a TOC where a capacity solution is present within the factors it can control.

Figure 6: Case Study summary box [London Midland Project 110]

Key parties involved	*London Midland (operator), Network Rail, ORR, Virgin Trains (indirectly)*
Capacity challenge	*Peak services into/out of London Euston among the busiest in the country*
Approach	• *Upgrade existing rolling stock to 110mph, and procure a small order of additional 110mph stock* • *As a result, operate two services in the path formerly occupied by one* • *Deliver both capacity improvements and journey-time benefits to passengers*
Enablers	• Opex focus over capex • Competitive intensity • Strength of customer demand • Productive relationship with Infrastructure Manager

2 Appendix 2 – Greater Anglia

2.1 Situation and Background

2.1.1 Description of scenario

- The Greater Anglia route is currently operated by Abellio Greater Anglia, a joint venture between Abellio, Go Ahead, and Stagecoach following National Express' failure to retain its original franchise.
    - This includes providing passenger services across the Anglia region as well as into London Liverpool Street.
- Service improvements from the routes covered by Greater Anglia – the West Anglia Main Line and the Great Eastern Main Line – were first outlined in the Greater Anglia Route Utilisation Strategy published in 2007 and fall into different Control Periods.
    - **CP4** – CP4 ran between 2009 and 2014 with upgrades predominantly consisting of acquiring new rolling stock and minor infrastructure improvements.

      "The major physical enhancements during CP4 were based around adding new rolling stock to the line and small infrastructure gains such as power increases and platform upgrades."

      Director, Abellio Greater Anglia
    - **CP6** – CP6 is due to begin in 2019 and is in the planning stages. Unlike its predecessors, it included early-stage TOC engagement plus discussions with numerous other stakeholders.

      "We involved all the various stakeholders in this process from the TOCs and FOCs to TfL and local councils – it simply could not work without everyone being involved together."

      Lead Strategic Planner for London & the South East, Network Rail
        - The planning took two forms: 'market studies' and 'route studies.'
            - **Market studies** – Aimed at investigating which rail markets are underserved regardless of the routes they use.
            - **Route studies** – Aimed at identifying gaps in the network where capacity is exceeded by demand projections.
    - Additionally, a paper entitled *Improving Connectivity* was published in December, 2014, which looks at alternative methods of improving network performance.

Abellio Greater Anglia operate passenger services on a portion of the UK rail network for which Liverpool Street is the focal London hub

2.1.2 Measurement/quantification of capacity

- Capacity on the Anglia network is measured in terms of total passengers able to arrive at a given station during a specified period of time.
    - This is measured in particular with relevance to one- and three-hour peak periods, both in the morning and evening.
- Network Rail, through its High Level Output Specification (HLOS), has set a target of increasing capacity into Liverpool Street by ~43% during the three-hour morning peak by 2018-19.[4]

Capacity is measured in terms of potential passenger arrivals and departures, in particular over the morning and evening one- and three-hour peaks

[4] This is an increase from 66,800 in 2013-2014 to 95,400 in 2018-2019. Of these, 33,000 are expected to be carried by the Crossrail line which will carry passengers through Liverpool Street – the capacity of trains terminating there is actually expected to decrease from 66,800 to 62,400. "Route Plan Anglia Summary Business Plan," Richard Schofield and Dave Ward, *Network Rail*, p. 28.

2.1.3 Capacity challenge

- High levels of customer demand, especially during peak hours for commuter services into London, put high levels of strain on the network.
    - The termination point of Anglia commuter services – Liverpool Street – is the third busiest overground terminal in central London with over 60,000 peak arrivals each morning.[5]
- Liverpool Street station was identified as the major choke point on this line, especially during the crucial peak hours when there was no opportunity for additional trains to operate into the station.

> *"The biggest constraint harming service frequency was identified as Liverpool Street which simply could not take more trains. As a result, we are now adding stations there to enable us to run additional services."*
>
> Lead Strategic Planner for London & the South East, Network Rail

- Additionally, rail investment in the Anglia region had been low for a prolonged period of time, causing existing capacity problems to magnify.

> *"Investment on the Great Anglia routes had been low for a long time, which meant we were able to identify a number of critical pinch points."*
>
> Director, Abellio Greater Anglia

Figure 7: Greater Anglia route map

Customer demand and limited investment put pressure on the rail network, a problem which was exacerbated by the limited platform capacity at Liverpool Street Station

2.1.4 Solution employed

a. CP4:

- CP4 was heavily focused on increasing traffic into Liverpool Street Station, especially during peak times.

> *"During this period (CP4), the DfT made increasing capacity into Liverpool Street during the morning peak a major priority."*
>
> Director, Abellio Greater Anglia

- The upgrade programme included new rolling stock for use as part of the Stanstead Express which was purchased by the TOC, and some limited infrastructure improvements funded predominantly by Network Rail.

[5] "City centre peak and all day arrivals and departures by rail on a typical autumn weekday, by city: 2013," *Rail Statistics*, Department for Transport, Jul 24., 2013 – Accessed on 05/03/2015 at https://www.gov.uk/government/collections/rail-statistics

"The upgrades were funded roughly 50/50 between the TOC and Network Rail, with the TOC covering the rolling stock, which Network Rail dealt with platforms etc."

Director, Abellio Greater Anglia

- Much of the new rolling stock was old London Midland trains, but this was supplemented with new 378-class trains intended specifically for Stanstead.
    - However, when it became apparent that Stanstead would be over-served, the trains were shortened, allowing some of the new stock to be diverted onto busier routes.

"Demand forecasting suggested that the 12-car formations planned for Stanstead were unnecessary so we reduced the size, allowing some stock to be diverted onto the Cambridge/Liverpool Street line."

Director, Abellio Greater Anglia

- However, because limited capex was available, the major changes were achieved through a complete re-writing of the timetable focused on maximising utilisation.

"We eventually over-delivered on the DfT's objectives for Liverpool Street, primarily by completely re-writing the timetable. With limited capex available, our approach focused heavily on working out how best to utilise our existing infrastructure."

Director, Abellio Greater Anglia

b. CP6:

- Network Rail began its CP6 Long Term Planning Process approximately two years ago by engaging with stakeholders from across the industry and beyond.
- Relying heavily on available evidence and modelling techniques, the aim was to identify the network's choke points so that they could be targeted for improvement.

"The studies were heavily evidence-based which, from our (Network Rail's) perspective, is a very important concept. It underpins so much of what we do… We considered a wide range of solutions to the choke points we identified, including double-decker trains, longer trains, and more frequent trains."

Lead Strategic Planner for London & the South East, Network Rail

- Options were reviewed relative to their cost-effectiveness in order to ascertain the appropriate solution. This was eventually decided to be increased frequency.
    - Given much of the additional capacity was required into Liverpool Street, it was decided that upgrades to allow more trains to terminate there were required.

"In the end, we determined that increasing service frequency was the most cost-effective solution so moved on to trying to tackle implementation. We identified the biggest constraint harming service frequency as Liverpool Street which simply could not take more trains. As a result, we are now adding platforms there to enable us to run additional services."

Lead Strategic Planner for London & the South East, Network Rail

- A crucial feature of the planning process was Network Rail's collaborative relationship with the TOC.
    - Network Rail required reliable data, much of which came from the TOC as a result of their collaboration on the CP6 planning.
    - Equally, TfL's involvement allowed for gaps regarding future housing planning – a key aspect of long-term projections – to be filled in.

"We never have a problem getting data of the TOCs [for use in strategic planning]. Similarly, working with TfL has certainly helped us a lot as they have been able to fill in a lot of the gaps around housing."

Lead Strategic Planner for London & the South East, Network Rail

- The relationship between the TOC and the FOCs is also beneficial, both for this process and more immediately as it facilitates a dialogue which can lead to the intelligent allocation/reallocation of capacity to increase overall network efficiency.

"We also have a good relationship with many of the FOCs meaning that, if there is an unused freight path which we would benefit from acquiring, we can speak to them and see if a solution can't be reached."

Director, Abellio Greater Anglia

c. Improving Connectivity:

- The *Improving Connectivity* report was written by a group of Network Rail signallers who were tasked with taking a new approach by looking at non-traditional rail markets (i.e. journeys not taken by rail) and foreign networks.
- The major focus was on vastly increasing the use of interchanges – a practice typically assigned significant disbenefits in Network Rail's modelling processes – in order to dramatically decrease journey times.
- The idea came from the premise that there is an over-reliance on the core trunk routes and that, through improving the under-utilised portions of the network, pressure could be eased on the lines suffering from excess demand.
    - This was conceptualised by comparing demand across the road and rail networks in order to identify population behaviour (see Figure 2).[6]

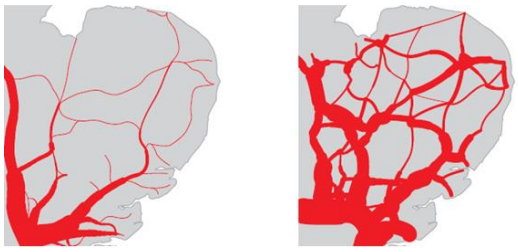


Figure 8: Rail and road usage across the Anglia region

- The study recommends using stations across the region as interchange hubs in order to achieve utilisation patterns similar to the road network.
- To do this, coordinating the rail schedules so that numerous trains are in each station simultaneously is crucial.
    - This requires journeys between hubs run just under half an hour, to allow trains to arrive at 00, 15, 30, or 45 minutes past the hour.[7]
- It also proposes creating a "Core Timetable" that would be reverted to as standard during periods of excess delay (e.g. major engineering works).

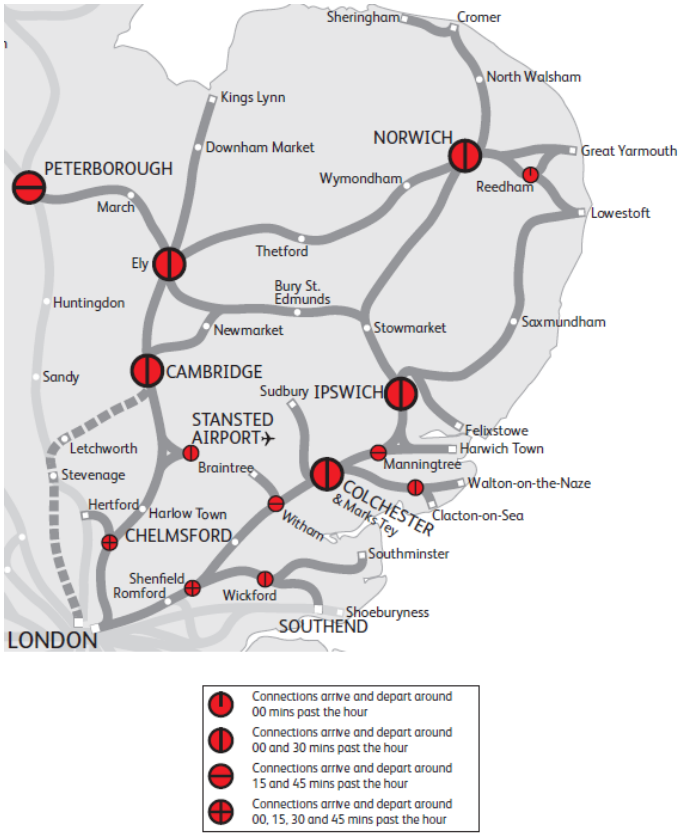


Figure 9: Proposed interchange hubs

> *"[The 'Core Timetable'] would be designed to ensure that connections etc. are still possible (i.e. people wouldn't just be stranded somewhere) so that at least a basic service could be provided to most people."*
>
> Lead Strategic Planner for London & the South East, Network Rail

Upgrades in the Anglia region have been somewhat modest in recent years. However, major collaborative planning initiatives which rely heavily on shared data have identified a number of potential opportunities, most of which focus around easing the pressure on Liverpool Street

[6] "Improving Connectivity," Paul Plummer and Peter Wilkinson, *Network Rail*, Dec. 2014, p. 6.

[7] Ibid., p. 10.

2.1.5 Relevance of study

- This case study represents an example from within UK rail where improvements have been achieved without substantial capex, including through the rewriting the timetable for services into Liverpool Street.
- It also illustrates the value of cooperation during both the planning and operating stages, not just between Network Rail and the TOC(s), but also amongst the wider group of stakeholders (including the FOCs, the DfT, and TfL).
    - In particular, the value of the information that can be collected and shared by amongst the interested parties, and its potential impact on predicting, and preparing for the future is potentially instructive.
- Finally, through the *Improving Connectivity* report, this case study raises the related issues of learning from foreign examples/adjacent industries and being open to unconventional thinking. In so doing, it is able to explore the potential benefits these may bring.

Greater Anglia shows the potential gains which can be achieved in the absence of major investment through creativity, collaboration, and evidence-based research

Figure 10: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Abellio's updated timetable produced additional capacity into Liverpool Street without requiring substantial investment*	(✓)
b. Performance optimisation	• *A recent study into 'Improving Connectivity' describes how service reconfiguration can improve complex passenger journeys*	✓
c. Efficient allocation of capacity	• *Before introduction of the new Class 378 rolling stock, a re-assessment was made of the intended deployment plan. Given rail demand to Stansted Airport had not reached predicted levels, NXEA (at the time) chose to strengthen Cambridge to Liverpool Street provision* • *The discussions between AGA and the FOCs on reallocating unused paths allow that capacity to be allocated more efficiently*	✓
d. Planning for future capacity in response to demand	• *There is an open engagement in place between AGA and Network Rail on CP6 enhancements* • *Continuity of personnel (regardless of owning group) means discussions can be extended beyond franchise terms (though not, in general, commercial discussions)*	✓

2.2 Analysis of incentive approach

2.2.1 Incentive to improve capacity

- The two major stakeholders – Network Rail and Abellio Greater Anglia – had substantially different incentive structures underpinning their attempts to increase rail capacity in the Anglia region.

a. Network Rail

- Network Rail predominantly acts in line with its licence agreement which, at least in the Anglia region, compels it to look for ways to provide additional capacity to meet high levels of demand.

> *"Our licence agreement requires us to improve the rail network and this is what pushed us to look for ways to boost capacity."*
>
> Lead Strategic Planner for London & the South East, Network Rail

  - This compulsion is particularly strong given the targets set by the DfT in their High Level Output Specification (including increasing traffic into Liverpool Street during the morning peak by 28,600).[8]

- Despite these conditions, the financial gains Network Rail could expect from any additional capacity it created are negligible, especially when compared to their values relative to the requisite costs.

> *"Monetarily, we are not really incentivised to boost the capacity of the rail network – we gain some additional track access charges, but these are not substantial and would not justify the work required to increase capacity."*
>
> Lead Strategic Planner for London & the South East, Network Rail

b. Abellio Greater Anglia

- Abellio's incentives are heavily tied to its franchise agreement, both with regards to raw capacity increase and the strategies employed.
  - In term of simply adding seats to the network, the terms of their franchise require it to deliver the capacity increases set out by the DfT.
  - The length of the franchise also heavily impacts the TOC's approach by pushing it away from major spending programs aimed at bringing long-term benefits towards cheaper, operational improvements.

> *"From our (Abellio's) perspective, investments in infrastructure etc. are heavily influenced by the franchise lengths as we have to think in terms of getting a return. As a result, we prefer timetable solutions to capital investment because it is much easier to see a return on something requiring such little expenditure over the relatively short period of our franchise."*
>
> Director, Abellio Greater Anglia

    - This reasoning explains Abellio's choice to re-write the timetable to increase traffic into Liverpool Street instead of investing in large capex projects.

- Despite the nature of the franchise agreements, there is also consideration given to preparing for the future, both because Abellio intends to retain beyond its end date and many of the staff in decision-making positions are likely to remain in them even should the franchisee change.

> *"It is important to note that we are always looking to the future as well and planning to win the next one (franchise). This means we are somewhat willing to invest beyond the end date because we believe it will be in our best interest going forwards, especially given things like that cannot hurt in the franchise bidding process.*
>
> *"Another factor to consider is that many of the personnel carry over, so from the perspective of some of the decision-makers, having investment that provides future benefits will likely help them later on."*
>
> Director, Abellio Greater Anglia

- Finally, there is a feeling within the TOC of obligation towards the customers which prioritises improving the network and providing passengers with a high-quality service.

> *"It's really important to understand that we are absolutely interested in what the best solution is for passengers and the rail network. Looking at this as a purely self-interested process would be a mistake – the people making the decisions genuinely care about doing a good job."*
>
> Director, Abellio Greater Anglia

[8] "Route Plan Anglia Summary Business Plan," Richard Schofield and Dave Ward, *Network Rail*, pp. 27-28.

Network Rail is primarily incentivised by its licence obligation whilst the TOC's focus is dictated largely by its franchise agreement. These are complimented by a desire to provide customers with the best possible service

2.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 11: Enablers identified within study

Enabler	Corresponding element of case study
1. Evidence-based decision making	*Given updated knowledge of demand for Stansted Airport flows, new rolling stock could be diverted and put into productive use elsewhere on the network. This is also integral to the CP6 planning process.*
2. Long-term planning horizons	*Discussions on infrastructure upgrades for CP6 are being attended by staff of the current franchise – although the owning group may change, personnel are likely to carry over, and so hold a keen interest in negotiating longer-term solutions (though this is not, in general, from a commercial perspective).*
3. Productive collaborative relationships between all the stakeholders	*Interaction between the GA route director and the operations team within the operating company enabled discussions that led to improvements in the solutions deployed. Equally, discussions between Network Rail and TfL have informed the CP6 planning process whilst TOC/FOC conversations allow paths to be allocated more efficiently.*
4. Culture of flexibility	*Capacity is a variable resource. In the case of the 378 deployment, a willingness to change plans led to better utilisation of resources to provide capacity where it was needed most.*

2.4 Conclusion

- A re-written timetable and additional rolling stock has allowed Abellio Greater Anglia to increase services into Liverpool Street.
    - Limited reallocation of unused freight paths, achieved during discussions with the relevant FOCs have also helped.
- Looking forwards, Network Rail has expanded its Long Term Planning Process for CP6 to include all the various stakeholders from the very beginning.
    - This has allowed it to collect a higher quality of data, a fact that is integral to its evidence-based decision-making process.
- Both the TOC and Network Rail are driven to increase capacity by conditions imposed upon them by the DfT.
    - For the TOC, this is its franchise agreement, whilst for Network Rail, its licence conditions are paramount.
- Meanwhile, a group of signallers produced a report entitled, *Improving Connectivity* which offers ideas around how increased use of interchanges could dramatically improve network efficiency.
    - It also suggests creating a "Core Timetable" which can be reverted to during periods of major delay in order to allow services to function with maximum efficiency, even when the infrastructure's capability is severely limited.

