Improving Connectivity
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I am delighted to share this study on an alternative method of improving connectivity to gain your feedback.

The industry has seen tremendous growth in both passenger and freight demand over the last decade and a half, with passenger numbers steadily increasing year-on-year by five per cent or more, even during the recession. However, this growth also makes it more challenging to keep improving the train service as key corridors around the country are nearing capacity.

This makes it vital to investigate new and innovative approaches to planning in order to make sure we are using our network in the best way to meet the needs of the passenger and freight markets.

The approach examined in this document is drawn from planning methods used by other countries which demonstrate how changes to the passenger service structure could achieve improved connectivity. The potential benefits are examined, alongside the challenges.

This document sets out three innovative principles and applies them through a case study on Anglia route. The desired level of improvement to connectivity cannot be implemented on the current infrastructure capability and the case study identifies changes to the infrastructure which would be required. The majority of these infrastructure changes fall into two categories; firstly, the provision of additional platforms at stations to support cross-platform interchange and secondly, route section upgrades to achieve the required journey time between proposed hub stations. Challenges to the industry planning processes are also identified.

This consultation is being undertaken now in order to gain feedback and understand what appetite exists for developing this approach further.

I would like to thank you in advance for your input to this consultation.

Paul Plummer

Group Strategy Director

Network Rail

I met the creators of Improving Connectivity a year ago. They were working at Victoria Area Signalling Centre, London, and developed this whole idea in their own time. It is not born of theory, but of their own practical observation and experience as signallers. I was immensely impressed by their ideas and presentation to me then, and I remain immensely impressed today.

A railway exists to serve passenger and freight markets. This project is exactly the kind of innovation that, over time, has the potential to re-align our railway with the modern interests of passengers, who increasingly use trains to travel across the country, between regions as well as to London and other city destinations.

A timetable that promotes more efficient connections between our regions is an essential ingredient in the way we begin to move from being producer-led to becoming market-led, in our ambition to put the needs of the railway’s users first.

I welcome this work and we at the DfT are first looking to bring this to life as part of our forthcoming East Anglia franchise.

This project is a credit to its creators and those in Network Rail who continue to support them.

Peter Wilkinson

Managing Director - Passenger Services

Department for Transport, Rail Executive
Executive Summary

0.1 Improving Connectivity is a long-term methodology being investigated to deliver improved rail connectivity across Britain. The improvements would be achieved by devising a new connectivity-based timetable, to be facilitated by alterations to the infrastructure. This document explores a case study of how the project might be applied to rail services in Anglia. Inevitably, such an ambitious project also raises a number of trade-offs and changes would be required to the way the industry plans services and allocates capacity on the network. We are seeking your views on this potential approach and would welcome your participation in this consultation. This can be completed online or as detailed in Chapter 6.

0.2 In the case of Anglia, the rail network has been very successful at attracting people making commuting and leisure trips to and from central London. However, road usage suggests that central London is not the only place people are interested in travelling to: demand exists for many other types of journey, right across the region. The railways have not tended to serve people making these other journeys so well. Improving Connectivity looks beyond traditional rail travel patterns with the aim of serving a broader range of markets.

0.3 The Anglia case study builds on the good rail connectivity many places already have with central London, and aims to provide an equally good service to the many other places people might wish to travel to. This would have the combined benefit of encouraging modal shift to rail and concentrating growth onto less heavily utilised parts of the network. The Swiss railways have been very successful at providing this sort of across-the-board connectivity and many aspects of this project were inspired by methods of operation on the Swiss network.

0.4 The future timetable is written at the start of the process, according to three principles that have been developed to maximise connectivity. Any necessary alterations to the infrastructure are identified at this stage. In addition to connectivity, the principles offer secondary benefits such as the potential for improved performance, maintenance access, efficiency and freight capacity.

0.5 The greatest improvements would occur on routes such as Romford to Cambridge, Harlow Town to Great Yarmouth, Kings Lynn to Stratford and Cambridge to Ipswich to name but a few. It is on these less traditional routes that rail currently fails to offer an attractive service compared to other modes of transport and where a transformation would have the most significant impact on modal shift.