Figure 12: Case Study summary box [Greater Anglia]

Key parties involved	*Network Rail; Abellio Greater Anglia; various other stakeholders*
Capacity challenge	*The DfT wants to increase traffic into Liverpool Street by 42% by 2018-19*
Approach	• *The TOC procured new rolling stock and re-wrote the timetable* • *Liverpool Street is due for major upgrades to allow extra arrivals* • *Network Rail have initiated a collaborative planning process which engages all the relevant stakeholders*
Enablers	• Collaboration between all stakeholders • The availability and use of data • Long-term planning horizons • Culture of flexibility

3 Appendix 3 – Strategic Freight Network

3.1 Situation and Background

3.1.1 Description of scenario

- The Strategic Freight Network (SFN) was defined in the 2007 Rail White Paper as:

> *"A core network of trunk freight routes, capable of accommodating more and longer freight trains, with a selective ability to handle wagons with higher axle loads and greater loading gauge, integrated with and complementing the UK's existing mixed traffic network."*[9]

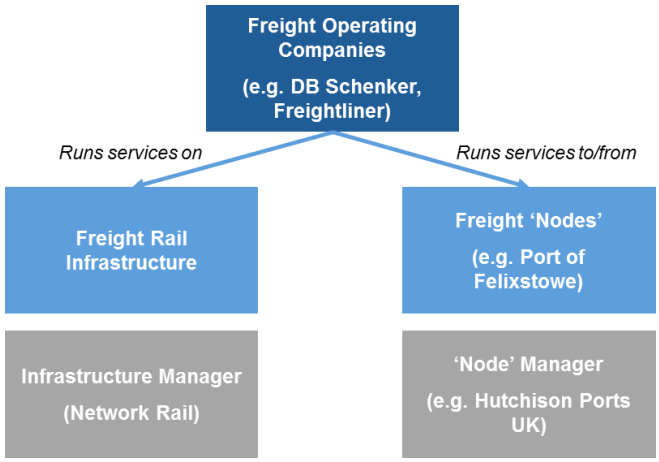


Figure 13: Stakeholder diagram

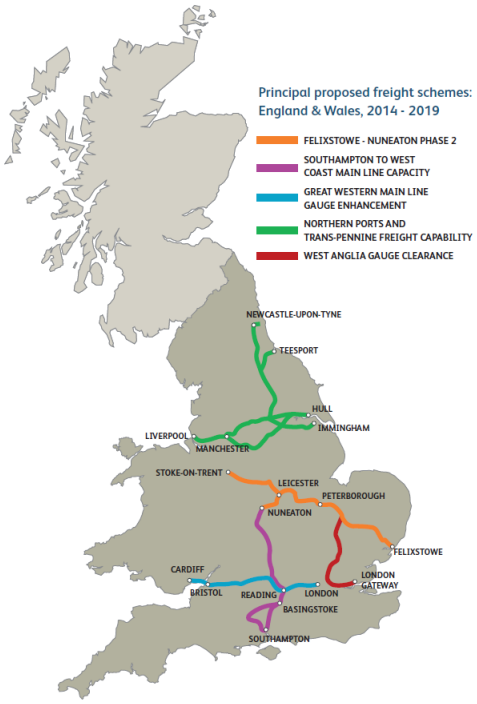


Figure 14: Schemes included within the SFN

- The SFN is designed to provide ring-fenced funding to further its nine objectives:
  - I. **Longer and heavier trains** – to optimise path utilisation, the aim is to move to standard intermodal[10] trains 775m in length.
  - II. **Efficient operating characteristics** – increased through-running to deliver environmental and journey-time improvements.
  - III. **7-day and 24-hour capability** – aspiration to increase frequency to meet changing business needs
  - IV. **W12 loading gauge** – all strategic intermodal routes to offer W10 and W12 loading gauge (where economically viable).
  - V. **UIC GB+ (or 'European') gauge freight link** – use HS1 to offer European gauge traffic from the Channel Tunnel to Ripple Lane.
  - VI. **New freight capacity** – additional intermodal routes to meet industry growth forecasts and avoid traffic moving onto the UK road network
  - VII. **Electrification of freight routes** – ongoing, rolling programme of electrification to secure diversionary and resilience benefits and incentivise the use of electric freight traction.

[9] "Britain's Transport Infrastructure – Strategic Rail Freight Network," *Department for Transport*, Sep., 2009, p.9.

[10] Intermodal freight is the transportation of freight in containers or vehicles which can be carried by multiple modes of transportation (including rail, truck, and ship), without the freight requiring handling.

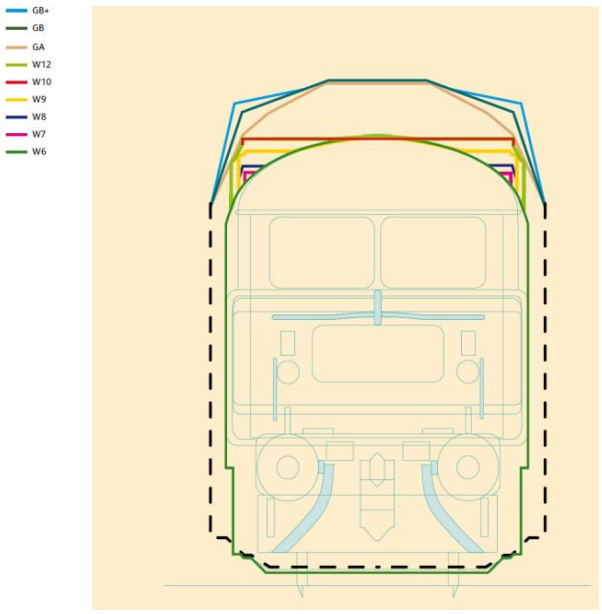


Figure 15: 'Gauge' refers to the maximum height and width of stock permitted to navigate a given route. (Image: Network Rail)

VIII. **Strategic rail freight interchanges and terminals –** continued provision of suitable interchange terminals for modal shift which can handle longer, electrically-hauled trains.

IX. **Strategic freight capacity initiative –** provision of a quantum of protected freight paths where growth is forecasted and tightening of 'use it or lose it' rules to optimise the use of capacity.

- However, the fund's purpose is not to support investments where the benefits are sufficient to warrant direct funding from the various stakeholders. In these cases, the expectation is that the beneficiaries will provide the funding themselves.

The Strategic Freight Network is a comprehensive plan for effectively allocating funds aimed at improving the UK rail freight network

3.1.2 Measurement/quantification of capacity

- The various infrastructure operators – Network Rail and the freight nodes (e.g. ports) – think about capacity in markedly different ways:

a. Network Rail

- Network Rail struggles to measure capacity owing to the irregularity of freight service, although the number of paths offers some idea of the theoretical maximum.

> *"Capacity is very difficult to measure for freight because defining a 'path' is not nearly as simple as it would be for passenger services. You can get into a situation where trains are running to one of two (or more) destinations. In that situation, you may have a train running every day, but going to different end points. As a result, it may appear you have low utilisation on some paths – the unused destination(s) – despite actually running the train every time.*
>
> *"Equally, path utilisation is very dependent on the industrial/economic climate. For some industries, freight acts as part of their manufacturing process and the trains will not run if production is low. However, you can't just treat that as empty capacity because without it, the industry which relies upon it during times of high production may be incapable of operating."*
>
> Senior Strategic Planner, Network Rail

b. Freight nodes

- For ports, capacity is predominantly measured by the amount of freight they can get onto the rail network each day. This is determined both by the paths available which determine maximum theoretical capacity (as a function of both quantity and quality) and their ability to load containers prior to the trains' scheduled departures.

Paths are a less constant concept in freight than passenger rail which makes measuring capacity more complex

3.1.3 Capacity challenge

- By January, 2014, economic growth had pushed freight levels to their pre-recession levels. Volumes grew 5% year-on-year between Q1 2013 and Q1 2014, thus creating a capacity challenge for the SFN.[11]
    - Intermodal freight has grown quickly relative to the rest of the industry, with volumes increasing 17.2% between 2008 and 2013 compared to 6.3% overall growth for rail freight.[12]
- 'Grandfathered paths' – ones traditionally held by freight operators which are hard for Network Rail to reclaim – exacerbate many of the problems. Whilst theoretically providing capacity, many which have low levels of utilisation at times remain empty (freight companies do not run services unless there is sufficient demand to make them economically viable), effectively occupying the infrastructure without actually carrying any freight.
    - These are therefore often achieving 0% utilisation, thus reducing practical network capacity.
- Problems also exist at freight nodes (ports etc.) where the network's poor reliability[13] can cause major utilisation issues by severely decreasing the available un/loading window.

> *"The amount of unreliability in the system can cause us major problems as a late arrival reduces the time we have to load and unload a train which can result in boxes being left behind (given the train has a fixed departure time). This means that reliability, or a lack thereof, can constrain our ability to fully load the trains before they leave our port."*
>
> Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

Increasing demand, in particular in the intermodal sector, is putting pressure on the UK rail freight network. This is magnified by structural peculiarities and unreliability

[11] "Column – January 2014: Rail Freight Revival," *Freight on Rail*, Jan., 2014 – Accessed on 17/02/15 at http://www.freightonrail.org.uk/ColumnJan2014.htm

[12] "The Logistics Report 2014," Freight Transport Association, p. 13.

[13] In excess of a quarter of all freight trains – 26.4% – arrived late at their final destination in 2013. This compares unfavourably with previous years (it is the lowest level since 2008), although on-time arrivals only rose above 75% once between 2008 and 2013 (75.3% in 2012). Ibid.

3.1.4 Solution employed

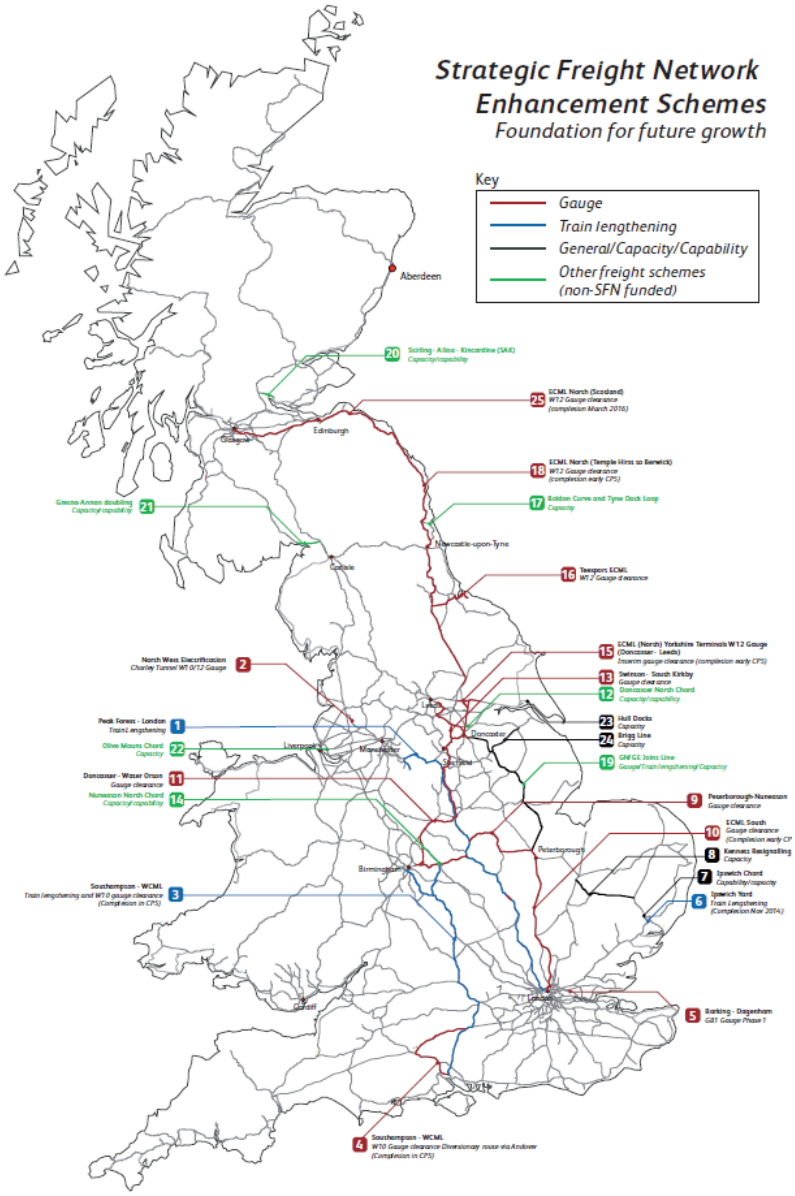


Figure 16: Specific schemes within the SFN programme (Network Rail)

- The SFN set up an industry-wide steering group comprised of a wide range of stakeholders, designed to provide strategic oversight to the development of the SFN (including those projects which are not directly funded by it).
    - The group includes representatives from, the large freight operators (e.g. DB Schenker, Freightliner, and GB Railfreight), as well as Network Rail, the DfT, TfL and other stakeholders.
    - Any decision taken by the steering group requires the consensus of all members.
- Projects identified by the steering group as likely to improve capacity are then passed to the Network Rail Investment Authority – the steering group does not possess any direct power over spending.
    - However, prior to the Network Rail Investment Authority reviewing plans, they require the steering group's approval, allowing it to direct which projects receive consideration for funding.
- A key part of Network Rail's strategy has been to divert freight away from major passenger centres, in particular looking to reduce the amount of freight that travels into London.

- However, it lacks the regulatory authority to reclaim underutilised paths from operators or impose substantial financial costs for failure to operate them efficiently.

  "Although there are the track access charges, as far as a percentage of the operating costs go, they are very low. As such, they can't really be used as leverage by us."

  Head of Freight Development, Network Rail

- Instead, attempts are made to offer more attractive services to the FOCs so as to convince them to move to the desired routes voluntarily.

  "We utilise a 'carrot' mechanism by creating potential service improvements through route upgrades which would benefit the operators. Given they are very cost-focused and this is mainly based upon operational efficiency, service improvements are often attractive to them. We can do this in a number of ways, but the best options are either increasing the network gauges, thus allowing trains to carry far greater payloads, or creating conditions to allow faster trains, thus reducing journey times."

  Senior Strategic Planner, Network Rail

- Additionally, some private entities with an interest in the improvement of the freight network opt to fund some schemes which provide them with direct benefits (though the scale of this is not significant).
- One such example of this is the Port of Felixstowe which is owned by Hutchison Port Holdings and has invested in both network improvements and a new intermodal freight terminal.

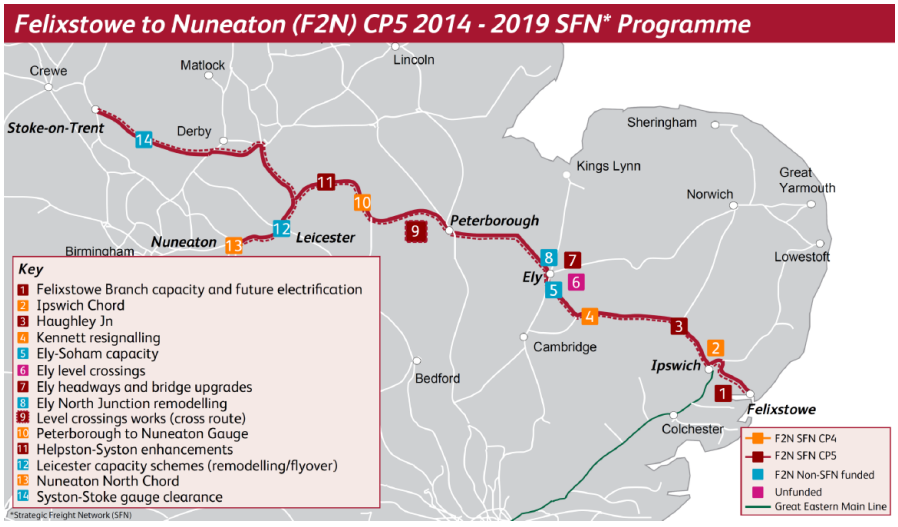


Figure 17: Current upgrade plan for the Felixstowe to Nuneaton line – Image provided by Network Rail

"There is currently an ongoing Network Rail initiative to improve the freight network and we have part-funded that. Meanwhile, we have also built a new terminal, using our own (private) capital."

Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

- The new terminal is designed to facilitate longer trains to increase capacity, as well as decrease delays (i.e. improve resilience at the Felixstowe freight node) to improve utilisation/efficiency.

  "Our new terminal is 730m long and designed to allow longer trains to run, potentially up to 35 cars in length… The other thing we are looking at is improving efficiency – with the network's capacity basically maxed out at the moment (the line to Ipswich is single-track so there isn't really much that can be done there), it's the best option we have."

  Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

- This was partly encouraged by increased competition from a variety of sources, including other ports (such as the recently-opened London Gateway) and airports, both of which have the capability of attracting freight away from Felixstowe.

The SFN, led by its industry-wide steering group, identifies investment-worthy upgrade opportunities. Additionally, private entities fund schemes which provide them with significant direct benefits

3.1.5 Relevance of study

- This case study represents an example of broad stakeholder engagement within the UK freight industry aimed at achieving mutually-beneficial results.

  - These may offer insights into the value of industry-wide collaboration in the planning and decision-making processes. In particular, there may be lessons to be learned from increasing the private sector's role.
- It also represents an area within UK rail where substantial private investment has been captured, an attractive concept to the industry as a whole should this be replicable more broadly.
- Finally, the prominence of intermodal freight, a rapidly growing sector, may be of interest given its increasing importance in the UK freight industry, and, by extension, the UK rail industry as a whole.
  - This will also provide a contrast to the franchise process in so far as the Port of Felixstowe can invest with a much longer-term payback horizon given that, as a freight node, it stands to benefit from infrastructure upgrades for an indefinite period.

This case study explores a growing sector of the UK rail industry in which all stakeholders are involved in making strategic decisions and private sector funding is prominent

Figure 18: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Licence conditions, and the terms of reference of the Strategic Freight Network's ring-fenced funding, were stated as key incentives to develop an effective programme of infrastructure upgrades (note that not all of these are directly capacity-enhancing)*	✓
b. Performance optimisation	• *Network Rail has an incentive to appropriately manage the freight network so as not to negatively impact performance on core passenger routes* • *As such, the more attractive the trunk routes are made, the less likely that long, slow freight movements will disrupt main lines*	✓
c. Efficient allocation of capacity	• *In this study, the level of control that the infrastructure provider may exert on operators is limited* • *Operation of services relies on private investment in stock, drivers, etc. over which Network Rail has little control – unlike passenger operations which are controlled through the franchising process* • *Opportunities to obtain paths are limited – a system of 'grandfathered' rights is a barrier to new entrants and does not guarantee the most efficient use of the infrastructure*	✓
d. Planning for future capacity in response to demand	• *N/A*	✗

3.2 Analysis of incentive approach

3.2.1 Incentive to improve capacity

- The incentive structures within freight differ somewhat between Network Rail and the various private sector parties.

a. Network Rail

- Network Rail views its primary objective as being to secure the rail network's ability to operate successfully over the long-term. In this way, improving the network (as opposed to merely adding capacity) becomes its focus.

> *"For us, it is not about incentives to better manage capacity, it is more looking at the network on an end-to-end basis over the period of many years to see how we can improve the overall functionality."*
>
> Head of Freight Development, Network Rail

  - However, it is currently pursuing schemes aimed at increasing capacity for a variety of reasons, many of which are related to ensuring the network remains fit for purpose going forwards:
    - **Demand** – There is currently insufficient capacity to meet customer demands and NR's forecasts suggest that this will become worse as time progresses.
    - **Licence condition** – Part of the condition of Network Rail's licence requires it to produce strategic documents on how to improve the UK freight network. Recent output supports increasing capacity, hence the expansionary drive.
    - **Government objectives** – Government, through the Department for Transport (DfT), want freight capacity increased in order to draw freight off of the road network. This is partially an environmental concern (rail represents a 'greener' mode of transport) and partially a road safety one.

b. Freight operators

- The FOCs are predominantly driven by customer demand and a desire to increase profits, especially given the margins in the industry are quite low.

> *"[FOCs] only make money on their last few boxes of each journey so naturally efficiency gains are hugely important to them and they're particularly keen to lengthen their trains."*
>
> Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

  - Equally, given the industry's limited path capacity, FOCs often hold onto underutilised ones to ensure they are accessible should demand patterns change in the future. This leads to an interesting dynamic by which Network Rail attempts to alter the incentive structure in order to lure the FOCs away from paths deemed suboptimal.

c. Freight nodes

- Similarly to the FOCs, nodes such as Felixstowe are strongly incentivised by high levels of customer demand.

> *"I'm already sending out 30 trains daily and if I could acquire extra capacity, I could fill it overnight."*
>
> Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

  - Similarly, the competition provided by other nodes (ports, airports etc.) makes capacity and reliability crucially important for entities such as Felixstowe.
- However, despite these varying incentives, the overall result is a group of stakeholders whose objectives are very similar.

> *"It's also important to understand that we are not unique in wanting extra capacity – everyone (ourselves, the FOCs, Network Rail) has the same aims. In that way, our incentives are strongly aligned."*
>
> Senior Manager, Strategic Rail Network Development, Hutchison Ports UK

- This alignment explains the success of the SFN's steering group in bringing together all the various stakeholders to work towards common goals.

- By having a wide range of stakeholders involved in upgrading capacity, and therefore ensuring a range of opinions are considered, the SFN is able to push backing towards schemes which will benefit as wide a range of rail users as possible.
  - Specifically, Network Rail's commitment to improving the overall UK rail network means that projects which draw freight away from passenger centres are supported because they can free up additional capacity for passenger services.
    - This is partially incentivised by Network Rail's licence conditions and the performance fines it risks should it fail to provide a high standard of service for all rail users.