0.6 The case study examines improving connectivity to Stansted Airport with direct trains to many parts of the Anglia network. One of the options examined identifies options for improving the journey time between Liverpool Street and Stansted Airport.

0.7 Improvements to journeys such as London to Cambridge and London to Norwich would be relatively modest: these routes already offer a competitive service. As with all major timetable recasts, there are some instances of journey times increasing by a few minutes. In some cases, this is caused by trains spending slightly longer in stations for the benefit of passengers making cross-platform connections. Elsewhere, existing stopping patterns are altered to provide greater consistency or to improve the service at intermediate stations where significant demand exists.

0.8 Many increases in frequency are provided using a mix of direct trains and trains involving a cross-platform interchange en-route. Where demand is low, a number of direct trains in the existing timetable are replaced by two services with a cross-platform change. To gain the most from this alternative approach, passengers will need to feel comfortable changing trains. Communicating pertinent, real-time information and holding connections in the event of minor delays will be key to instilling the necessary confidence in passengers.

0.9 Further work is on-going to construct a peak timetable and review this against the required peak demand. As the Anglia case study is in its early stages of development, to date the known infrastructure alterations have been costed at circa £1 billion and this only represents part of what may be required. No business case appraisal has been undertaken at this stage. The outputs described in this document represent, from a technical perspective, what the rail network could be capable of delivering with this level of investment.
What is included in this alternative approach?

1.1 Improving Connectivity is a long-term methodology being considered to understand a different approach to delivering improved rail connectivity across Britain. To achieve this requires a different approach to planning both the network capability and the train service which operates on it.

1.2 The first stage involves devising a new timetable using three principles, to be facilitated by infrastructure interventions. These principles, described in Chapter 3, offer many secondary benefits such as the potential for improved performance, maintenance access, efficiency and freight capacity. Inevitably, such an ambitious project raises a number of challenges and trade-offs, which are explained in Chapters 4 and 5.

1.3 Anglia has been examined as a case study, as there may be an opportunity to explore first stage implementation through the re-franchising process. The principles have been applied to recast the off-peak Anglia timetable and scope the necessary infrastructure interventions. Further work is on-going to construct a peak timetable and review this against the required peak demand.

1.4 Work on testing the Anglia case study is at an early stage of development and full costing and feasibility of the infrastructure required has not yet been completed. This consultation is being undertaken now to gain feedback which will be taken into account in any future developments of this project. We are seeking your views and would welcome your participation in this consultation. Further details can be found in Chapter 6.

1.5 The baseline used for the Anglia case study is the existing railway, together with schemes that are planned to be implemented during Control Period 5 (CP5).
2 Why is this approach being considered?

2.1 Britain’s railways have tended to focus operations and investment around traditional rail travel patterns. In London and the South East, this has focussed upon markets such as commuting and leisure trips to central London. Developing other potential markets has been less of a priority.

2.2 In the case of Anglia, this approach to planning and operating the network has resulted in the pattern of demand shown in Figure 2.1. Rail usage is extremely London-centric: lines close to the capital struggle to cope with demand, while some of those further out are so under-utilised they struggle to justify their existence.

2.3 Usage of Anglia’s trunk roads, Figure 2.2, suggests that existing rail demand is not an accurate reflection of overall travel demand. The road network supports a much wider set of regional flows and as a result demand is more evenly spread.

2.4 Improving Connectivity proposes shifting the strategic focus of the network’s development towards providing better across-the-board connectivity, to the extent that a viable alternative to other modes of transport is offered across a wide range of routes. Figures 2.1 and 2.2 suggest that much of the resulting growth would occur on under-utilised parts of the network.

2.5 This sort of wider connectivity has been very successful in Switzerland. The Swiss do not centre operations solely around getting people to Bern or Zürich. Instead, they have designed a network that provides a seamless journey between any two stations, either on a direct train or using a series of well planned and well managed interchanges. The timetable is designed many years ahead, which in turn drives their infrastructure investment.