3.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 19: Enablers identified within study

Enabler	Corresponding element of case study
1. Severity of problem/accrual of benefits to the infrastructure manager	*Where freight shares track with passenger services, performance risk and opportunity cost is high. As such, there exists a clear benefit to Network Rail if freight traffic can be moved off the core network, and this acts as an incentive to provide appropriate capacity elsewhere. This may also avoid financial disbenefits in the form of performance fines.*
2. Quality of relationships/ industry-wide collaboration	*Unlike franchised passenger operators, there is little means of directly influencing freight operators on choice of route. As a result, a mechanism which convinces operators to switch is required; this takes the form of improvements to the network that influence the operators' choice route. Industry-wide engagement through the SFN steering group, the resulting understanding of relationships this brings, is an important factor.*
3. Private sector benefits/long-term payback horizons	*The private sector's ability to accrue financial benefits from the network over long, potentially indefinite periods, incentivises it to invest in infrastructure improvements.*
4. Customer demand	*Industry growth means that increased capacity is required to satisfy customer demand which is directly monetised by the private sector parties. This is particularly true with regards to intermodal freight which is growing especially quickly.*
5. Licence conditions	*Network Rail is conscious of its institutional purpose to improve the rail network and believes increasing capacity will achieve this. Equally, the SFN has a specific set of Terms of Reference that describe the way that its ring-fenced funding is to be spent. Network Rail is also conscious of the government's desire to reduce carbon emissions and freight rail is markedly 'greener' than the alternative: road haulage.*
6. Ability to assign dynamic value to capacity	*However, a drawback of this case is that there is a clear disbenefit from not having a means of exchanging paths with other users of the infrastructure – e.g. there is no formal mechanism to reallocate capacity in advance where it has been identified as spare. Were this to be present, we believe it would act as an enabler of more efficient capacity management.*

3.4 Conclusion

- This case study looks at industry-wide decision making with regards to public investment in infrastructure improvements through a pot of ring-fenced funding.
    - It is also notable for the manner in which the various stakeholders' incentives are aligned towards desiring increased network capacity, albeit for varying reasons.
- It also illustrates the extent to which the private sector is willing to fund infrastructure improvements when it expects to see direct benefits.
    - This is further enabled by the indefinite payback periods given the lack of a franchise system.
- Finally, it explores the manner in which Network Rail has to incentivise FOCs to change their path preferences in the absence of stronger regulatory powers.
    - This suggests that a system through which capacity could be more easily reallocated, potentially even dynamically reallocated through a system of trading, would prove beneficial.

Figure 20: Case Study summary box [Strategic Freight Network]

Key parties involved	*Network Rail; freight operators; freight nodes; other industry stakeholders*
Capacity challenge	*Rail freight is a growing industry, in particular intermodal freight*
Approach	• *The SFN provides ring-fenced funding for upgrading the UK freight network* • *This is allocated by Network Rail to projects approved by an industry-wide steering group* • *Private entities with an interest in the network also invest in upgrades from which they can derive direct benefits*
Summary of Enablers	• Severity of the capacity constraint • Industry-wide collaboration • Commercial/financial incentives • Licence conditions

4 APPENDIX 4 – TRANSPORT FOR LONDON

4.1 Situation and Background

4.1.1 Description of scenario

- Transport for London (TfL) is a government body responsible for implementing the Mayor's transport strategy for Greater London.
  - TfL is responsible for both the planning and delivery of transport within the capital.
  - The organisation is split into three directorates (Figure 1) under the Commissioner, Sir Peter Hendy, who reports to the TfL Board and its leader, the Mayor of London.
- In this case study, we focus on the most directly relevant directorate to heavy rail, Rail and Underground.

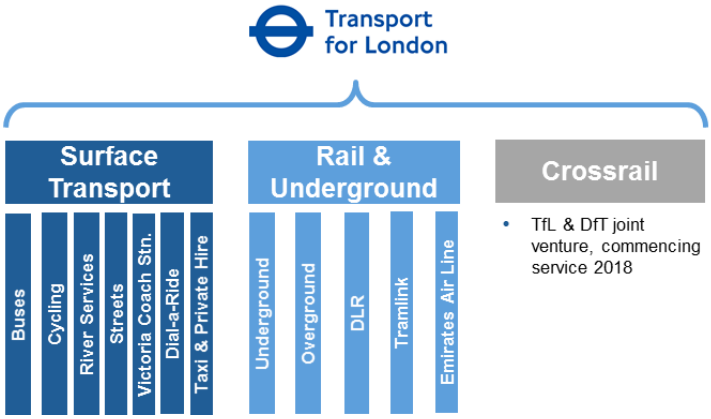


Figure 21: Organisational structure of Transport for London

- **London Underground** (LU) is an interconnected system of 11 lines, many of which were initially designed and operated as separate railways but are now entirely unified under TfL's control.
  - Together, the LU network serves 270 stations over 250 miles of track of which, despite the name, 52% is above ground.
  - LU operates a high-intensity 'metro' timetable, meaning that customers can almost universally expect a 'turn up and go' service.
  - TfL is today both the operator and infrastructure manager for LU. Formerly, maintenance and upgrade of infrastructure was the responsibility of two public-private partnership companies, Metronet, and Tube Lines, though after financial struggles these were purchased by TfL to become wholly-owned subsidiaries in 2008 and 2010 respectively.
- **London Overground** (LO) is a heavy rail network controlled by TfL, but operating partly on Network Rail infrastructure. It was launched in 2007 with the aim of integrating "older networks [in the north and west] into new routes in east and south London to create a fully orbital network".[14]
  - On being transferred to LO, an investment programme upgraded stations and provided new train fleet, and Oyster pay-as-you-go was introduced.
  - Similarly to LU, services on LO operate under a 'turn up and go' principle with high frequency.
  - Subsequent line extensions have expanded the LO network, including the incorporation of the East London Line (formerly operated by LU) and extensions to Highbury and Islington and Clapham Junction (amongst other locations).

TfL is an integrated body, reporting to the Mayor of London, responsible for planning and delivery of transport

4.1.2 Capacity challenge

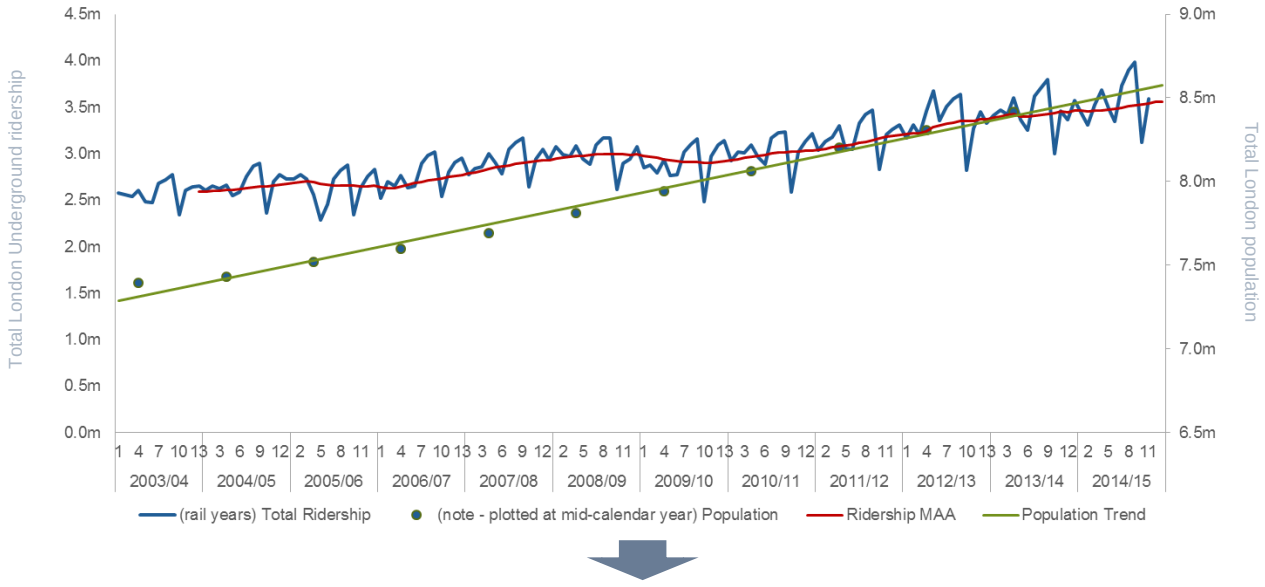
- Population growth is a major challenge for London, whose population recently reached record levels of over 8.6m people.

[14] "London Overground," Transport for London – Accessed on 05/03/2015 at http://www.tfl.gov.uk/corporate/about-tfl/culture-and-heritage/londons-transport-a-history/london-overground

- Projections suggest that this could grow as high as 10m by 2030, placing immense strain on the city's transport network.[15]

- Ridership on London Underground has grown substantially, and the annual (13-period) average is shown by the red line on Figure 2.
  - There is a recurring annual seasonality of ridership, where fewer journeys are made in the summer months (due to a number of factors including as hot weather and associated problems with cooling the deep tube).
  - Underlying year-on-year ridership growth between 2010/11 and 2013/14 was c. 3.8%, which is out of step with population growth of c. 1.1% growth.
- LU journey demand is clearly growing, which is a principal component of the capacity challenge.
  - Other factors include the requirement to modernise out-of-date (sometimes Victorian) infrastructure at a number of pinch-points, where capacity is provided inefficiently.
  - There are also geographical centres of population growth (see 1.1.3c.) where the balance of demand will may shift in location due to urban development.

Figure 22: Comparison of growth in LU ridership against growth in total London population



Annual growth in LU ridership has been c. 4% since 2010/11, which is a challenge to accommodate within a network already close to capacity

4.1.3 Solutions employed

- TfL is continually adapting and enhancing its network in order to tackle capacity challenges. There are a large number of individual projects either in progress or being planned, many of which are aligned to the long-term plan for tube modernisation. This is called the Tube Upgrade Plan.
- We have selected two projects that demonstrate TfL's approach to capacity; these focus on Underground and surface rail operations.

a. London Overground – introduction to service and recent move to 5-car workings

- The Overground has seen capacity growth both by expanding the network and in an 'organic' sense by upgrading existing lines.
  - Under-utilised services have been transformed when brought under TfL control, making more efficient use of the capacity available.
  - An ongoing programme of improvement has added capacity to workings on core routes, including the move to five-car workings.

[15] "London's booming," Dave Hill, *The Guardian*, Jan. 9, 2015.

- **Network inception** – Formerly, the London inner suburban railway was fragmented and under-utilised, with a series of operational and social problems.
    - Fare evasion was high (around 35%), stations were often deserted early in the morning and late at night and certain lines were termed 'the mugger's railway' due to inherent social problems.
- TfL implemented a programme of measures to drive better utilisation of the latent capacity this network was disguising.
- As lines came into London Overground, the service was overhauled, including:
    - New rolling stock.
    - Implementation of service frequency enhancements to provide a 'turn-up-and-go' service across the lines.
    - Integration with other TfL services through the Tube Map and Oyster compatibility.
    - Installation of gatelines.
    - Staffing of stations throughout the course of service, from the first train in the morning to the last train at night
- The contractual model for LOROL means TfL retains responsibility for long-term evolution of the service and investment:

> *"On transfer to TfL, we invested heavily in the infrastructure of the line. On the operations side, we let a concession to LOROL and incentivise them heavily on service performance and customer satisfaction. TfL retains revenue risk under this arrangement."*
>
> Director, London Underground & London Rail, TfL

- This was a successful model, and led to dramatic growth in ridership of around 160% in the first five years between 2007 (on first taking over services from Silverlink) and 2013.[16]
- **North east inners** – Future developments include the integration of the inner-suburban routes currently operated by the Greater Anglia franchisee.
    - GA as an operator bears revenue risk, and may struggle to achieve a return from shorter-distance, low-yield flows.
    - TfL can take a longer-term view and invest with (e.g.) a 50-year horizon, which will always be beyond the length of any franchise term.

> *"While some of the stations involved are among the worst in London, we undertake to staff them and bring the other improvements that Overground delivers. We expect demand to rise."*
>
> Director, London Underground & London Rail, TfL

- **Five-car operation** – Despite the positive enhancements, there remain some capacity constraints, notably that there is little to no availability of additional paths to increase capacity through running more trains. This is due to freight reservations on the line.

> *"Given the reservations on the lines for freight services, our approach to building further capacity is to run longer trains rather than new paths – which is the driver of the 5-car programme"*
>
> Director, London Underground & London Rail, TfL

LO demonstrates how existing capacity can be better utilised under a transformed operating and ownership model

b. Northern Line Upgrade and Bank Station Capacity Upgrade

- TfL is in the middle of implementing its Tube Upgrade Plan – this includes capacity upgrades on all Underground lines, with a succession of projects planned that last into the 2020s and beyond.
    - The Northern Line is a key part of the plan, and there will be a staged programme of upgrades between 2014 and 2021 to increase capacity.

[16] 'London Overground introduces five-car trains to meet increasing demand', TfL, February 2013

- The upgrades adopt a phased approach.

> *"Our approach is to address the most easily deliverable improvements first, such that we can provide capacity benefits to customers as soon as possible."*
>
> Director, London Underground & London Rail, TfL

- To illustrate the cumulative effect of upgrades, the plans for the Northern Line follow the following progression:
    1. **NLU1 (signalling)** – TfL has just completed signalling works (installing CBTC) that has reduced the headway between trains and led to a 20% increase in capacity on the Line.
    2. **Battersea & Nine Elms** – Works will deliver a new section of track and two new stations to serve new demand from the Vauxhall / Nine Elms / Battersea Opportunity Area. This is planned to be complete by 2021. Five new trains will be required to serve the extension.
    3. **NLU2 (stock purchase)** – After the signalling upgrades of NLU1, TfL will procure an additional 20 trains in order to provide the much higher level of service that will then be permitted. These sets will be matching units to the 1996 Stock currently in use.
    4. **Station pinch-points** – At the same time, there are a number of critical stations where upgrades are required, including remodelling at Kennington to support passenger interchange volumes from the NLE, major works to upgrade capacity at Bank, and a programme of upgrades at Elephant and Castle.
    5. **Segregation** – The long-term aim for the Northern Line is to achieve full separation of the current two branches. To achieve this will require major change at the intersection at Camden Town, where there are challenges because of a complex underground junction (which permits trains from either direction to proceed to either of the branches) and a physically constrained site preventing expansion of the station above ground.

Figure 23: Northern Line Extension, dotted line, running to new stations at Battersea and Nine Elms (TfL)

- When assessing the viability of these options, TfL will typically assess not only the costs and benefits to its own operation, but instead takes a holistic view of the benefits of agglomeration on the area (see discussion in 4.2.1c).

TfL's approach to production of capacity is appropriately separated into short- and long-term goals – deriving early benefits / relief where possible

4.1.4 Relevance of study

- TfL provides a comparable operation to GB Rail where the responsibility for infrastructure and operations is divided amongst parties in a different way.
    - **London Underground** – LU provides a good example of a UK operator where, for the most part, there is a vertically-integrated infrastructure and operation. This operation has to deal with major capacity problems.
    - **London Overground** – In the case of LO, infrastructure is (mostly) the responsibility of Network Rail, while services are managed by TfL and train operations are let on a concession.
        - TfL is responsible for setting fares, procuring rolling stock and determining the appropriate level of service.

  - The concessionaire (currently LOROL, an MTR/Arriva joint venture) takes 10% of the revenue risk.
- This stakeholder structure has evolved different incentives and outcomes to that of GB Rail.
  - There are a variety of other contributing factors and enablers that contribute to the overall incentives in place, which we outline in the sections to follow.

TfL operates services that are broadly comparable to those in GB Rail – especially the London Overground, which is very similar to other inner-suburban routes run by L&SE TOCs

Figure 24: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• Deep knowledge of the network underpins creative approaches to identifying capacity • Staged approach to upgrades – tackle the most achievable improvements first (e.g. signalling before new stock, before line extensions)	✓
b. Performance optimisation	• The expansion of London Overground network has demonstrated how the integrated authority has been able to invest to maximise utilisation of available capacity – with ridership growth of around 160% achieved • The structure by which the concessionaire and TfL share responsibilities for the Overground network is also key to the performance improvements that have been seen (e.g. concessionaire heavily incentivised on customer service and train service performance, but without full revenue risk)	✓
c. Efficient allocation of capacity	• *Difficulty experienced in areas where capacity is shared (e.g. Euston to Watford Junction) – this highlights that the simpler the stakeholder structure, more often the easier it is to manage capacity between parties*	✓
d. Planning for future capacity in response to demand	• TfL considers the agglomerated benefit of capacity projects – i.e. business / feasibility cases for projects include (for example) how this will support urban development plans for the area ○ This is distinct from other transportation providers, who would likely consider the impact on their own operation (or perhaps industry) foremost	✓

4.2 Analysis of incentive approach

4.2.1 Measurement/quantification of capacity

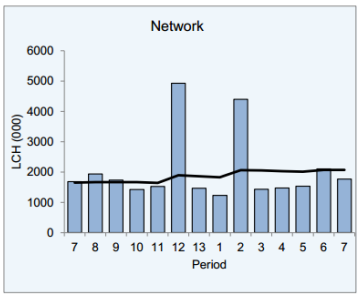
- For this case study, the means of measuring capacity has a strong incentive effect.

a. Measuring capacity day-to-day

- Capacity of the network is most often measured in terms of the frequency of service on a given line or line section.
    - The most common measure used is trains per hour (tph) – from a customer perspective, this would be experienced as the number of minutes' wait between trains at station platforms. Since a uniform stock type is in use on most lines, with an approximately uniform capacity, this acts is a good proxy for capacity.
    - Given the turn-up-and-go frequency across LU lines at all times of the day, waiting time is more important, and more noticeable, to customers than adherence to a planned timetable.
- TfL has a number of medium- and long-term schemes in place to improve service frequency across a number of its line.
    - In particular, peak service frequency on the Victoria Line is to be increased from 33tph to 36tph by 2016 through a signal upgrade programme. This scheme will provide for a 9% increase in capacity.

b. Measuring capacity during disruption

- London Underground has a suite of measures, or KPIs, through which it monitors service performance.
- From a capacity perspective, an important measure is Lost Customer Hours (LCH).
    - This measure provides a volume-weighted view of delays due to network disruption. LCH represents the cumulative number of delay minutes experienced by all customers because of a given disruption event.
    - LCH therefore allows differentiation between disruption events according to the number of passengers impacted – so (in general) a disruption in Zone 1 during the morning peak will incur a higher 'LCH' than a disruption of the same duration in Zone 4 in the middle of the day.
    - LCH is publicly reported by underground line on a monthly basis. The top five incidents by LCH for each line are presented, stating the station(s) affected and categorised by cause.



	Period 6 (000)	Period 7 (000)	MAA (000)
Bakerloo	58	59	82
Central	858	601	478
Victoria	150	86	171
District	171	206	232
Metropolitan	68	78	126
Circle & Hamm	166	204	200
Jubilee	327	163	365
Northern	159	211	160
Piccadilly	111	153	239
Waterloo & City	36	4	19
NETWORK	**2,104**	**1,764**	**2,073**

Lower numbers represent better performance

Figure 25: Excerpt from LU Performance Report (P7 2014-15) showing LCH by line and overall. Periods 12, 2 and 6 reflect the impact of industrial action on the Central and W&C lines.

- The use of LCH incentivises the preservation of the services that carry the most passengers – i.e. those whose capacity is most usefully employed in carrying customers.

Figure 26: Comparison of performance metrics

PPM (Public Performance Measure)	• Percentage of trains that arrive at their *terminating station* 'on time' (according to the service timetable)
	  ○ Combines punctuality and reliability of services into one measure
	  ○ 'On time' for commuter services means within five minutes, or within ten minutes for long-distance services

LCH (Lost Customer Hours)	• Total additional journey time, measured in hours, experienced by customers as a result of service disruptions lasting two minutes or more

- There are a number of important differences between the LCH (TfL) and PPM measure (as adopted by Network Rail[17]).
  - While LCH are accrued at any and all points in a customer's journey, PPM is only recorded at the *destination* station. The PPM measure will therefore obscure delays at intermediate stations if the delay is 'made up' before arrival at the destination.
  - The delay threshold (minutes lost before an event is classed as a delay) varies between the measures – and the relevance of such a threshold may be questioned. The risk of a high threshold (e.g. 10 minutes on long-distance services) is that sub-threshold delays can quickly mount up. For example, there is significant customer impact from a succession of 5 long-distance services each delayed by 8 minutes, though none would be recorded under the PPM measure.
- Given TfL's high-intensity, heavily-used services, it appears that the LCH measure provides an appropriate differentiation for the severity and customer impact of delays and encourages all parties to focus on the most appropriate capacity usage and service recovery strategies.

The LCM measure acts as an incentive to preferentially protect passenger capacity on the busiest lines, at the busiest times

4.2.2 Incentives to improve management of capacity

a. Political pressure

- Given TfL's place as the Mayor's transport executive, there is a clear line of political accountability to the Mayor for success or failure in providing an appropriate transport network.
  - This applies to both the current and near-term, solutions to capacity management, and also to plans for the future – these are both levers by which the electorate can gauge the success of the overall transport strategy.

  "For the Mayor, who is unusual in that he is directly politically accountable and directly in charge of TfL, transport is his biggest electoral strength (or potential weakness) – his performance on transport is the one which most strongly enables him to show his achievements in the job and conversely, any failure on his part is going to be most damaging during a re-election campaign."

  Director, London Underground & London Rail, TfL
- The outcome here is a situation whereby not only the transport provider, but also a political figure (and often a very prominent one) is incentivised to drive improvements.

Direct accountability to the electorate gives the Mayor a strong motivation to provide a quality transport system; a motivation that is communicated straight to TfL as his executive body

b. Vertical integration

- As mentioned previously, TfL has control (albeit through subsidiary companies) of both the infrastructure and train operations.

[17] It should be noted that another measure, Average Minutes Lateness, is also used by NWR and TOCs to monitor performance, this measures arrival time of services vs. timetable and does not include volume weighting.

- This level of vertical integration enables a straightforward approach to decision-making. In particular, ideas can be worked up and signed-off on a shorter time-scale, leading to a more direct relationship between planning and implementation.

> *"In situations where we need to engage with Network Rail, other TOCs etc., the processes to negotiate capacity improvements is more complicated because the number of individual stakeholders is greater and each tends to have different objectives.*
>
> *"An example of this would include the DC lines from London Euston to Watford, where we have a compelling business case for upgrades, but there is a lot of 'conversation' required to get a solution delivered"*
>
> Director, London Underground & London Rail, TfL

Capacity planning is made more straightforward through a relatively simple stakeholder structure

c. Horizontal integration & approach to strategic planning

- Whether in the case of long-term capital works, or for incremental upgrades, TfL takes a holistic approach to the planning and cost-benefit analysis of its capacity projects.
- Business cases consider improvements in capacity as a means of delivering social and economic benefit to specific areas of the capital.
    - For example, increased service frequency leads not only to potential revenue uplift for the operator, but also to benefits for local businesses and time savings for TfL's customers (to which a value can be attributed).
- One of the enablers of this approach is a cross-disciplinary team. In particular, within the directorate for Strategy and Service Development at TfL sit transport and urban planners alongside project sponsors, train planners, customer service teams, and asset managers.
    - There is also a cooperative relationship between TfL and the GLA for broader planning, for example covering urban development 'Opportunity Zones', and strategic land use.

> *"One of the important concepts for us is how our work interacts with the overall objectives of the Mayor and his vision for London. A lot of this has to do with city planning (next areas for growth/regeneration etc.) and, as a result, we are a big part of these conversations. They are very iterative and we are very much part of the group that drives the long-term planning around things like the visions for London in 2030 and 2050."*
>
> Director, London Underground & London Rail, TfL

- The work of this team is backed up by a suite of modelling and planning tools, particularly TfL's Railplan Transport Assignment Model. This predicts passengers' modal choice and the crowding impacts as a result of new schemes or changes to the base operation plan. The model, and others in TfL's strategic modelling suite, provide a further data-driven analysis for capacity planning.
- **VNEB Opportunity Area** – TfL has an established mechanism to leverage private funding to drive capacity enhancements. This was first established for the Jubilee Line Extension in the 1990s, was applied for Crossrail, and is now being extended to other schemes.
- A specific example of this approach in practice is the business case in support of the Northern Line Extension to Battersea.
    - An underlying principle of this is that with additional transport links, an area will become more attractive from a residential and a commercial point of view, thus creating the demand to quickly fill the capacity.
        - It could be argued that TfL has benefitted from the fact that London has achieved astonishing growth in recent years, suffering only to a minor extent from the economic recession. As such, constructing business cases for investment in a growth environment could be considered more straightforward than under other circumstances.

- TfL developed proposals at the same time as plans were being drawn up by the Battersea Power Station Development Company for the site itself. An interrelationship was developed between the two projects.

  "The proposals include lock-step agreements between ourselves and the developers to ensure that they are incentivised to complete their project in accordance with the pre-agreed plans. Relatedly, it would not be feasible for TfL to continue development if the Battersea plans were to fall through."

  Director, London Underground & London Rail, TfL

TfL's business case process considers not only impacts on transportation but the effects of agglomeration on the local and national economies. This leads to integrated thinking where transport is an enabler of urban growth

4.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 27: Enablers identified within study

Enabler	Evidence
1. Political accountability of the Mayor of London	*TfL implements the Mayor's Transport Strategy who, in turn, attracts attention to transport issues and can exert political pressure to get things done owing to his high-profile status. In another sense, transport is an important lever for the Mayor, as changes to policy can be enacted quickly (e.g. fares), have a day-to-day impact on voters, and long-term projects (e.g. Crossrail) tend to capture the public imagination.*
2. Vertical and horizontal integration	*Strategic planning within TfL is intrinsically linked to urban development – for example, the business case for line extension is tied into the Mayor's intended Opportunity Zone developments, and is aligned to overall city planning objectives. TfL contains the necessary cross-disciplinary expertise in-house in order to support this process. It also both owns the network infrastructure and operates the rolling stock service on top giving it total control of the London Underground.*
3. Long-term investment horizon	*TfL will exist in perpetuity (though structures may change, transport will be controlled by a body resembling TfL in future). In contrast to TOCs, this allows for a long-term investment horizon. TfL is taking advantage of this distinction through the structure of the London Overground, where a concessionaire operates the service, whilst TfL procures rolling stock, controls stations, and takes 90% of the revenue risk.*
4. Access to various funding streams	*TfL is able to access substantial funding for infrastructure improvements from three streams:* *1. Public sector – Money provided by government.* *2. Farebox revenue – Money earned through ticketing.* *3. Private sector – Money provided by business interests with vested interests in expanding/upgrading the network.*
5. Appropriate suite of KPIs	*During disruption, the use of a volume-weighted measure of performance (LCH) acts as a means of prioritising preservation of capacity. The result means that action is taken where disruption is likely to affect the greatest number of customers.*

4.4 Conclusion

- Capacity is an acute problem for TfL, which is dealing with a city of strong population growth and a growth in ridership that outpaces this.
- A large number of schemes are in place, arranged under umbrella projects such as New Tube for London / Tube Improvement Plan and which contribute to overarching master plans such as the 2050 Infrastructure Plan.
    - Within this, London Overground is a clear example of the capability for transformation of existing capacity to improve its utilisation.
    - The Northern Line extension illustrates how capacity planning can be a driver for the overall prosperity of a region, and as such how this might see progress prioritised, with structures in place (such as lock-step agreements) to secure the involvement of other stakeholders.
- An incentive for good capacity management may lie partly in the measurements employed, such as the LCM measure for recording the impact of disruption and delay – this promotes the most efficient protection or prioritisation of scarce capacity in terms of customers affected.
- Moreover, TfL has a number of structural incentives that drive its performance. We see this as a combination of the stimulus provided by political pressure, and the freedom or capability to deliver change through appropriate vertical and horizontal integration.
- Though London benefits from a supportive environment for investment (it is arguably more straightforward to drive a business case in a growing economy), as shown above there are a number of elements of the supporting environment that may have relevance elsewhere.

Figure 28: Case Study summary box [Transport for London]

Key parties involved	*TfL, Greater London Assembly, Mayor of London*
Capacity challenge	*High population and ridership growth, requirement to serve Opportunity areas with sufficient capacity to support development*
Approach	• *Long-term Infrastructure Plan (to 2050)* • *A number of specific schemes -we highlight London Overground and the Northern Line extension* • *Business casing of projects based on agglomeration effects* • *Alignment of KPIs to customer impact*
Summary of Enablers	• Political accountability of the Mayor of London • Vertical and horizontal integration • Long-term investment horizons • Access to various funding streams • Appropriate suite of KPIs

5 APPENDIX 5 – VANCOUVER SKYTRAIN

5.1 Situation and Background

5.1.1 Description of scenario

- Vancouver uses a fully-automated metro system, much of which runs on elevated track. Its three lines use a range of two, four, and six-car trains running with as little as 108 seconds headway. During normal periods, trains run from 5:00am until 1:30am on weekdays (with reduced weekend service), although these are regularly extended for special events such as the 2010 Winter Olympics.
- The operator, SkyTrain, is a subsidiary of the South Coast British Columbia Transportation Authority, the public sector body responsible for the regional transportation network in the Vancouver Metro region.
- Capacity was not an initial problem for Vancouver, whose population of 1.4m only resulted in ~5,000 people traveling per hour at peak times in the city centre. Instead, the issue was ensuring the frequency and quality of service associated with a city metro without incurring an excessive cost burden.

Vancouver runs a fully-automated metro system known as the SkyTrain which is operated by a subsidiary of the public transport authority

5.1.2 Capacity challenge

- The major challenge for capacity came as the population increased. Having grown by over a million people since SkyTrain's initial opening in 1986, Vancouver is projected to balloon to approximately 3m people by 2025. As such, the old timetable which relied heavily on two-car trains operating with 210 seconds of headway became incapable of matching the increasing demand.
- Demand increased particularly substantially between 2009 and 2010, with a combined total of almost 33m extra journeys taken on the SkyTrain. Even accounting for the opening of the new Canada Line in August, 2009, and the Winter Olympics in February, 2010, this still represented strong annual growth of ~4%.[18]
- Equally, the growing population meant extreme strains were placed upon the network during times of increased demand. Whilst peak times became a problem, major events such as sporting fixtures and large conventions were capable of overwhelming capacity.

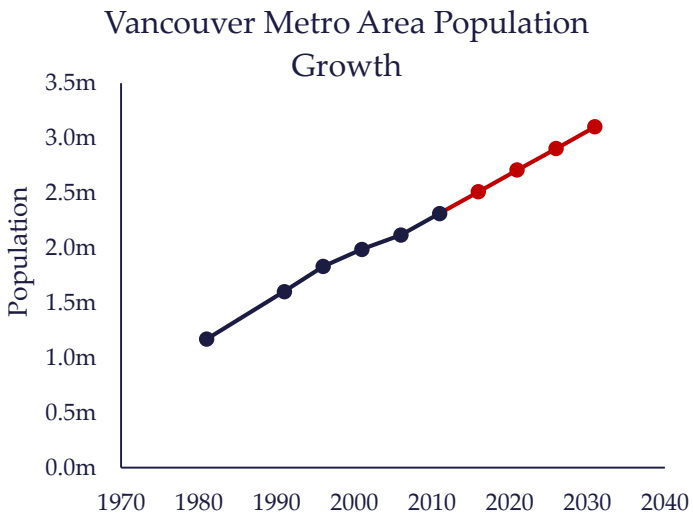


Figure 29: Red data points indicate projection based upon 2006-2011 growth rate

Population growth and a related increase in the number of people using SkyTrain is putting strain on the network's capacity

[18] "TransLink 2010 Ridership," South Coast British Columbia Transportation Authority, Feb. 10, 2011 – Accessed on 12/02/15 at www. TransLink.ca/en/About-Us/Media/2011/February/ TransLink-2010-Ridership.aspx

5.1.3 Measurement/quantification of capacity

- Vancouver's predominant measure of capacity is the number of passengers carried per hour, both in terms of network utilisation and its maximum potential.
    - Utilisation is assessed through periodic manual observations by SkyTrain staff, observations which indicate that the network is regularly experiencing excess demand.

      "We have been operating very close to capacity for a long time (expansions have been taken up in one-two years) so we have a good sense of how many people are using our network as a result of that."

      Manager, Operations Planning, Vancouver SkyTrain
- Additionally, given the quantity of available rolling stock is the most serious capacity constraint, capacity is also measured partly in terms of the percentage of rolling stock in use on the network at any given time.

  "Our key limitation on capacity is quantity of rolling stock. At peak times, 92% of units are in use so after taking into account maintenance and reserves, the opportunity to send out more does not exist."

  Manager, Operations Planning, Vancouver SkyTrain

5.1.4 Solution employed

- Vancouver is in the process of implementing a wide range of solutions to its capacity challenges:
    - **Service alterations** – Owing to the SkyTrain's automation, during periods of high demand extra trains can be sent out at relatively little cost (assuming sufficient available rolling stock).
        - However, the quantity of rolling stock available means that this solution cannot be implemented during peak times and is therefore predominantly used to cope with irregular periods of high demand (e.g. major sporting events).
    - **Station upgrades** – Targeted investment is being used to improve those stations with particularly high passenger footfall with the intention of reducing dwell time and thus increase the theoretical maximum capacity of the network.
        - In particular, an additional platform at the key interchange platform, Commercial-Broadway, is being built to allow trains to be boarded from both sides. It is hoped this will also improve the utilisation of space within the train cars.
        - Plans are also in place to use escalator operations and station signage to direct 'tidal passenger flow' such that boarding and alighting occur on different sides of the train (previously there had been plans to officially designate one side for each – known as the 'Spanish Solution' – but these have since been scrapped).
    - **Stock modifications** – Some of the oldest portions of Vancouver's fleet are undergoing an internal redesign in order to increase the amount of standing room. This will increase the overall capacity of the cars.
- On top of these solutions are more major, capex-heavy, projects which require substantial funding from the provincial and federal governments. Notably, these include a new line, the Evergreen Line, and a major programme of upgrades and rolling stock purchases.
- However, the financial crisis caused a substantial decrease in the available funding which meant the upgrades were scrapped in favour of the more politically-enticing Evergreen Line.

  "When this funding package collapsed, a choice had to be made and the political consensus opted to continue the Evergreen Line project but halt much of the related upgrade programme."

  Manager, Operations Planning, Vancouver SkyTrain
- More recently, a proposal has been made to raise sales taxes 0.5% to pay for much of the original upgrade package which is due to go to a public referendum. This is receiving considerable support from the businesses which are eager to see improvements to the metro system owing to the percentage of their workforce which uses it for their daily commutes.

  "The business community began to take a much greater interest in our service around 2010 (when workers began using it in greater numbers) and are currently in the process of lobbying for a 'Yes' vote."

  Manager, Operations Planning, Vancouver SkyTrain

SkyTrain is able to implement a variety of small initiatives to increase capacity. However, the larger, capex-intensive projects require government funding, potentially achieved through a new tax initiative backed by the business community

5.1.5 Relevance of study

- Vancouver is subject to similar challenges to the UK resulting from population growth and the strains this places on a rail network.
- Equally, it is an example of a public body attempting to combat such challenges during a period of constrained funding (as evidenced by the programme of upgrades which had to be postponed following the financial crisis).
- Further similarities can be seen between SkyTrain's commitment to reducing carbon emissions and the UK's imperative to decrease road traffic in order to meet its obligations under various environmental treaties.
- However, the significance of the business community in lobbying for additional revenue streams to fund infrastructure improvements may provide lessons regarding the benefits of engaging with the non-rail private sector and how their support can be leveraged to improve capacity.

Vancouver SkyTrain illustrates an example of a public body which has cultivated a potentially hugely beneficial relationship with the private sector

5.2 Approach

5.2.1 Incentive to improve capacity

- SkyTrain operates under three enablers based around its institutional culture and the society in which it exists.
    - **Social obligation** – SkyTrain believes it has an obligation to the Vancouver community to provide the best possible service to the public. This is particularly true because of the economic importance SkyTrain has gained as the use of public transport for commuting has increased.

      "With over 50% of people heading into the city centre on public transport, it is vital that it is capable of serving everyone's needs."

      Manager, Operations Planning, Vancouver SkyTrain
    - **Environmental concerns** – The environmental damage caused by vehicle omissions concerns SkyTrain and it therefore wants to encourage as many people as possible to use its service over their cars. To do so, a high-quality service with sufficient capacity is required.

      "There is a huge environmental benefit to maintaining a reliable rail network with the capacity to serve everyone. It is a far 'greener' option than driving so encouraging people to use our service, and increasing capacity to the extent that they can, is very important to us."

      Manager, Operations Planning, Vancouver SkyTrain
    - **Public perception** – Although a less material concern to the previous two, public perception is important to SkyTrain given the potential ramifications dissatisfaction can result in. Notably, a series of issues in July, 2014 – a very unusual occurrence for SkyTrain – caused public opinion to shift and recently cost the CEO's job.
- As a result, SkyTrain is institutionally committed to improving capacity and service quality.

- Public perception also has an additional mechanism in directing specific projects because of how it interacts with the political process which funds them – politicians prefer new build projects over upgrades because they are more popular politically.

> *"Political will is very influential with regards to what sorts of projects get funded. This usually leads to large capex projects getting prioritized over upgrades because they are 'flashier' and easier to rally public support for."*
>
> Manager, Operations Planning, Vancouver SkyTrain

  - The prioritisation of the Evergreen Line over the programme of upgrades was a direct result of this process.
- Additionally, farebox revenue acts as an incentive to increase passenger flow, although not particularly strongly given the revenue passes to the parent organisation, Translink, as opposed to SkyTrain directly.

> *"Ticket revenue is not a direct priority to us as an organisation, though it is of concern to Translink who pays the bills."*
>
> Manager, Operations Planning, Vancouver SkyTrain

Figure 30: Mapping of approach to study objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Customer demand is growing* • *Environmental/social concerns make creating capacity in order to draw passengers off of the road network very important*	✓
b. Performance optimisation	• *Ensuring service quality remains high is a priority of SkyTrain who is committed to serving the best interests of Vancouver* • *Public perception matters to SkyTrain. Following a rare series of problems in July, 2014, the resulting negative publicity cost the CEO's job*	✓
c. Efficient allocation of capacity	• *N/A*	✗
d. Planning for future capacity in response to demand	• *Willing to work on longer-term projects and is currently in the process of pushing towards a plan to double capacity from 12,500 passengers-per-hour to 25,000 (currently at 15,000)*	✓

5.2.2 Costs and benefits

- One of the peculiarities of SkyTrain is the potential to have a series of upgrades funded through a tax increase which is put to a public referendum. This is particularly notable because of the support this initiative is receiving from the politically-influential business community which recognises the economic benefits provided by a high-quality metro system.

> *"One particularly public advocate [for SkyTrain funding increases] is the CEO of a very influential trade group – the Vancouver Board of Trade – who recognize the economic benefits improving the transit system would bring. Government is receptive to groups like this so there is a chance that pressure from the business community could result in funding increases."*
>
> Manager, Operations Planning, Vancouver SkyTrain

- The benefits of an improved metro system can also be seen in developments in the local real estate market.

> *"There has also been a paradigm shift in the development/real estate industry over the last five or so years. It is now recognised that good transit access (preferably rail) is extremely desirable for office space and multi-family developments. Vacancy rates have been falling and rents rising for office space near transit versus more car-dependent locations."*
>
> Manager, Operations Planning, SkyTrain

- Such a structure could, if it receives the necessary public support in the referendum, result in a new source of funding for the programme of upgrades.[19]

5.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 31: Enablers identified within study

Enabler	Corresponding element of case study
1. Culture of social and environmental responsibility	*SkyTrain is committed to providing socio-economic benefits to the city of Vancouver through the provision of a high-quality metro system. It therefore needs to create sufficient capacity to meet public demand. SkyTrain also has a desire to reduce carbon emissions which means it is committed to drawing traffic from the roads onto its network. To do this, it must provide and high-quality service and secure sufficient capacity to accommodate the additional passengers.*
2. Business community engagement	*As the percentage of people commuting by metro has increased, the local business community has become increasingly aware of the importance of SkyTrain. Subsequently, support for SkyTrain improvements has come from influential groups including the Vancouver Board of Trade who have since begun advocating very strongly in favour of increased funding for service improvements. This has included lobbying for a "Yes" vote in an upcoming referendum on increasing property taxes by 0.5% to pay for upgrades to SkyTrain.*
3. Public pressure	*SkyTrain is somewhat sensitive to public pressure and will therefore seek the necessary service alterations to satisfy them. The public's ability to put sufficient pressure on SkyTrain to cause management changes is representative of its significance.*

5.4 Conclusion

- This case study highlights the manner in which strong societal obligations can act as a powerful incentive for increasing capacity, even when the financial rewards are limited.
  - This is particularly pertinent in the case of a public body which is, in ways, analogous to Network Rail.
- There is also evidence of the influence which a political system can wield in directing which strategy is followed for increasing capacity.
- Perhaps most interestingly, a symbiosis between the business community which relies upon a metro system to deliver its workforce each day, and SkyTrain, the metro operator, is developing.

[19] Although the overall cost of the upgrades may be high, it would be matched by the funding increase, thus resulting in a minimal change in SkyTrain's net spending.

- By delivering material advantages to the private sector through the provision of a high-quality service, SkyTrain has gained a potentially powerful ally/lobbyist in its attempt to procure funding through increased taxation.