2.6 In Britain, applying the Swiss model is complicated by the dominance of London. The three timetabling principles described in the following chapter, although inspired by the Swiss, were developed specifically for Britain.
3 Principles

3.1 Principle 1

3.1.1 Principle 1 uses cross-platform interchanges to simplify connections and avoid train service duplication. This principle is explained using the following two case studies from Anglia.

Case study: Newmarket

3.1.2 At Newmarket, Principle 1 is used to double the frequency of the Ipswich to Peterborough service (currently every 2 hours) and accelerate the service between Ipswich and Cambridge, in an efficient manner. The traditional way to timetable such trains would be to run a direct hourly service on each of the two routes, as shown in Figure 3.1.

3.1.3 If we wish to provide good connections at Ipswich, such as from the East Suffolk line, we end up with a dilemma. Do we time the East Suffolk line arrival to connect with the Cambridge service or the Peterborough service? To connect properly with both, the Cambridge and Peterborough services would need to depart Ipswich within a few minutes of each other, resulting in the two trains duplicating one-another over a significant distance.

3.1.4 To solve this dilemma, Principle 1 is applied. The direct Ipswich to Peterborough service is replaced by a Newmarket to Peterborough service, running via a reinstated Warren Hill Junction – Snailwell Junction chord, as shown in Figure 3.2. A semi-fast Ipswich to Cambridge train connects into this service with a cross-platform connection at a reconstructed Newmarket station.

3.1.5 No services are duplicated and connections at Ipswich are simplified: the East Suffolk line arrival need only connect with the Cambridge train. This method of operation combines two markets on one train, achieving a 35 per cent reduction in train miles and halving the number of passenger train paths required on this busy freight corridor. In addition, Newmarket gains a direct service to Peterborough.
### Case study: Colchester

3.1.6 At Colchester, Principle 1 is used to provide a direct service that does not currently exist and improve frequencies to both the Harwich and Clacton branches. With minor alterations to the existing track layout at Colchester, the island platform can be used for cross-platform interchange. Two service patterns operate, alternating every 30 minutes. The first pattern provides a direct train between London and Clacton, with a cross-platform connection at Colchester for Harwich Town (Figure 3.3).

Figure 3.3: Proposed cross-platform connections at Colchester (timetable cycle 1)

3.1.7 The second pattern (30 minutes later) provides a direct service between London and Harwich Town, with a cross-platform connection at Colchester for Clacton (Figure 3.4).

Figure 3.4: Proposed cross-platform connections at Colchester (timetable cycle 2)

3.1.8 Harwich Town gains a direct hourly service to and from London; Clacton retains its hourly London service. Passengers from either branch who make use of the cross-platform connection facility gain a half-hourly service to London. End to end journey times will increase, although only by a few minutes: trains will have to spend a little longer at Colchester while passengers make the cross-platform connection between them. To have provided a half-hourly service with direct trains would have required four paths on the congested Great Eastern Main Line, but by using this principle, just two are required.

### Principle 1 in use today

3.1.9 Users of the Docklands Light Railway will be familiar with this principle of operation in the evenings. At Canary Wharf in East London, a Lewisham to Bank service arrives every 10 minutes alongside a waiting train for Stratford. Passengers for Stratford simply cross the island platform to their connection: there are no steps, subways, bridges or lifts to negotiate. The trains then proceed on their separate ways. Unnecessary duplication of services between Lewisham and Canary Wharf is avoided. The infrastructure at Canary Wharf was designed to provided this interchange. On-train announcements are made to inform passengers exactly where to go.

Figure 3.5: Cross-platform interchange on the DLR at Canary Wharf. Passengers took less than a minute to cross the platform between the two trains
3.2 Principle 2

3.2.1 Principle 2 orders arrivals and departures at interchange stations to minimise waiting times between connecting trains. This principle is explained using two case studies from Anglia.