Figure 32: Case Study summary box [Vancouver SkyTrain]

Key parties involved	*SkyTrain; provincial and federal governments; the business community*
Capacity challenge	*Population growth is projected to push demand beyond network capacity*
Approach	• *Reliability and flexibility of automated system used to combat irregular demand spikes* • *Small, incremental improvements to station and rolling stock design used to increase network capacity* • *Larger, capex-heavy projects reliant upon government funding which may be boosted by a tax increase which is supported by the private sector*
Summary of Enablers	• Culture of social and environmental responsibility • Business community engagement • Public pressure

6 APPENDIX 6 – EUROSTAR 'GOLD'

6.1 Situation and Background

6.1.1 Description of scenario

- Eurostar is an international high-speed rail operator which operates primarily between London, Paris, and Brussels by passing through the Channel Tunnel.
    - Additional routes are available to Alpine resorts during the ski season and there are plans to further expand the network.
        - As of December, 2014, a year-round service to Geneva has been added.
        - In May, 2015, a UK to Provence service will begin, stopping at Lyon, Avignon, and Marseille.
        - In December, 2016, a host of new destinations in the Netherlands will be added, with direct trains to Rotterdam, Schiphol Airport, and Amsterdam being rolled out, as well as a service to Antwerp in Belgium.
- It was formed as a joint venture between French state-owned railway company, SNCF (55%), its Belgian counterpart, SNCB (5%), and the UK Treasury (40%).
    - In March, 2015, the UK Government announced the sale of its stake to a consortium of Canadian investment firm, Caisse de dépôt et placement du Québec (CDPQ), and UK-based independent private investor, Hermes Infrastructure for £585m.[20]

Figure 33: Map of direct Eurostar services (March, 2015)

    - Unlike the rest of the UK rail market, Eurostar operates a full reservation service.

Eurostar provides a high-speed rail service between London and continental Europe via the Channel Tunnel

6.1.2 Measurement/quantification of capacity

- Eurostar think about capacity in two ways:
    - **Value** – The primary metric used by Eurostar is the overall value of each train. That is, instead of measuring the number of people carried, the total revenue generated by the train is calculated.
    - **Volume of high-value customers** – Whilst total passenger volume is not a major factor, the number of regular/business-class customers on each train is tracked to ensure Eurostar is aware of which services are most important to its most valuable passengers.

[20] A further £172m is being generated through the redemption of the UK Treasury's preference share, meaning the total deal will be worth £757m. "Eurostar sale to net British taxpayers more than £750m," Patrick Wintour, *The Guardian*, Mar. 4, 2015.

- These are both quantified as the average over a six-month period.

"We track the value of all of our trains – the amount of revenue they are carrying – over six-month periods so that we can work out which services are particularly popular and generate the most revenue for us."

Route Director & Former Head of Customer Proposition, Eurostar

Instead of focusing on passenger volumes, Eurostar think in terms of revenue when quantifying capacity

6.1.3 Capacity challenge

- Over the 20 years Eurostar has been operating, its passenger numbers have increased dramatically, rising from 3m in 1995 to 10.4m in 2014.
- However, pure capacity is not a problem for Eurostar as there is sufficient unused space on the line that it can simply run additional services if necessary.
    - Their major problem comes during periods of delay when the Channel Tunnel can become backed up, causing serious problems.
- The main challenge for Eurostar is maintaining their competitive advantage over the short-haul airlines with whom they compete.
    - Eurostar is currently, according to their press releases, the preferred travel option between London and Paris. Maintaining a high-quality service, especially for repeat customers, is vital to maintaining this position.[21] It is also ensures it is well-positioned to compete should new operators enter a liberalising market.

Figure 34: Eurostar passenger growth since inception. (Reproduced using data from Eurostar Press Office)

Despite demand increases which have seen Eurostar overtake airlines as the preeminent London-Paris mode of travel, its only capacity constraints exist during periods of severe delay

6.1.4 Solution employed

- Eurostar's focus on being a customer-centric business, more akin to an airline than a traditional rail service, combined with the capacity constraints caused by running through the Channel Tunnel results in a single major goal with regards to capacity management: ensure the customer experience is maintained during periods of delay.
    - Overall network capacity is less concerning given there is an excess available which allows additional services to be run if necessary.

"We do not have an overall capacity constraint as there is unused space on the network – if we need to run additional services, we can (rolling stock permitting).

Route Director & Former Head of Customer Proposition, Eurostar

[21] "Travelling with Eurostar," Eurostar – Accessed on 06/03/2015 at http://www.eurostar.com/uk-en/eurostar-deals/eurostar-train-deals/trains-france/why-travel-with-eurostar

- However, maintaining the customer experience during delays is problematic as no alternate routes or modes exist (i.e. they cannot use another line or replacement buses to ease congestion).
    - As such, it is often impossible to keep all services running well meaning the customer experience is guaranteed to be diminished. The key for Eurostar is finding a way to limit the impact.
- To combat this, Eurostar designates just over 10% of its services 'Gold Trains' which are given priority treatment whenever issues.

    "We designate 45 of our ~400 services as 'Gold Trains' which we give priority when there are problems. What this means is, we send those through the tunnel ahead of the non-gold trains regardless of the schedule (i.e. they will be allowed to go ahead of other trains if necessary)."

    Route Director & Former Head of Customer Proposition

    - The 'Gold' services are selected every six months and constitute a form of priority/core timetable for the following half year.
    - These are determined by weighting all services 50/50 with regards to total average revenue generated and the number of 'most valuable customers' on board.[22]

    "When deciding which trains are to be designated 'Gold' for the next six months, we take into consideration both how much money they generate – this usually correlates to how full they are – and how many of our top 1,000 or so customers are regularly on board. These two metrics are weighted equally."

    Route Director & Former Head of Customer Proposition

    - These priority trains are also given additional benefits unrelated to reliability to improve the customer experience in line with the objective.
        - These include a level of crewing consistency to provide friendly faces for regular travellers offering the highest standard of service (the crews used are Eurostar's best) and newer carriages (where possible, the 'Gold Trains' are run on the newest rolling stock).

    "Not only do we give our 'Gold Trains' operational preference, we also ensure our best crews are on them and that, whenever possible, they use the nicer, new carriages."

    Route Director & Former Head of Customer Proposition

- The 'Gold Trains' initiative is heavily reliant upon two features of Eurostar's service:
    - **Full reservation railway** – Eurostar only serves passengers who make reservations and does not have walk-ons. This allows it to know exactly who is on each train, giving it a high degree of understanding over service utilisation.
    - **Data gathering** – Eurostar does not just know who is on each train, but it collects and collates this data to calculate the average utilisation statistics over prolonged periods. Without this data, it would not be possible to designate the 'Gold Trains' with the same level of objectivity.

In order to optimally manage capacity during periods of delay, Eurostar uses utilisation data to determine which services to prioritise. It labels these 'Gold Trains'

6.1.5 Relevance of study

- This case study illustrates a different method of measuring and considering capacity – revenue instead of volume – compared to the broader rail industry.

[22] These valuable customers are mainly regular/business class travellers who are members of Eurostar's reward scheme.

- It also demonstrates how accurate utilisation data can be used to prioritise those services which provide the greatest benefit to the overall passenger population.
    - However, Eurostar's full-reservation service means it has the ability to collect more accurate data than would be possible for the UK network which has a high percentage of walk-ons whose exact train usage is harder to ascertain.

Eurostar's 'Gold Trains' offers a different perspective on measuring capacity, as well as illustrating the benefits on collecting and using accurate utilisation data

Figure 35: Mapping of incentive approach to study objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Not directly relevant – in times of disruption, capacity is maintained in the most effective manner – though this case study does not present an approach to creating new capacity*	(✓)
b. Performance optimisation	• *N/A*	✗
c. Efficient allocation of capacity	• *The choice of how to reallocate reduced capacity during disruption ' is influenced both by Eurostar's focus on customer service (to develop ongoing relationships with regular travellers) and by recognition of the commercial value of each train* • *Thus, in a situation where decisions have to be made on which services to prioritise, this can be achieved through an agreed process* • *Spare capacity on 'Gold' trains is always offered to those previously booked on other services, meaning that the overall number of passengers carried is not negatively affected by choice of train*	✓
d. Planning for future capacity in response to demand	• *N/A*	✗

6.2 Analysis of incentive approach

6.2.1 Incentive to improve capacity

- Eurostar is predominantly incentivised by its commitment to provide its customers with the best possible service.
    - This is because of its corporate culture as well as competition with airlines for passengers traveling between London and Paris.

      "At Eurostar we aim to ensure, wherever possible, that the 'Eurostar experience' is maintained for our customers. Doing this ensures passengers are more likely to use us than the alternatives (i.e. to fly)."

      Route Director & Former Head of Customer Proposition
- Additionally, Eurostar as a private company is incentivised to maximise revenue which explains its 'Gold Train' selection process.
    - This impacts the 'Gold Trains' as they are prioritised directly on revenue and indirectly (top revenue-generating customers).

- As well as explaining Eurostar's approach to capacity management during delays, this incentive structure also impacts the overall customer experience strategy of which improving resilience for the 'Gold Trains' is a part.
    - This includes providing a consistency in staffing and the provision, where possible, of the newest rolling stock.

Eurostar wishes to maintain the customer experience for as high of its revenue base as possible. This is in order to maintain its position as the method of choice for traveling between London and Paris. Capacity management during delays represents part of an overall strategy for achieving this

6.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 36: Enablers identified within study

Enabler	Corresponding element of case study
1. Knowledge of high-value passengers	*Because Eurostar operates a full-reservation railway (i.e. no walk-on passengers), it is able to gather far more accurate data about the usage of its services and the population traveling on them.*
2. Knowledge of the commercial value of services	*Through detailed analysis of the contribution of individual trains to company revenues, an informed decision can be made on the prioritisation of services that will lead to optimal commercial value. Without the availability of data on loading, and some additional insight through Eurostar's loyalty programme, such insight would not be possible.*
3. Presence of a mechanism through which to respond to unplanned disruption	*There is an established approach to prioritising services, which leads to quick and efficient decision-making in times of disruption.*
4. Customer-centric decision-making process	*Eurostar views itself similarly to an airline and subsequently places the greatest value on the customer experience. By contrast, operational planners in GB Rail are more likely to think in terms of trains than people when assessing performance.*
5. Variable cost allocation	*Costs can be assigned directly to each train service operated – a large constituent of this is the tunnel access charges payable for each trip. This incentivises a commercial analysis of the profitability of each service, which in turn leads to an efficient use of capacity.*

6.4 Conclusion

- This case study illustrates a rigorous method of identifying and prioritising those services which are utilised most highly, thus allowing capacity constraints to have the smallest overall impact.
    - Achieving this relies upon the collection and analysis of high-quality data, something that Eurostar is able to do primarily because it operates a full-reservation service and therefore has greater visibility with regards to the passenger composition of each train.
- It also highlights an alternative manner of considering capacity and how this can impact the decision-making process with regards to its allocation.
    - Thinking in terms of revenue, as opposed to volume, may alter which services are priorities and therefore get preferential treatment during periods of delay.

- Finally, it looks at capacity management as one part of an overall strategy for ensuring priority trains receive a heightened service quality.
    - This conceptualisation of capacity management as part of achieving a more comprehensive goal may provide lessons for the UK rail industry when it comes to designing its approach to improving capacity.

Figure 37: Case study summary box [Eurostar 'Gold']

Key parties involved	*Eurostar*
Capacity challenge	*During periods of delay, Eurostar aims to maintain the customer experience for as high a percentage of its revenue base as possible*
Approach	• *Eurostar gathers utilisation data which allows it to accurately divine which services consistently generate the most revenue* • *It then averages this data over a six-month period to work out which services are most important to it* • *These are then designated 'Gold' status and receive priority, both in operational and service-quality terms*
Enablers	• Accurate data from full-reservation railway • Focus on (high-value) customers • Competition with other transport modes (aviation) and the potential for other rail operators entering the market

7 APPENDIX 7 – KOMBIVERKEHR

7.1 Situation and Background

7.1.1 Description of scenario

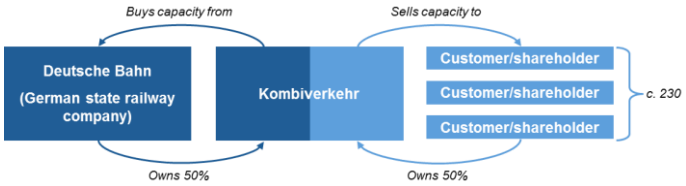


Figure 38: Stakeholder diagram

- Kombiverkehr is a major European freight company founded in 1969 in Frankfurt. It operates across borders throughout Western, Central, Northern, and parts of Eastern Europe.
- It operates a shared-ownership structure – it is owned jointly by Deutsche Bahn (50%) and ~230 companies (national and international freight forwarders, and transport companies) who are both equal limited partners and customers.
    - Kombiverkehr exists entirely to serve these companies and provide them with a market-leading, cost-effective freight solution.
- Kombiverkehr operates an intermodal freight service – a container-based shipping method which allows the cargo to travel via multiple modes of transportation (including rail and ferry) without needing additional handling – across Europe.
    - In countries outside Germany, Kombiverkehr also works with national partners.
    - Unlike many of the freight services in the UK which do not run when demand is low, Kombiverkehr's services run on a regular timetable which more resembles a passenger service.

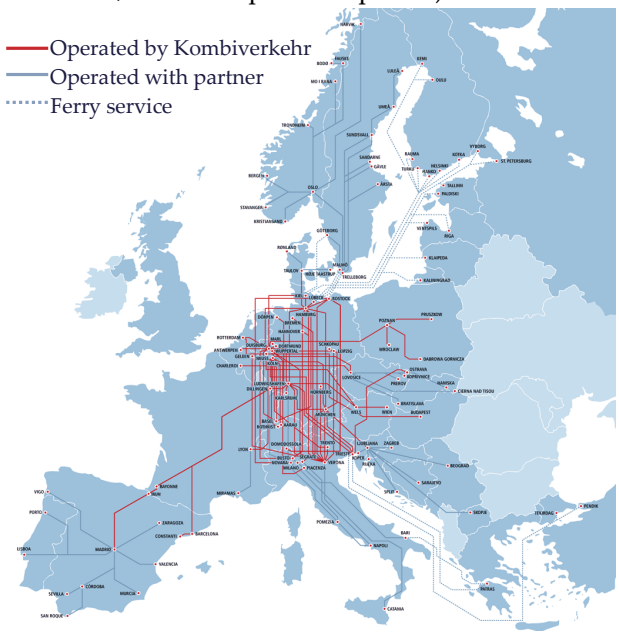


Figure 39: Kombiverkehr's European network (red) and its antenna services (blue) – graphic provided by

Kombiverkehr runs a regular, intermodal freight service across Germany and, with the help of international partners, mainland Europe

7.1.2 Measurement/quantification of capacity

- Kombiverkehr look at capacity in two complimentary ways: the maximum transportable weight and the utilisation of each train journey relative to both this maximum and the level required to break even.

> *"We think about capacity in two ways. The first is the maximum amount of freight that can be carried by a wagon or train; this is determined by its weight (which is set by EU law). The second is what percentage of a train is full (i.e. utilised) in order to ensure that we are running desirable (i.e. heavily utilised) services… which do not lose us money."*
>
> Manager, Northern European Traffic, Kombiverkehr

- Further, paths are only run if they have an economic case behind them. If there is not reasonable certainty that services on a given path would achieve a high utilisation, Kombiverkehr will not run the path and instead it will be offered up for other services (which might include passenger services).
- Implicit in this methodology is a requirement for a market-based analysis of routes, and good accessibility of data to inform this.

- Operators are aware and exposed to the fully-loaded cost of operating a path – and as such there is an active disincentive from 'hoarding' paths.

Key capacity metrics are the weight of freight transported and, at an individual train level, the percentage of total capacity utilised. This prompts a market-based analysis of routes and a mechanism by which they can be surrendered

7.1.3 Capacity challenge

- Pathway availability is heavily constrained within Germany which places restrictions on Kombiverkehr's ability to run the services desired by its customer-shareholders.
- The limited availability of paths also means that a large quantity of freight arrives at ports at suboptimal times. For example, ~50% of Kombiverkehr's freight to Luebeck is delivered up to 12 hours before it is due to depart by ferry, creating undesirable backlogs.[23]

7.1.4 Solutions employed

- Kombiverkehr relies on two common solutions to combat customer demands for extra capacity:
  - **Wagon set optimisation** – The first option looked into is optimising the 'wagon set' (i.e. the setup of the various container types being carried by the trains).
  - **Additional departures** – If demand exceeds that which can be covered by wagon set optimisation, additional departures will be sought out. Kombiverkehr has some in-built additional capacity and could theoretically run some extra services if necessary, but given the importance of maintaining high levels of utilisation, this is generally only done if the level of excess demand becomes substantial.
- Further to these, there one additional way in which existing services can be 'capacity-enhanced':
  - **Train length increases** – When demand spikes so substantially that the previous two solutions are insufficient, Kombiverkehr will look to lengthen its trains from (e.g.) 600m to 700m. However, this incurs substantial additional costs and is therefore an option which will be employed only after careful consideration of other possibilities.

    "When we originally acquire paths, we do so for the maximum configuration possible (i.e. largest train) and therefore find it very hard to expand the capacity on any given individual service."

    Head of Marketing, Kombiverkehr
- Given the strength of market forces that are present, there is an ongoing process by which innovative solutions for the medium-term are proposed and tested – though inevitably not all of these reach implementation.
- One such example is the intermodal 'conveyor belt' which was conceived for the Duisburg-Luebeck line in 2004. This was intended to increase operational efficiency by having trains complete daily round trips. This would also allow for decreased time spent sitting idle and taking up space in stations and ports.
  - The overall result was to be a doubling of freight capacity, as well as a substantial increase in operational efficiency without needing substantial capex to purchase additional rolling stock.
  - However, an inability to negotiate the necessary fast daytime pathways eventually stopped this solution being fully implemented (currently, six round trips are run each week). Despite this, Kombiverkehr remains interested in the concept and is looking to implement similar solutions on other routes.

[23] "Doubling intermodal freight train capacity," EUREKA, Oct. 5, 2004.

"Although the Duisburg-Luebeck conveyor belt has not proven possible, internal research conducted as a result suggests that we should be able to implement similar services for medium-range journeys (300-500km)."

Head of Marketing, Kombiverkehr

- Finally, Kombiverkehr does not maintain under-utilised/low-demand services, instead choosing to relinquish those paths that become unpopular with its customer-shareholders.

"If a given service is not popular enough to meet costs, we will look to give up the path."

Head of Marketing, Kombiverkehr

Kombiverkehr monitors daily performance, with a set of approaches available to optimise capacity. Over the medium-term, it has identified innovative solutions for known pinch-points, such as the intermodal 'conveyor belt', and this process of innovation is ongoing

7.1.5 Relevance of study

- There is an underlying set of problems is shared between the German and UK freight networks – that is, how capacity can be provided to commercial freight entities on a network shared in many places with timetabled passenger services.
  - This question is complicated by the typical characteristics of long, slow freight movements.
- The regularity of Kombiverkehr's freight services may offer lessons on how to use capacity more efficiently. Services operate with high regularity, which is a different model from that in the UK where 'grandfathered' paths can sometimes lie unused.
- Given the rapid growth in intermodal freight in the UK market, it may also prove illustrative to look at solutions being employed by a more mature intermodal market in mainland Europe.
- The consideration of interdependent stakeholders beyond the rail network (ports and ferries) may also provide lessons of how to deliver an interconnected timetable.

Kombiverkehr illustrates an alternative approach to accommodating freight on a mixed-use network. It also represents a mature intermodal market

Figure 40: Case study relevance to ORR objectives

ORR highlighted area of focus	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Customer demand is growing* • *Imperative, through ownership structure, to expand network (or to operate incremental paths), but only when it is efficient to do so*	✓
b. Performance optimisation	• *Network optimisation is a central goal, led by a data and knowledge-driven assessment of which paths are economical to operate* • *Kombiverkehr has cultural objectives to maintain market-leadership, supported by its customers' expectations*	✓
c. Efficient allocation of capacity	• *Fragmented customer base of c. 230 – each has a vested interest in Kombiverkehr's performance, which drives the way capacity is shared* • *Perception of acting in the 'social good' by reallocating under-used capacity*	(✓)

d. Planning for future capacity	• *Continual process of assessing medium-term solutions is driven by market forces and supported by teams with local specialism and deep localised knowledge*	✓

7.2 Analysis of incentive approach

7.2.1 Incentives to improve capacity

a. Customer-shareholder structure

- The key goal of Kombiverkehr is to achieve network optimisation. The customer-shareholder structure that is in place prioritises this over revenue maximisation or returns for Kombiverkehr.
- Kombiverkehr is strongly incentivised to increase capacity directly in line with the demands of its customer-shareholders.

> *"First and foremost, new capacity is added because customers ask for it. We exist to provide them with the best service, so if they are requesting a service, it is something we will of course look to provide."*
>
> Manager, Northern European Traffic, Kombiverkehr

- This imperative to provide the optimal service for customer-shareholders also results in a predictive approach to capacity increases (i.e. it aims to create a service which would be desirable, but which has not specifically been requested).
    - Beyond the imperative, market competition is also responsible for pushing Kombiverkehr to look for additional capacity in areas where it has not previously been requested.

> *"We are currently the market leader, a position we take very seriously… Part of maintaining this status is making sure we are the fastest market participant to respond to new opportunities. If we fail to do so, we risk being left behind and our customer[-shareholders] will begin asking, 'What went wrong?' Therefore, the competition in the marketplace very much drives us to continually look for areas in which we can expand that would interest our customer[-shareholders]."*
>
> Manager, Northern European Traffic, Kombiverkehr

    - This competition from two different sources is substantial: other railway operators (who are enabled to compete because of EU open railway regulations) and road haulage.
- It is important to note that increasing its revenues and profits is not something Kombiverkehr is strongly incentivised to achieve. Its financial considerations are predominantly based around avoiding making a loss and, assuming that is achieved, providing a solution which is maximally beneficial to its customer-shareholders.

> *"Our remit is not to maximise profits, but rather to provide the best intermodal freight service in Europe to our [customer-]shareholders."*
>
> Manager, Northern European Traffic, Kombiverkehr

> *"Kombiverkehr's basic business model is about providing the most cost-effective solution to its customer-shareholders. Although, like any business, we are aiming to make a profit (which we then pass back to our shareholders), it is not our primary objective."*
>
> Head of Marketing, Kombiverkehr

b. Stakeholder relationships

- Another important factor is Kombiverkehr's collaborative relationship with other stakeholders in the entire freight transportation process (e.g. ports, ferry companies etc.).

> *"We get strong support from many of the ports as a result of our collaborative relationships with them, relationships which provide mutual benefits. Indeed, these actors are able to influence our scheduling in profound ways. For example, our freight schedule is heavily dependent on the ferry operators' schedules [as optimal arrival timing allows us to shorten journeys and improve our overall service level]."*
>
> Manager, Northern European Traffic, Kombiverkehr

- Kombiverkehr's approach to finding a solution is grounded in two broad principles:
  - **Customer engagement** – Strong customer engagement is required to identify areas in which excess capacity is desirable. Given the integral relationship between said demand and a solution, it is crucial that Kombiverkehr engages in dialogue with customers to identify areas for investigation. Equally, when designing a predictive solution, this engagement is important in making the prospective customers aware of the opportunity.
  - **Regional expertise** – Kombiverkehr's corporate structure includes small departments of regional experts which are responsible for identifying local opportunities and maintaining an understanding of the market(s) they cover. These departments conduct the necessary research to test potential solutions, as well as create a network of contacts across their regions with whom they maintain relationships in order to identify potential areas for growth.

Kombiverkehr's shared ownership model compels it to create capacity in order to provide its customers with a market-leading service

7.2.2 Costs and benefits

- **Costs** - The solutions employed by Kombiverkehr range markedly in their costs, but the mechanism through which they are conceptualised and researched – the team of regional experts which engages with customers – is relatively inexpensive.
  - Indeed, it appears to require very limited expenditure to maintain; beyond staff salaries, costs are low, extending to areas like conference travel and phone calls which account for a minimal percentage of the company's overall operating costs.

    "[Our research methodology] is not that expensive and there are not a lot of additional costs associated. We may have to… pay for employees to travel to conferences etc., but the overheads are very low overall relative to the benefits provided."

    Manager, Northern European Traffic, Kombiverkehr

7.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 41: Enablers identified within study

Enabler	Corresponding element of case study
1. Shared-ownership model	*Kombiverkehr's relationship with its shareholders means that it does not run low-demand services, thus leaving the paths for more efficient uses.*
2. Data-driven approach to achieving maximum utilisation	*Paths will not be operated unless there is confidence that utilisation will be high. Paths currently operated that fall below the breakeven benchmarks are usually relinquished.*
3. Market competition/drive to remain the market leader	*Kombiverkehr's commitment to remaining the market leader forces it to strive to improve the efficiency and capacity of its services.*
4. Collaborative relationship with other stakeholders (ports etc.)	*Working with external stakeholders who impact the rail network opens the possibility of discovering alternative choke points.*
5. Regional expertise/maintaining a strong network of connections	*Regular engagement with heavily engaged parties across its network allows Kombiverkehr to identify potential capacity enhancement ideas.*

7.4 Conclusions

- This case study shows that it is possible to create a system where operators recognise the true cost of services.
    - However, in order for this to be possible, analysis is required to discern which current services are performing efficiently, and to forecast the likely demand (and regularity of demand) for potential new services to be viable.
- In this example, paths are a tradable asset; a path can be returned to the infrastructure provider in the even that no productive use can be made of it.
- Having these factors in place drives innovation over the long-term, providing more sustainable solutions than merely adding wagons.
    - The intermodal 'conveyor-belt' is one such example.
- An ownership structure that is consensus-based incentivises not only profit but also the provision of the best-possible service to customers.
    - This promotes a thorough understanding of capacity and its potential.
    - In this case there is a tri-partite relationship between the infrastructure operator, its customers and other stakeholders (potential users of the shared asset) which leads to a consensual view of the best solution for all parties.
- Overall, this is a case where societal aims and the efficiency of the overall network are prioritised above short-term profits.

Figure 42: Case Study summary box [Kombiverkehr]

Key parties involved	*Kombiverkehr; Deutsche Bahn; customer-shareholders; external stakeholders*
Capacity challenge	*Freight path availability is severely constrained*
Approach	• *Data-driven assessment of efficiency and utilisation of active paths and potential new paths* • *Structure that supports decisions being made in favour of overall network efficiency* • *Common solutions: Alter wagon configuration; lengthen trains; add new paths; surrender uneconomical paths*
Summary of Enablers	• Shared ownership structure • Market forces • Stakeholder collaboration • Localised expertise

8 APPENDIX 8 – OFCOM 4G AUCTION

8.1 Situation and Background

8.1.1 Description of scenario

- With the end of analogue television, Ofcom opted to allocate its old spectrum bandwidth (800MHz), along with another section (2.6GHz) to serve the new 4G mobile broadband technology. To do this, it split the availability into small 'lots' and sold it off through a complex auction process.

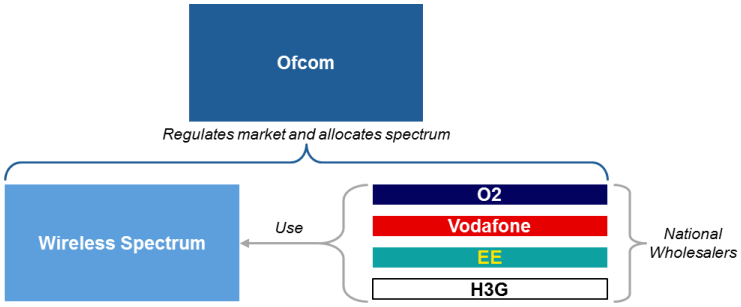


Figure 43: Stakeholder diagram

    - Of these two spectrum bands, 800MHz is regarded as better for providing 4G coverage because it better penetrates buildings and can be used to serve larger areas with less physical infrastructure.
- The rules included a range of specifications designed to ensure 'efficient allocation of capacity' (i.e. that it went to those parties who would use it to provide the greatest benefits to the customers and that they would pay the Treasury the spectrum's true value to their businesses).
    - One such rule was the 'second price' rule which stipulated that the highest bidder would pay the price offered by its nearest competitor. It was believed that this would reduce the incentives to bid tactically, thus leading to bids which reflected the true value of the spectrum.
- There was also a desire to ensure the market remained competitive which was achieved in a variety of ways, including through the reservation of a small portion of the spectrum for a prospective fourth national operator (alongside EE, Vodafone, and O2/Telefonica).
    - This was won by H3G, the only party who ended up bidding for it.
- The results of the auction saw five parties – EE, Vodafone, O2, H3G, and Niche (a BT subsidiary) – win spectrum for a combined price of £2.34bn.
    - This was ~£1.15bn less than the Treasury had estimated, although that estimate was considered high by observers even before to the auction had taken place.

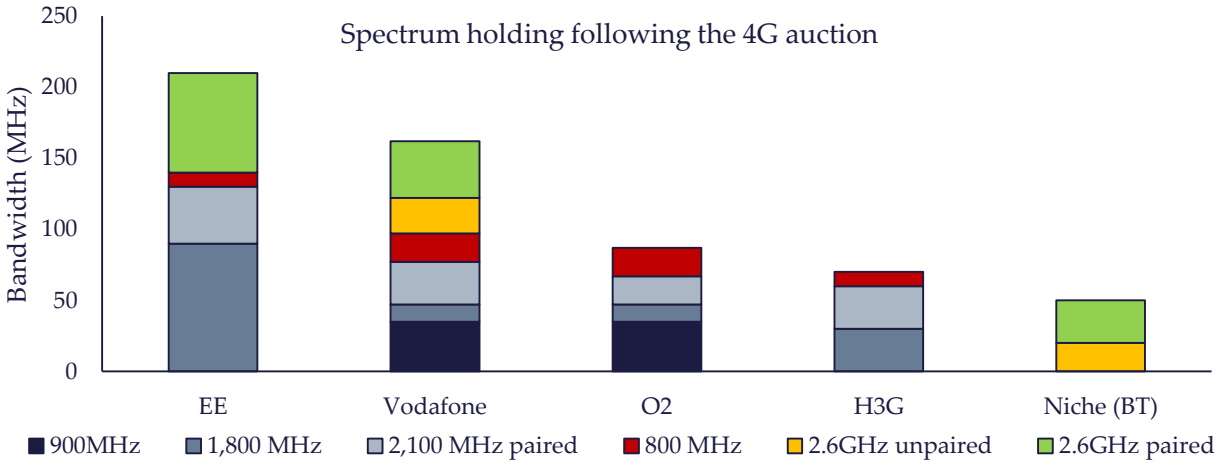


Figure 44: Reproduced from data provided by the National Audit Office[24]

Ofcom ran an auction to allocate the capacity it was releasing for the provision of 4G mobile broadband

[24] "4G radio spectrum auction: lessons learned," Phil Airey, John Ellard, Sarah Shakespeare, and Mark Babington, *National Audit Office*, Mar. 6, 2014, p. 21.

8.1.2 Measurement/quantification of capacity

- Ofcom thinks about capacity in two related ways:
  - **Coverage** – The amount of the country which receives mobile broadband service above a certain minimum standard. For the 4G Auction, a target was set for achieving indoor coverage within 98% of residential dwellings by 2017.[25]
  - **Bandwidth** – The range of frequency, measured in megahertz, available for the provision of a service. During the 4G Auction, 245MHz were sold off (60 in the 800MHz band, and 185 in the 2.6GHz band).[26]
- These two methods of quantification heavily impacted the auction design which included a number of caveats designed to ensure both capacity creation and efficient allocation through competition.

Ofcom looks at capacity both in terms of the bandwidth available for data transmission and the area effectively able to access this coverage

8.1.3 Capacity challenge

- Amongst the challenges Ofcom was looking to combat was the lack of capacity available in remote parts of the country where mobile broadband coverage was limited.
- Equally, with the growth in mobile broadband usage, especially the implementation of 4G technology which brought a faster service, the current spectrum was at risk of being put under unsustainable levels of demand.
  - Indeed, the spectrum reserved for H3G (the minority player) was an acknowledgement of this – it was apparent to Ofcom that, should H3G, the first provider to offer an unlimited broadband service, fail to secure additional bandwidth, its ability to continue offering a competitive service package would be severely diminished by likely regular network outages (resulting from excess demand being placed upon the infrastructure).

Ofcom wanted to free up additional bandwidth to facilitate the implementation of 4G technology whilst also expanding mobile internet coverage to 98% of the UK

8.1.4 Solution employed

- Ofcom had two complementary goals which influenced how they chose to allocate the capacity released during the 4G Auction:
  - To achieve 98% indoor mobile broadband coverage for residential dwellings.
  - To sustain a competitive market place by making sure that multiple (at least four) 'credible national wholesalers' remained able to operate going forwards.
- To ensure the coverage was achieved, a 'coverage obligation' was attached to the licence conditions of one of the most desirable lots of spectrum (the lot eventually won by O2/Telefonica). This lot had a much lower reserve price (£250m as opposed to £450m for the unobligated lot).
- The resulting cost assigned to the coverage obligation by the market – £0 during the preliminary clock rounds (see Figure 2) and £31m in the final outcome – appears to suggest that allowing the market to price this was an efficient solution.

[25] Ibid., p. 20.

[26] Ibid., p. 19.

"Clearly this shows how effective the obligation and auction model was – had we tried to simply price it ourselves, whilst we would have gone lower than £200m, we would certainly not have come to such a low figure which means we would have priced things inefficiently."

Director, Ofcom

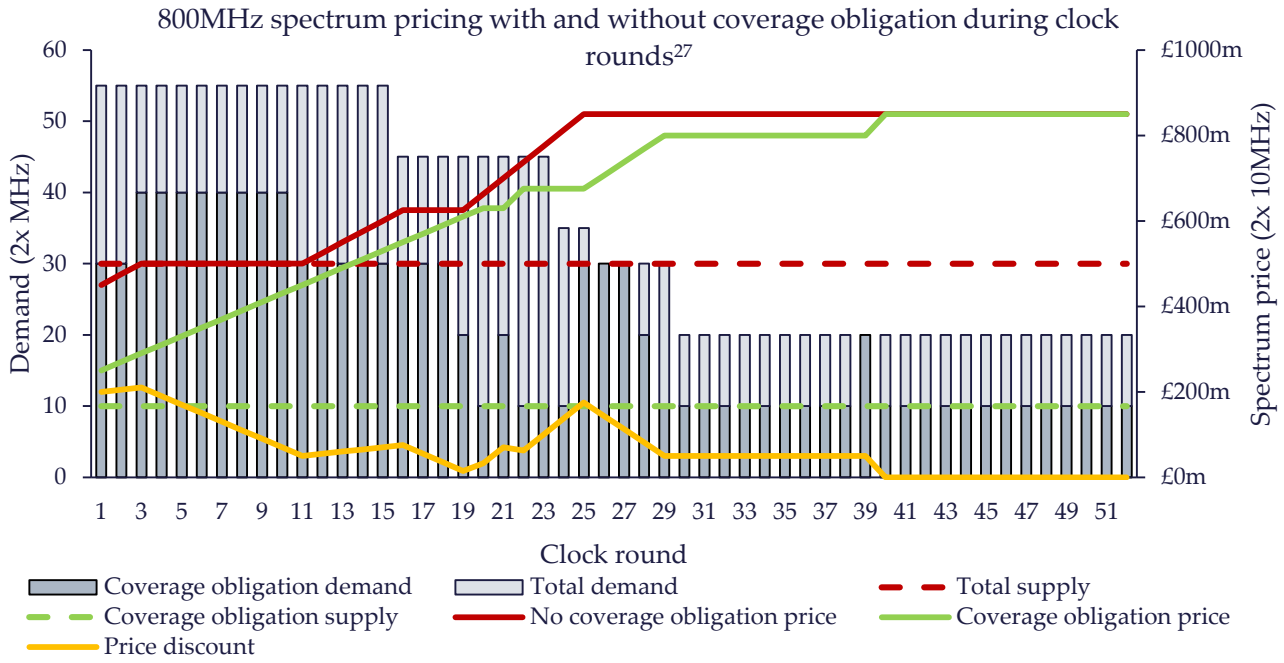


Figure 45: Reproduced using data provided by Ofcom

- **The clock phase** – The clock phase was used to gauge market interest in the various lots available:
  - It was conducted over 52 rounds where each bidder could register its interest.
  - If demand for any group of lots (800MHz obligated, 800MHz unobligated, 2.6GHz paired, 2.6GHz unpaired) exceeded supply, the price was raised and another round occurred.
  - Participants could alter their desires each round, including re-registering interest in lots they previously indicated they did not want. This was because the collective packages they desired may change as different lots prices increased.
  - As shown in Figure 45, although the final price movement in the 800MHz spectrum occurred during round 39, the auction continued whilst the concurrent 2.6GHz bidding concluded.
  - This stage did not (directly) impact the allocation of capacity – it was proceeded by a final, sealed-bid round, the results which determined the awarding of spectrum.

- The maintenance of market competition was also integral to the auction design adopted by Ofcom because it believes competition is in the best interests of the public and is the most effective mechanism for effectively pricing and allocating capacity.

"We deem competition to be crucial to the efficient operation of the market and in the best interest of the public, [and, as such, we] implemented three measures to ensure its survival."

Director, Ofcom

- These three measures were as follows:
  - **Spectrum reservation** – A small portion of spectrum (2x 5MHz of 800MHz bandwidth) was reserved for a fourth player (i.e. not O2, EE, or Vodafone). This was deemed by Ofcom to be

[27] The coverage with the obligation was solid in one 2x10 lot. The unobligated coverage was sold in four 2x5 lots.

the minimum amount of spectrum required for a fourth provider to offer a 'credible' set of services going forwards. This was done to ensure the big three could not have bought up all the spectrum, thus reducing competition.

"[The spectrum reservation] was important to H3G which was one of the first operators to roll out the 'all you can eat' data service, a service which, without additional spectrum, may have come under pressure to maintain speed/access as it added more users."

Director, National Audit Office

"We implemented [the spectrum reservation] because we thought it was too risky to trust the market to preserve [competition] otherwise – the three largest players could credibly have bought all the spectrum between them, thus reducing H3G's competitive ability."

Director, Ofcom

- H3G ended up winning this lot for the reserve price, far cheaper than any of the comparable spectrum cost for the other operators.

- **Overall bandwidth cap** – A cap on the total bandwidth any single provider could hold following the auction was set at 210MHz. This was to avoid any one player controlling too large a portion of the mobile broadband spectrum.
  - EE ended up hitting this cap with the packages it acquired.[28]
- **Low bandwidth cap** – Because lower bandwidths have operational advantages, an additional cap was placed on the amount which any operator could hold.
  - Both O2 and Vodafone hit this cap with every bid they put in designed to do so.

- The fact that all three measures appear to have impacted the auction results (the reserved portion went for the reserve price and both caps were hit) indicates Ofcom was able to impact the allocation of capacity whilst still allowing market forces to control much of the process.
  - Ofcom is benefitted in this regard by having a wide range of regulatory powers relative to its peers in some other industries.

    "It is worth noting that Ofcom is a relatively powerful regulator with a number of powers available to it – it could, for example, have chosen to block mergers between the big three, or to have regulated the types of contracts which can be sold to customers. Instead, it opted to ensure the marketplace had space for an extra competitor."

    Director, National Audit Office

Ofcom ran an auction to allow the market to efficiently allocate capacity. However, it included a number of conditions to ensure rural coverage was increased and competition preserved

8.1.5 Relevance of study

- The capacity auction process undertaken by Ofcom is somewhat analogous to the franchising process run by the DfT in the UK rail industry. However, there exist two major differences which benefitted Ofcom's pursuit of efficient capacity allocation:
  - **Capacity focus** – Ofcom chose to focus on ensuring capacity was achieved through its auction process and societal benefits were maximised by implementing the coverage obligation. This was done with the explicit acceptance that it would likely reduce the revenue achieved.[29]

[28] Previously, during the merger of Orange and T-Mobile which created EE, it was forced to divest a portion of its resulting bandwidth portfolio for similar reasons. This 1,800MHz spectrum package now represents a large portion of H3G's holdings.

[29] It is worth noting that maximising revenue is not just tangential to Ofcom's goals, but specifically contravenes its mandate.

"Ofcom did not have a revenue target for the auction, nor did it have an obligation to achieve the highest price. Rather it was incentivised by the Communications Act to push for the greatest benefit to society."

Director, National Audit Office

"We chose to include these stipulations because, although we believe auctions are very good at efficiently pricing capacity as the operator who will derive the most value will bid the highest, it is important to protect against monopolies."

Director, Ofcom

        - This differs from the rail franchising process which places a major emphasis on revenue accrual and usually favours the bidder who will provide the highest premium payments (i.e. revenue to the DfT and, indirectly, Network Rail).
    - **Long-term contracts** – The licences let through the 4G Auction are indefinite which differs from the seven-to-ten-year terms of most rail franchises.[30] This allows operators to consider payback periods over a longer period of time, and thus make more substantial infrastructure investments than would make sense in rail.
- There does exist similarity in the desirability of the capacity being sold in both the auction and franchising processes. Like Ofcom, the DfT is always able to find multiple potential bidders. Indeed, every rail franchise process has had at least three participants, all of whom usually expect to make 3-4% margin should they win.
    - This desirability gave Ofcom the ability to attach conditions to what it was selling and may provide the DfT with a similar opportunity.