Case study: Marks Tey

3.2.2 Figure 3.6 shows the arrivals and departures at Marks Tey in the existing timetable. The Sudbury branch train arrives at Marks Tey at 45 minutes past the hour. A main line train then calls in each direction providing good connections to London. The branch train returns to Sudbury after the main line trains have departed. However, the asymmetry in the timetable results in unsatisfactory connections between the branch and northward services: a connection to Ipswich is available after 12 minutes, yet there is a 43 minute wait for the same connection in the opposite direction. Similarly, after arriving at Marks Tey from Colchester Town, a 12 minute connection to Sudbury is available, whereas the wait in the opposite direction is 48 minutes.

3.2.3 Principle 2 is applied in the timetabling of both main line and branch line services to reduce waiting times, as shown in Figure 3.7. The Sudbury branch train arrives at Marks Tey just before the half-hour. A main line train then calls in each direction. The branch train returns to Sudbury after the main line trains have departed. No alterations to the existing infrastructure at Marks Tey are required.

3.2.4 Good connections are still provided between the Sudbury branch and a London service; northward connections are significantly improved. Firstly, the main line trains connecting with the branch are symmetrical: trains run to and from Clacton and waiting times are more or less the same in both directions. Secondly, someone travelling to or from either Harwich or Walton-on-the-Naze may use the Clacton train to make a cross-platform connection at either Colchester or Thorpe-le-Soken; there is no need to wait 30 minutes at Marks Tey for the direct Harwich train. Another cross-platform connection is available at Manningtree for passengers wishing to travel to Ipswich and beyond. Nobody has to wait at Marks Tey more than seven minutes for a connecting train.
Principle 2 across the network

3.2.5 Operation at Marks Tey shows Principle 2 at its simplest. It can be applied to much more complex interchange hubs where a number of trains from different directions are required to connect. The principle is the same: all trains arrive just before a particular point in the hour, passengers make their connections, then all trains depart just after that point in the hour. Other modes of transport, such as buses, can also form part of this pattern of arrivals and departures. Using this principle of operation, Anglia’s rail network could form the backbone of a multi-modal integrated transport network.

3.2.6 This principle involves a number of trains being in the station at any one time. Unlike at Marks Tey, some of the proposed hub stations on Anglia do not have sufficient platforms for this principle of operation. For instance, at Norwich new platforms are required. Conversely, not withstanding any potential performance benefit, the timetable does not necessitate the single track Trowse Swing Bridge to be doubled: a series of arrivals just before the hour, followed by a series of departures just after the hour, removes any need for trains to pass one another on Trowse Swing Bridge.

3.2.7 In order to provide this pattern of arrivals and departures at all interchange hubs on the network, the journey time between each hub must be a little under a multiple of half the service frequency. For example, if an hourly service were run, the journey time between hubs would need to be a little under 30, 60, 90 minutes and so on. In countries that use this principle of operation, such as Switzerland and Austria, route upgrades are undertaken to achieve these necessary journey times. Maximising connectivity is given a higher priority than reducing a journey time for its own sake. Anglia’s proposed interchange hubs are shown in Figure 3.8.
3 Principles

Case study: Ely

3.2.8 Table 3.1 shows existing waiting times between connections at Ely. It can be seen from the table, that good connections are the exception rather than the norm, and where a good connection is offered, asymmetry in the service pattern means no corresponding good connection is provided in the opposite direction. For example, someone travelling from Kings Lynn to Ipswich will have a good connection on their outward journey, but on their return leg they will be faced with a 53 minute wait.

3.2.9 This situation is not unique to Ely: similar waiting times exist at other interchange hubs on Anglia and many journeys, which cannot be completed on a direct train, involve long waits. With such a large proportion of some journeys being spent not moving, rail journey times cannot match those offered by other modes of transport, even when each leg of the journey may offer a competitive journey time in its own right. In some cases, interchanges are so poor that passengers making cross-country journeys may choose instead to travel via London, worsening already congested parts of the network.