The Ofcom 4G Auction illustrates a model of allocating infrastructure capacity through a competitive bidding process which contrasts to the rail franchising process

Figure 46: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *The technical requirements of sustaining a 4G network under increasing demand necessitated capacity increases* • *The coverage obligation was designed to increase capacity in rural/underserved parts of the country*	✓
b. Performance optimisation	• *N/A*	×
c. Efficient allocation of capacity	• *The purpose of running an auction was to allow market forces to allocate the newly available capacity with maximum efficiency, both with regards to the winning parties and the prices paid*	✓
d. Planning for future capacity in response to demand	• *The various clauses designed to ensure ongoing competition in the marketplace were used to guarantee efficient capacity usage in the future*	✓

[30] The auction prices cover the first 20 years of holding the spectrum, which is then subject to annual fees after this period. However, it is very unlikely for an operator to lose a licence assuming it is willing to pay said annual fees.

8.2 Analysis of incentive approach

8.2.1 Incentive to improve capacity

a. Ofcom

- Ofcom operates under a strict mandate to work towards maximising the societal benefits accrued by Britain from the telecoms industry. In the case of the 4G Auction, this meant ensuring the capacity was allocated in the best interests of the British public, both with regards to coverage and competition.

> *"Ofcom's mandate – to provide the greatest benefit to the consumer – impacted its understanding of efficient spectrum usage. To them, it was based around achieving the maximum consumer benefit (in terms of monetary value) for every element of spectrum."*
>
> Director, National Audit Office

> *"From a social point of view, it would be short-sighted to battle over [the price we sold the spectrum for] because, no matter what they turn out to be, they will always represent a tiny fraction of the GDP gains achieved thanks to the spectrum being sold."*
>
> Director, Ofcom

  - The importance of Ofcom's mandate as an incentive structure, and the clear set of goals it produced, underwrote the entire auction design process.

> *"Ofcom had a set of very clear goals ahead of the auction, clear goals which benefitted it during the process as it was able to tailor it towards prioritising factors such as efficient capacity allocation and securing a competitive market over increasing the sale price."*
>
> Director, National Audit Office

b. National wholesalers

- From the wholesalers' perspective, the incentives were commercial/financial – the acquisition or creation of more capacity was integral to growing their business, especially in the 4G space. Given this represented a substantial revenue opportunity, conditions such as the coverage obligation were deemed costs worth paying.

Ofcom's mandate compels it to prioritise maximising consumer/societal benefits which it aimed to achieve by increasing network capacity. Meanwhile, the national wholesalers are incentivised by the revenue potential additional capacity provides

8.2.2 Costs and benefits

a. Costs

- The auction process imposed two costs on Ofcom, one directly quantifiable, one less so, both as a result of attempting to guarantee competition plurality:
  - **Lost revenue** – By reserving a portion of spectrum for a fourth national wholesaler, Ofcom enabled H3G to acquire one lot of 800MHz spectrum for far less than comparable spectrum was bought for by its competitors. This was partly responsible for revenue falling over £1bn below the Treasury's estimates.
  - **Reduced efficiency** – Ofcom's influencing the auction results through its various caveats ensured that the results were different from what would have occurred in a straight pricing competition. This was done to ensure ongoing competition.

    "There was an associated cost to this solution that may have led to inefficient allocation of spectrum, but we deemed it worthwhile because of the consumer benefits competition brings."

    Director, Ofcom

b. Benefits

- The auction model offers one clear benefit relative to many other procurement models:

- **Efficient pricing** – In theory, an auction allows the market to efficiently price the asset up for sale. In Ofcom's case, this was mitigated by the various conditions in order to ensure the survival of competitive intensity.

Overall, auctions provide a streamlined method of capacity allocation which allow the market to efficiently price the asset. In Ofcom's case, the imposition of conditions to ensure continued competition may have decreased revenue, but this was viewed as a worthwhile trade-off

8.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 47: Enablers identified within study

Enabler	Corresponding element of case study
1. Desire to maximise societal benefits over revenue	*Ofcom's mandate does not allow it to chase revenue. Instead, it compels it to attempt to maximise the benefits to society provided by the allocation and use of its infrastructure. As such, it was able to pursue a capacity-enhancing solution without concern for increasing the price.*
2. Competitive environment	*Ofcom strongly believed that the competitive environment ensured the efficient allocation of capacity because it placed strong costs on failure. They looked to preserve this through various auction conditions.*
3. High market value/desirability of spectrum being sold	*It was imperative for their businesses that the various auction participants won some of the spectrum on offer. This therefore enabled Ofcom to attach conditions to the lots knowing that they would still be purchased.*
4. Long-term contracts	*The length of the licences being sold – indefinite with the price covering the first 20 years of operational fees – meant bidders could view their costs and potential returns over a very long timeframe.*
5. In depth market knowledge	*Ofcom's in depth knowledge of the UK telecoms market meant it was able to design an auction to satisfy its various desires (including the creation and allocation of capacity). This was particularly true of the clause reserving a portion of spectrum for a fourth national wholesaler – H3G.*
6. Contractual freedom	*It was possible to tie the coverage obligation to a lot of 800MHz spectrum because Ofcom possessed sufficient legal freedom in writing the licences. It was also permitted to run an outcome-based auction.*

8.4 Conclusion

- This case study highlights an alternative model to allocating capacity from the franchising system used in rail – a competitive auction.
- The use of an auction allows competition, driven by market forces, to price the capacity, ensuring it is valued and allocated in an efficient manner.
    - Various caveats were used in order to ensure prices were not inflated by one or more parties attempting to reduce future competition through the creation of a monopoly.
        - This was done because Ofcom believes competition to be a key enabler of efficient use of capacity and were enabled by Ofcom's commitment to societal benefits over revenue maximisation.

- There is also evidence of what can be achieved by a powerful regulator during the process of allocating highly desirable capacity when it has a clear set of objectives.
- Finally, letting licences/contracts over a longer period allows operators to consider infrastructure costs in a different way – they can think about an appropriate payback period as being longer-term which incentivises capex spending.

Figure 48: Case Study summary box [Ofcom 4G Auction]

Key parties involved	*Ofcom; winning bidders (O2/Telefonica, Vodafone, EE, H3G, Niche)*
Capacity challenge	*Poor coverage in some remote areas and limited available spectrum*
Approach	• *Split the spectrum into lots and ran a competitive auction* • *Attached a coverage obligation to a particularly desirable lot to ensure remote coverage exceeded 98% of residential dwellings* • *Included various caveats, including a spectrum reservation, to ensure ongoing competitive intensity*
Summary of Enablers	• Mandate to maximise societal benefits as opposed to revenue • Intensely competitive marketplace • In depth market knowledge • Regulatory power

9 APPENDIX 9 – NATS / HEATHROW AIRPORT

9.1 Situation and Background

9.1.1 Description of scenario

- NATS is a private-sector provider of air navigation and air traffic control services, and in the UK has two major roles.
  - It controls UK airspace under a licence from the Civil Aviation Authority, which involves the provision of en-route air traffic control to airlines.
  - NATS also operates air traffic control under contract with fifteen UK airports, including all four airports within the Heathrow Airport Holdings group (Heathrow, Southampton, Aberdeen and Glasgow).
- In this case study, we focus on NATS air-traffic control operations at Heathrow – the UK's busiest airport, and the third busiest airport in the world by passenger volume.

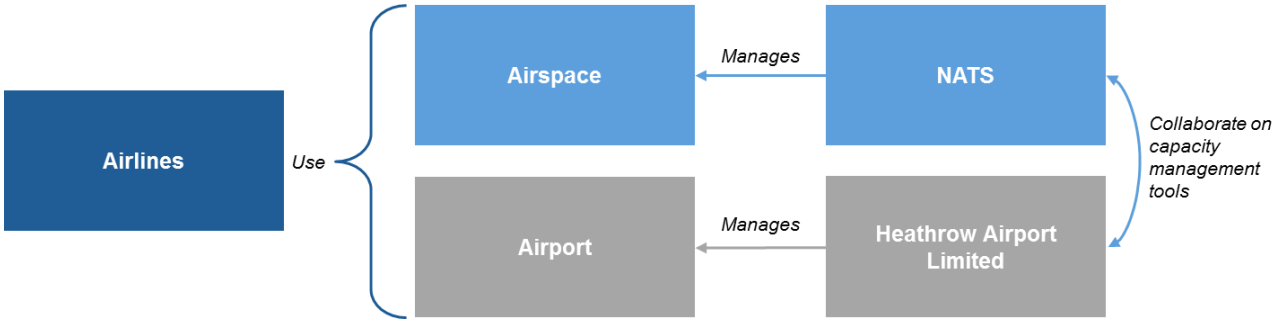


Figure 49: Stakeholder diagram

- The relationship between NATS and Heathrow is critically important, as their roles are strongly interdependent.
  - NATS controls aircraft movements, setting the schedules for take-off and landing, taxiways, and controlling the circling ('stacking') process in the immediate vicinity of Heathrow.
    - Such planning must consider the infrastructure constraints (i.e. runway availability) at the airport itself, but must also interface directly with European and worldwide airspace. There is a high level of interconnection between Heathrow and other European and worldwide hubs, meaning that problems elsewhere can swiftly impact operations at Heathrow.
  - Meanwhile Heathrow Airport Limited, as the operator of the airport, is responsible for ground operations (e.g. development of infrastructure, baggage handling and terminal operations). It holds contractual relationships with commercial airlines and airfreight firms to operate at the airport, and also manages non-aeronautical activity such as retailing within terminals.
- A major role for NATS is the seasonal planning of aircraft movements into and out of Heathrow.
  - A new planning approach has recently been introduced, which will produce its first set of advance schedules during Spring/Summer 2015 for the coming winter season. This process is known as the Runway Scheduling Limits (RSL).
- There is also an innovative approach employed for short-term 'tactical' planning of movements on, or close to, the day of operation.
  - NATS approach is of particular interest to this study for the way that 'big data' is employed in a number of ways to improve the approach to capacity management.

NATS manages aircraft movements at Heathrow airport, and employs a 'big data' solution designed to aid collaborative decision making and improve dynamic capacity management

9.1.2 Measurement/quantification of capacity

- Heathrow measures capacity in terms of 'movements' where a single movement is either a take-off or a landing.
    - Its yearly movements are capped by law at 480,000 (which equates to 240,000 full take-off/landing cycles). These movements are allocated in terms of 'slots' which allow airlines to operate a take-off or landing at a given time.
- Capacity can also be viewed as a valuable commodity, evidenced by the fact that some airlines now include their slots as assets on their balance sheets.[31]
    - These valuations are based in part upon the secondary market which exists for slots, a market which has seen pairs trade for upwards of $50m each.[32]
    - Thus, slots are a tradable asset with a clear market value. As a result, the creation of extra slots has a value and this value can be realised through sales.
    - This allows Heathrow to monetise its capacity – a new pair of slots was identified in January 2015 which were sold to Vietnam Airlines, a new entrant at the airport.

      "Each aircraft 'slot' is a commercial entity for an airport and they are therefore able to charge for its use. In this particular instance, the new slots were taken by Vietnam Airlines."

      Senior Consultant, NATS

Capacity is primarily measured in terms of 'movements' which have a yearly cap. However, its value means it can also be thought of in terms of its potential for generating revenue

9.1.3 Capacity challenge

- Many UK airports operate at, or near, full capacity, with Heathrow Airport particularly oversubscribed.
    - Heathrow is currently operating at ~98% of its maximum capacity and has been capacity constrained for over a decade.
    - In a 2012 study by the Board of Airline Representatives, 86% of airlines stated that they would run more flights in and out of Heathrow if the opportunity was available.[33]
    - The level of demand is so high relative to existing capacity that airlines have become desperate to gain additional take-off and landing slots leading to a massive expansion in the practice of secondary slot trading.
        - The Department for Transport forecasts that, by 2020, there will be 11m unserved passengers who could have travelled through Heathrow, potentially rising as high as 28m by 2030.[34]

[31] "BMI puts £770m value on its Heathrow airport slots," Kevin Done, *Financial Times*, May 24, 2008.

[32] This figure is based upon four slots which Continental bought for a combined total of $209m in 2008. "Continental pays Heathrow record," Kevin Done, *Financial Times*, Mar. 3, 2008.

[33] "Airlines turning their backs on UK over Heathrow capacity," *The Daily Mail*, Apr. 18, 2012 – Accessed on 16/02/15 at http://www.dailymail.co.uk/travel/article-2131523/Heathrow-Airport-capacity-constraints-Airlines-turning-backs-UK.html

[34] "Airports Commission Discussion Paper 01: Aviation Demand Forecasting – Heathrow Airport Limited Response," Heathrow Airport, Mar. 15, 2013, p. 2.

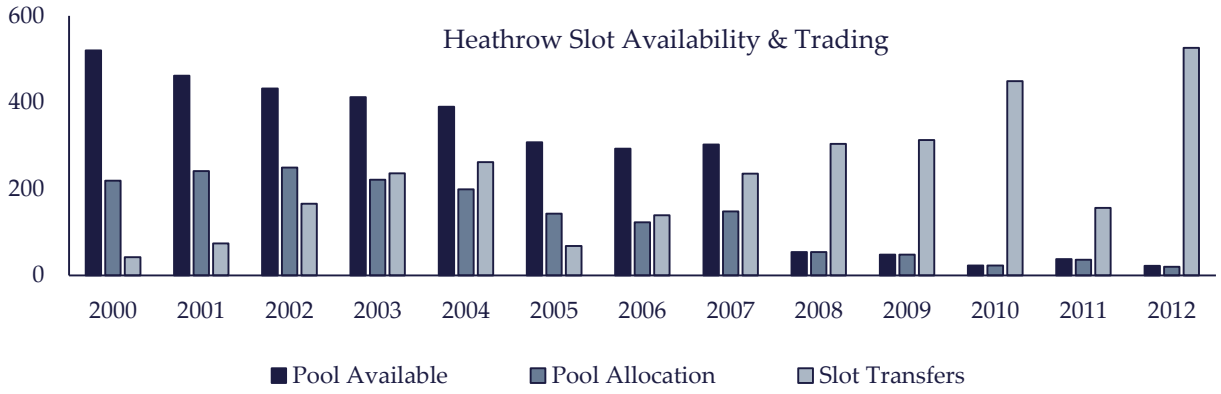


Figure 50: Growth in slot trading over time as 'pooled' capacity at Heathrow has reduced. Reproduced from data retrieved from the Centre for Aviation[35]

Demand for additional slots is incredibly high, but Heathrow is already operating at 98% capacity. Effective capacity management is therefore a strategic imperative

9.1.4 Solution employed

- A tender process began in 2012 for a system to address the long- and short-term capacity and operational constraints at Heathrow. NATS responded to this tender and was awarded the contract to develop and implement a solution.
- NATS approach addressed each of the three key stages in capacity planning (see: Figure 51). These begin with seasonal planning, carried out around seven months ahead of time, to pre-tactical and tactical planning within ten days of the day of operation:
    - **Strategic** – This mainly involves the seasonal schedules which are issued twice per year and describe how capacity will be allocated within Runway Scheduling Limits (RSL). Historically, these schedules have been prepared over a period of three months.
        - For example, a winter baseline schedule would usually be worked out between February and May (though an inherent problem with this is that the previous winter season is not yet complete when planning begins – i.e. there is an incomplete understanding of the outturn of the prior set of schedules).
    - **Pre-tactical** – This is an ongoing business activity which is carried out ten days before each day of operation. Near-term data is used to refine the schedule in light of improved visibility of the situation (such as weather patterns and unplanned taxiway closures). This allows for the production of an airport operating plan for the day of operation.
        - Given the levels of unpredictability, the operating plan could reasonably be described as a 'best guess' of what will happen on the day of operation.
    - **Tactical** – This is the real-time management of the airport and is based around optimising the use of runways on the day of operation.
- NATS undertook a comprehensive review of the end-to-end approach to capacity management. Within the strategic planning phase (RSL), NATS was able to revamp the entire process and streamlining it such that the tasks which originally were spread over three months now take only a week.
    - Crucially, this involved a holistic view of the airport's operations and drilling right down to the key moving parts of the problem: passengers, planes, and bags.

      "A vital component of our process was looking at scheduling from an end-to-end perspective, by which we mean considering things like terminal usage at passport control to ensure that we did not simply move the bottleneck from the taxiway to another part of the airport."

      Senior Consultant, NATS

- This was heavily reliant upon the use of modelling techniques which could test 'what if' scenarios to assess the potential implications of schedule alterations.
  - These in turn relied upon technological advances in the handling of large quantities of information, often termed 'big data.'

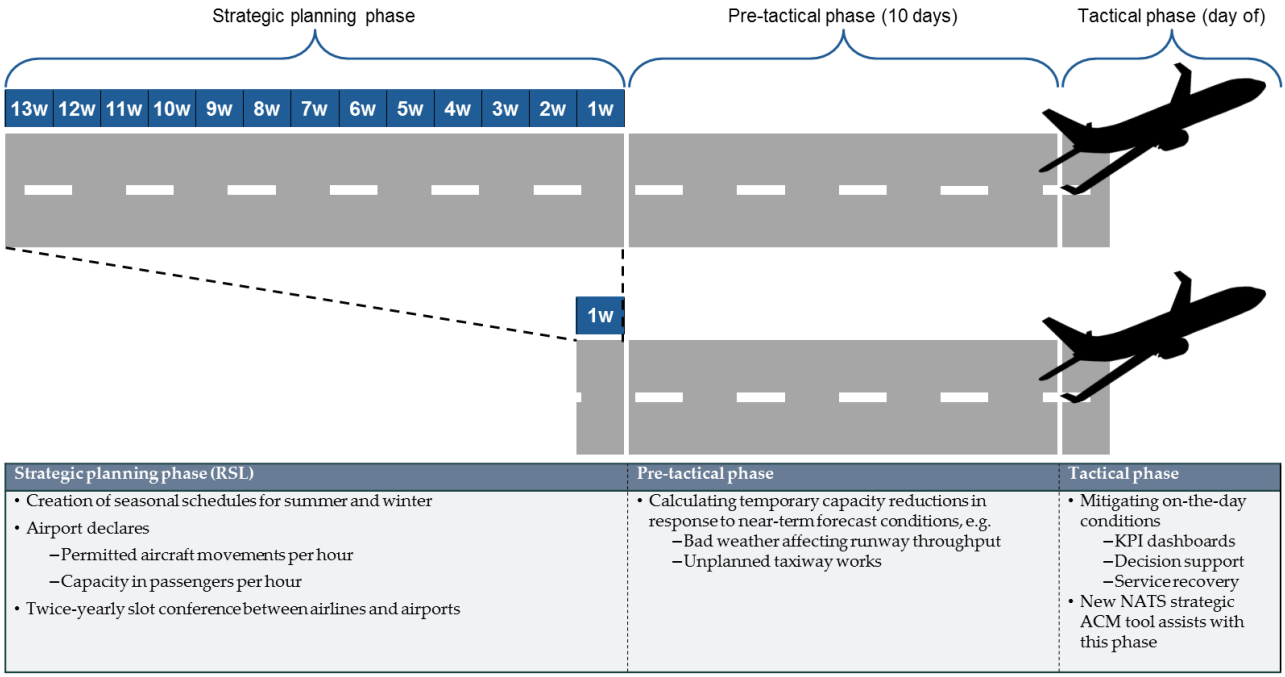


Figure 51: Phases of airport capacity planning diagram

- Stakeholder engagement was also integral, with both the airport and the airlines being involved throughout the process.
- During the 'pre-tactical' and 'tactical' phases, cooperation underpins the conference call approach used to adjust the schedules.
  - When there are major delays, either predicted ahead of time due to weather forecasts etc., or experienced during operations, the airlines, Heathrow, and NATS conference call with each other to discuss which services can be pulled from the schedule to alleviate the pressure placed upon the network.

    "Three days prior to operations, we are able to assess things like weather which gives us an idea of the likely impacts on our capacity. We can then run a teleconference with the airlines in an attempt to reduce their requirements (i.e. cancel flights)."

    Senior Manager, Air Traffic Management, Heathrow Airport
  - Although the final decision falls to Heathrow, this process is a collaborative one which allows all the stakeholders to present their opinions in an attempt to find the best overall solution.

    "This is not a mandatory process, it's a collaborative one. First, we get a MET update, then NATS and the airport operations team will both fill us in. Next, the airlines give their views regarding which parts of their programme are essential and whether they feel they need to run a full one – for example, if an airline is expecting a pilot strike etc., it may already have plans to reduce its operations, thus solving the problem."

    Senior Manager, Air Traffic Management, Heathrow Airport
  - This process is not an industry-wide standard and has subsequently required a cultural shift for it to work.

    "This is not a widespread process and has required a bit of a culture change… Overall it has worked thanks to a sense of goodwill from the big players towards those airlines running limited services as it's easier for the big airlines to reduce their schedules without facing major repercussions."

    Senior Manager, Air Traffic Management, Heathrow Airport

- For the day-of operations, investment was made in a real-time decision support tool which facilitates 'collaborative decision making' by collecting vast amounts of data and presenting it in a user-friendly manner.
    - As part of the design process, NATS consulted with McLaren Applied Technologies, who have developed similar tools within Formula 1 racing to facilitate decision-making in the heat of a motor race. The concept for NATS' ACM tool was based on the idea of maintaining human agency (i.e. allowing people to make the final decisions), but improving this process by providing previously inaccessible information.

      "[The solution employed] was based upon the principle of 'keeping the human in the loop'. The idea was not to remove the human from the decision-making process, but rather to provide decision support by offering a range of possibilities and recommendations which the human operator can choose between."

      Director, McLaren Applied Technologies
- The software package created allows solutions to be judged against a range of key performance indicators and offers different suggestions depending on what is deemed most important at the time.
    - For example, early in the day there is likely to be a focus on arrivals and departures, whereas as the day ends, arrivals will be prioritised in order to empty the skies before the night-time restrictions come into force.[35]
        - This means KPIs which focus on on-time departures are weighted more heavily than they are earlier in the day.
    - The entire process relies heavily upon the use of 'big data' which is managed in a central airport operating centre.

NATS facilitates cooperation between the various stakeholders to create maximally efficient schedules. It then leverages 'big data' to provide decision support to air traffic controllers in order to enable dynamic network management to improve day-of operations

9.1.5 Relevance of study

- There is a clear similarity in the acuteness of the capacity constraint at Heathrow – there are a number of route and termini on the UK rail network that represent severe choke points.
    - In both cases, we have a situation of fixed capacity where it is very difficult and often expensive to add further capacity through infrastructure upgrades.
    - Further, Heathrow mirrors the position of the rail industry in holding excess demand which must be accommodated by the allocation of these scarce resources.
- Another similiarity is the availability of data which can be used to model passenger demand, future scenarios, the impact of changes etc.
    - However, whereas in aviation this data is being leveraged to inform the approach and achieve improvements capacity and efficiency, current data utilisation within rail appears less sophisticated.
    - It is worth noting that while aviation may benefit from a greater availability and depth of data, there is still a large amount of data available in rail that could potentially be better employed.
- The competitive environment present in the aviation industry that impacts Heathrow is different to the situation in rail.
    - Both routes and destinations are heavily competed in aviation, giving customers a lot of choice and encouraging operator innovation. In rail, most routes are either served by a single

[35] Heathrow has restrictions placed upon its operations between 23:00 and 07:00 to avoid excess noise.

provider or, in the rare cases that this is not true, there exists a clearly dominant preference and an industry mechanism in place for sharing the revenue accordingly.

- Perhaps more importantly, there exists no direct competition between stations in rail comparable to the competition between airports. Heathrow competes intensely with both other UK airports, most notably Gatwick, and major European ones – Frankfurt, Schiphol (Amsterdam), and Charles de Gaulle (Paris) – to act as an international hub for various long-haul airlines. To do so, it requires sufficient capacity to satisfy airline demand which creates an imperative to generate capacity.

- This competitive environment has led to an alignment of incentives between the airlines, the airport, and NATS. This encourages collaboration between the various stakeholders which in turn enables solutions to be found and implemented which benefit the collective good.
  - In rail, this is not the case as the infrastructure operator, Network Rail, lacks an analogous clear incentive to increase capacity.

Heathrow is operating under a competitive intensity and with an alignment of incentives unfamiliar to the rail industry. However, the acuteness of the problems it is tackling, combined with the availability of useful data in rail, mean there are undoubtedly valuable lessons to be learned

Figure 52: Case study relevance to ORR objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Customer demand for 'slots' far exceeds their availability. Therefore, strong pressure to extract more capacity from a finite asset (the runway) is present*	✓
b. Performance optimisation	• *Heathrow's primary objective is maximising the quality of the passenger experience* • *Service unpredictability is a major challenge for the aviation industry. NATS attempts to minimise its impacts in order to allow Heathrow to improve performance*	✓
c. Efficient allocation of capacity	• *NATS's software aids collaborative decision making and is designed to improve the allocation of space on Heathrow's runways in order to reduce delays* • *The software evaluates air traffic controllers' various options against a set of KPIs, allowing them to make the optimal decisions with regards to their current objectives*	✓
d. Planning for future capacity in response to demand	• *NATS's began by trying to tackle the seasonal planning process.* • *It eventually managed to streamline operations, getting them down from three months to one week*	(✓)

9.2 Analysis of incentive approach

9.2.1 Incentive to improve capacity

- A number of stakeholders influence the situation at Heathrow Airport, each with their own incentive structure.
    - **Heathrow** – Heathrow is a hugely constrained airport, currently operating at around 98% capacity, and has been for a long time. As such, space on its runway is hugely in demand making it a valuable commodity of which supply is constricted in the extreme.

      "The new slots [NATS and Heathrow] just found are the first new ones since 1996. Incidentally, this is allowing the first new airline, Vietnam Airlines, to begin operating flights in and out since 1996 as well."

      Senior Consultant, NATS

        - Another problem caused by Heathrow's level of operations is the resulting lack of network resilience which makes it incredibly sensitive to a variety of factors, ranging from severe weather to international baggage handling strikes.

      "The current utilisation levels which mean there is very little resilience in the network. To give you an example of what this can mean, if we have an hour of headwinds (a common occurrence), it can take maybe six hours to clear the delays from the schedule if no planes are cancelled."

      Senior Consultant, NATS

        - Equally, the inter-connectedness of the international aviation industry means that any problem which occurs at Heathrow can have significant knock-on effects across Northern Europe.
        - This problem is exacerbated by the fact that Heathrow's operations are restricted at night, reducing the period during which flights can take off and land.

      "[Heathrow's] operations must remain within a specific window which can cause major problems when a backlog develops."

      Director, McLaren Applied Technologies

        - With regards to finding additional capacity, there is also a powerful set of financial incentives in place given the monetary value of each pair of slots.
        - The level of competition present between different airports for passengers is also central to Heathrow's challenge – if it fails to meet demand, it risks losing business to its competition.
            - This could either be in the form of passengers flying from other UK airports such as Gatwick, or airlines choosing an alternative as their European hub.
        - The competitive pressures felt by Heathrow led to an 'open-minded' perspective on new solutions. Given NATS' position as the architects of a solution for Heathrow, there is evidence that it had the freedom to suggest and implement its various 'big data' solutions without facing the level of scepticism which is sometimes present.

      "Getting people to sign off on the use of things like 'Big Data' is often quite challenging. At Heathrow this was not the case because of the intense competitive environment."

      Head of Information, NATS

    - **Airlines** – The airlines are also incentivised to search for ways to improve the efficient use of capacity because improved airport operations increase the reliability of their services which is crucial to keeping passengers happy.

      "Passengers of airlines are able to more with their feet, meaning that airlines will suffer commercially from poor performance. This is unlike the situation in rail, where there is often only one train operator for a given route."

      Head of Information, NATS

- **NATS** – Finally, NATS is paid based partly upon the number of movements it facilitates into and out of Heathrow each year giving it a direct financial incentive to increase capacity.

  "As for us (NATS), our fees are based upon the number of movements we can facilitate per year, as well as the amount of fuel we save people (by avoiding them circling Heathrow waiting to land) so we are directly incentivised to improve efficiency and capacity."

  Senior Consultant, NATS

- Overall, there is a very strong alignment of incentives between Heathrow, NATS, and the airlines which leads to collaboration between the various parties in searching for solutions to the capacity constraints.
  - This alignment is responsible for NATS engaging with all the various stakeholders when they are looking at ways to improve capacity management.
- These incentives are then aided by technological advances in leveraging data to enable NATS to tackle the problem.

9.2.2 Costs and benefits

- The costs and benefits in play diverged markedly – whilst the cost of implementing NATS's data-driven solution may have run to a few hundred thousand pounds, the payback of finding a new slot was tenfold in the first year (with subsequent returns being available indefinitely).

9.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 53: Enablers identified within study

Enabler	Corresponding element of case study
1. Competitive environment	*The intense competition present across the aviation industry (between airports and between airlines), pushes everyone to find additional capacity.*
2. Power of the capacity constraint	*Improving the infrastructure to provide more capacity was not possible outside of the Davies Commission framework. Heathrow, NATS and other stakeholders are all therefore incentivised to work on maximising the efficient usage of existing assets.*
3. Aligned incentives	*Heathrow and the airlines are all incentivised to improve the quality and availability of capacity. The aligned incentives enables collaborative solutions to be sought out.*
4. Monetisation of extra capacity	*Heathrow is able to monetise any extra capacity it creates (a new slot it created was recently sold to Vietnam Airlines. It will also bring in additional revenue through passenger spending in the terminal). This strongly incentivises it to look for more, as well as providing a direct payback mechanism to cover any associated costs.*
5. Technological innovation	*In order to act on the various situational enablers, a solution utilising 'Big Data' was required. The software provided by NATS to enable collaborative decision making in response to flight delays is a highly technical, data-driven solution that relies heavily on technological innovation.*

9.4 Conclusion

- This case study highlights the challenges faced in an environment where creating additional capacity through network expansion is, at least in the short-to-medium term, effectively impossible and subsequently efficiency increases are necessary.
- The use of 'big data' provides a greater understanding of the network's operations and allows for the decision-making processes regarding its management to be substantially improved.
    - Technological innovation is crucial to maximising the value added through leveraging tools such as 'big data'.
- Collaboration is also shown to be hugely valuable in achieving efficiency as cooperation between stakeholders enables substantial gains to be achieved.
    - An intensely competitive environment and strongly aligned incentives, in this case financial, are clearly hugely important in encouraging the various parties to work together.

Figure 54: Case Study summary box [NATS]

Key parties involved	*Heathrow; NATS; airlines*
Capacity challenge	*Airport operating at 98% capacity with huge excess demand*
Approach	• *Approached capacity management in three phases looking at the problem various distances from the day of operation* • *Leveraged 'big data' to improve airport efficiency by tackling the major choke points, most notably the taxi way* • *Engaged all the various stakeholders in order to achieve a collaborative solution*
Summary of Enablers	• Intense competition • Extreme capacity constraint and high levels of excess demand • Strongly aligned financial incentives • Technological innovation

10 APPENDIX 10 – M25

10.1 Situation and Background

10.1.1 Description of scenario

- The M25 – the 188km ring road which encircles much of Greater London – is operated by Connect Plus, a consortium backed by Balfour Beatty, Skanska, Atkins, and Egis Road Operation UK.
- Connect Plus was awarded a £6.2bn, 30-year Design, Build, Finance, and Operate (DBFO) contract in May, 2009, to manage both the M25 and its key arterial links.
    - The consortium was specifically formed for this purpose.
- However, the overall responsibility for the M25 rests with the Highways Agency.
- Between 2009 and 2012, Connect Plus completed a major programme of upgrades, including widening two sections of the motorway, between junctions 16-23 (the stretch between the M40 and the A1M), and between junctions 27-30 (the stretch between the M11 and the A13).
    - These upgrades allowed for continual four-lane running and were completed in time for the London 2012 Olympics.[36]
- Currently, Connect Plus' obligations under the DBFO contract agreement cover three broad areas:
    - The original road-widening project which has been completed.
    - Renewal of the current infrastructure.
    - Basic operations and maintenance.

Figure 55: Map of the M25

10.1.2 Measurement/quantification of capacity

- Capacity on the M25 is measured in terms of how many cars can travel along a given section of road each day.

10.1.3 Capacity challenge

- The M25 is one of Europe's busiest motorways, with some sections carrying upwards of 200,000 vehicles every day. As such, it is severely capacity constrained with major congestion-related delays a common occurrence.
    - The Dartford crossing – a tolled pair of tunnels and bridge which traverse the Thames between Junctions 31 and 1A – is a particular choke-point, carrying up to 150,000 cars a day.

[36] "Project Story: The M25 Motorway," Balfour Beatty – Accessed on 12/03/2015 at http://www.balfourbeattycsuk.com/our-project-stories/the-m25-motorway/

10.1.4 Solution employed

- A variety of solutions have been implemented or proposed for use on the M25, including 'Smart motorways' and automated tolling for the Dartford Crossing:

a. 'Smart motorways'

- 'Smart motorways', also known as 'managed motorways' are sections of road which use active traffic management (ATM) techniques to smooth traffic flows and increase capacity. These techniques include:
  - **Variable speed limits** – Variable speed limits allow the infrastructure operator to alter the speed limit in response to weather conditions, delays etc. They rely on electronic signs to convey the changes to road users and are used to improve traffic flows by reducing stop-start driving.
  - **Hard-shoulder running** – Hard-shoulder running allows it to be used as an additional lane for regular traffic, effectively increasing capacity on the road by as much as widening to add an extra lane. This can either be done temporarily, during periods of congestion, or instated as a permanent condition.
- These are due to be introduced between Junctions 10 and 16 over the coming years, having been announced in 2014 by the Chancellor.

  "Smart motorways were announced in the 2014 Autumn Statement and will effectively create a five-lane road between Junctions 10 and 16. This will allow that section of the M25 to carry around 200,000 people a day which should go some way towards easing congestion on that stretch."

  Executive, Connect Plus

b. Dartford Crossing

- The Dartford Crossing, which includes two tunnels and the Queen Elizabeth II Bridge, saw an average daily throughput of 136,015 cars between April, 2013, and March, 2014 which caused significant delays for many motorists.[37]
  - Despite the construction of a multi-lane toll plaza, the toll booths remained a particular choke point and were the biggest cause of congestion.
- In response, the Highways Agency, in collaboration with Connect Plus, chose to remove the toll booths in favour of using an automated system – Dart Charge – which is similar to the Congestion Charge used in central London.

  "Although motorway planning is run by the government, we (Connect Plus) were consulted during the 2011-12 conversations which resulted in the decision to remove the toll booths from the Dartford Crossing. This was done in order to keep the traffic flow continuous."

  Executive, Connect Plus
- However, whilst the localised improvements are expected to be substantial, the knock-on benefits for the network as a whole are projected to be far more modest.

  "We expect the impact on the rest of the road/wider road network to be minimal."

  Executive, Connect Plus
  - Given implementation occurred on November 30th, 2014, it is hard to say exactly what the outcomes will be at this time.

10.1.5 Relevance of study

- This case study looks at the potential benefits of repurposing infrastructure which has never previously been used for traffic (i.e. the hard shoulder) and allowing it to ease congestion.
- It also highlights some of the potential benefits which technology can provide to a network and how immediate disruption can be traded off against the potential long-term efficiency gains.

[37] "New Dartford Crossing toll changes: what you need to know," Alex Robbins, *The Telegraph*, 27 Nov., 2014.

Figure 56: Mapping of incentive approach to study objectives

Objective	Corresponding element of case study	Key focus of study?
a. Efficient production of capacity	• *Hard shoulder running allows for a substantial increase in capacity without having to spend the amount required to widen the road*	✓
b. Performance optimisation	• *The use of variable speed limits is designed to smooth traffic flow in order to increase the efficiency with which vehicles use the road* • *Equally, the move towards automated tolling at the Dartford Crossing is designed to increase throughput by removing a major choke point from the network*	✓
c. Efficient allocation of capacity	• *N/A*	×
d. Planning for future capacity in response to demand	• *N/A*	×

10.2 Analysis of incentive approach

10.2.1 Incentive to improve capacity

- The two stakeholders with responsibilities related to the M25 – the Highways Agency and Connect Plus – have different incentive structures underlying their work to increase capacity.

a. The Highways Agency

- The Highways Agency is mandated to operate, maintain, and improve the strategic road network by the UK Government.
  - The strategic road network consists of motorways and other major trunk roads.
  - Lesser roads are operated by local authorities.

"The overall capacity of the M25 is the responsibility of the Highways Agency."

Executive, Connect Plus

- Given the levels of congestion, the Highways Agency subsequently aims to increase capacity to satisfy this mandate by improving the infrastructure's ability to meet public demand.
- Additionally, political pressure impacts the selection of the various solutions which are partially selected for reasons other than their pure strategic value.

"Many of the road enhancement schemes that end up getting the go ahead are partially politically motivated rather than selected on the basis of their strategic value alone."

Executive, Connect Plus

  - This is because substantial investment is required and this requires an invested party to produce a compelling business case.

"Investment in capacity improvements goes where the business cases are written which take precedence over the creation of an overall strategic business plan."

Executive, Connect Plus

b. Connect Plus

- Unlike the majority of PFI's, Connect Plus operates as a fully-fledged company in its own right.

"Connect Plus is a basically a regular PFI, but with a big twist: instead of setting up a synthetic business, we've set up a real one to run the M25."

Executive, Connect Plus

- However, despite this it is not incentivised financially to search for ways to increase capacity.
  - This is because of the terms of its DBFO agreement with the Highways Agency.

"We are not currently in a position to implement any innovative solutions to capacity because of our mandate – although theoretically we could come up with some interesting ideas on how to combat the constraints, we just aren't incentivised to do so… We have some very sophisticated tools for identifying opportunities and could acquire even more by hiring specialist staff, but we would not be compensated for it so there is no reason for us to do so."

Executive, Connect Plus

- Instead, Connect Plus, through the terms of the DBFO agreement, justifies capacity improvements as part of implementing the Highways Agency's plans.

10.3 Enablers

- We consider the following to be the major enablers that support the incentive structure identified:

Figure 57: Enablers identified within study

Enabler	Corresponding element of case study
1. Political will reacting to public pressure	*Investment decisions regarding which parts of the Motorway to upgrade, and which parts of the wider road network, as made based upon which areas have the necessary political support and therefore have supporting business cases produced. This political support is based upon public pressure to improve visible choke points.*
2. Integrated decision-making structure	*An integrated decision-making system, although currently not in place, would better engage Connect Plus M25. Doing so would allow them to leverage their market knowledge and capabilities to more efficiently produce capacity through targeted upgrades.*
3. Licence conditions	*The Highways Agency is compelled to increase capacity because of its government mandate to improve the strategic road network. Equally, Connect Plus acts to implement the Highways Agency's plans because of its DBFO agreement.*
4. In-depth market knowledge	*Possession of in depth market knowledge, gained through research and modelling, provides a detailed picture of expected demand going forwards. This picture allows for a more sophisticated understanding of where capacity is needed and allows for it to be created much more efficiently.*
5. Open culture / willingness to challenge convention	*The M25's openness to accepting the use of new technological solutions was integral to its capacity enhancements. Equally, the willingness of the various stakeholders to alter their thinking around what may be possible within the confines of running a safe motorway, in particular the conversion of the hard shoulder, was a key feature in their success.*

10.4 Conclusion

- This case study looks at both the potential for targeted investment to tackle choke points (Dartford Crossing), and broader network upgrades ('Smart motorways').
- It also highlights the value of technology as a tool for enabling capacity improvements on a very congested transport network.
- Thirdly, with the use of hard-shoulder running, it demonstrates the ways in which a culture which allows conventions to be challenged can breed innovative solutions which may previously have been rejected.
    - Were it not for this culture, it is likely safety concerns would have prevented hard-shoulder running from being implemented.
- Finally, it explores the merits and drawbacks of the PFI financing model for capacity upgrades:
    - On the one hand, it allows the infrastructure owner to dictate very specific terms to the operator, thus ensuring it has a high degree of control over the projects put in place.
    - However, this level of control disincentivises innovation on the part of the operator, potentially resulting in wasted potential and intellectual resources.

Figure 58: Case Study summary box [M25]

Key parties involved	*Connect Plus; Highways Agency*
Capacity challenge	*The M25 is one of the busiest motorways in Europe, carrying over 200,000 people each day on some sections*
Approach	• *'Smart motorways' have been used to implement variable speed limits and hard shoulder running to improve flow and increase traffic throughput* • *The Dartford Crossing was identified as a major choke point, in particular its toll booths. These have been removed and replaced with an automated system similar to the one used for the Congestion Charge in central London in order to allow traffic to run smoothly*
Enablers	• Political will/pressure • Integrated decision-making structure • Licence conditions • Market knowledge • Willingness to consider new ideas