Table 3.1: Existing connections at Ely

<table>
<thead>
<tr>
<th>Time</th>
<th>Departure Location</th>
<th>Arrival Location</th>
<th>Time</th>
<th>Direct train</th>
<th>Up to 10 minutes’ wait</th>
<th>11-20 minutes’ wait</th>
<th>More than 20 minutes’ wait</th>
<th>Not applicable</th>
<th>Not shown beyond Peterborough</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx:13</td>
<td>Arrival from: Peterborough</td>
<td>n/a</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:14</td>
<td>Arrival from: Stansted Airport, Audley End, Cambridge</td>
<td>n/a</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:25</td>
<td>Arrival from: Kings Lynn, Watlington, D’ham Mkt, Littleport</td>
<td>50*</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:26</td>
<td>Arrival from: Cambridge</td>
<td>n/a</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:31*</td>
<td>Arrival from: Peterborough, Whittlesea, March, Manea</td>
<td>45*</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:38</td>
<td>Arrival from: Norwich, Wymondham, Attleborough, Thetford, Brandon</td>
<td>37*</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:45</td>
<td>Arrival from: Norwich, Thetford</td>
<td>30*</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:51</td>
<td>Arrival from: Kings Cross, Cambridge, Waterbeach</td>
<td>24</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:52</td>
<td>Arrival from: Peterborough, March</td>
<td>n/a</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx:58*</td>
<td>Arrival from: Ipswich, Stowmarket, Bury St Edmunds</td>
<td>18*</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: All trains run hourly except Ipswich and Peterborough stopping services. Services that continue outside the Anglia area are not shown beyond Peterborough. Connections are deemed not applicable if a better connection between trains serving the same stops exists, or the connection results in trains serving the same stops rather than services to Ipswich or Peterborough. Minimum interchange time: six minutes.
3 Principles

3.2.10 Principle 2 is used to improve connections at Ely. The current journey times from Ely to Cambridge, Norwich and Peterborough are sub-optimal: the journey time from Ely to Cambridge is a little too short, and it takes a little too long to travel from Ely to Norwich and Peterborough. Instead of developing the existing capacity-constrained Ely station, a new interchange hub station is proposed in the vicinity of Ely North Junction. In addition, an upgrade of the Ely to Norwich line is required. This solution improves interchanges, abolishes level crossings, provides additional freight capacity and serves new housing developments in North Ely. Waiting times between trains at the proposed Ely North station are shown in Table 3.2. Passengers will not have to wait more than eight minutes.

<table>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>xx:26 arrival from: Peterborough, Whittlesea, March, Manea</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>D</td>
<td>5</td>
<td>7*</td>
<td>7</td>
</tr>
<tr>
<td>xx:26 arrival from: Norwich, Wymondham, Attleborough, Thetford, Brandon</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>4*</td>
<td>5</td>
<td>D</td>
<td>-</td>
</tr>
<tr>
<td>xx:26 arrival from: Stansted Apt, Cambridge, Chesterton Int, Waterbeach, Ely</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>D</td>
<td>-</td>
<td>D</td>
</tr>
<tr>
<td>xx:28 arrival from: Kings Lynn, Waterbeach, Downham Market, Littleport</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>2*</td>
<td>-</td>
<td>D</td>
<td>5</td>
</tr>
<tr>
<td>xx:29 arrival from: Newmarket, Soham, Ely</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
<td>2*</td>
<td>n/a</td>
<td>4*</td>
</tr>
<tr>
<td>xx:56 arrival from: Peterborough, Whittlesea, March, Manea</td>
<td>D</td>
<td>5</td>
<td>7*</td>
<td>7</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>xx:56 arrival from: Norwich, Wymondham, Attleborough, Thetford, Brandon</td>
<td>4*</td>
<td>5</td>
<td>D</td>
<td>-</td>
<td>8</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>xx:56 arrival from: Kings Cross, Cambridge, Chesterton Int, Waterbeach, Ely</td>
<td>n/a</td>
<td>D</td>
<td>-</td>
<td>D</td>
<td>8*</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>xx:58 arrival from: Kings Lynn, Waterbeach, Downham Market, Littleport</td>
<td>2*</td>
<td>-</td>
<td>D</td>
<td>5</td>
<td>6</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>xx:59 arrival from: Newmarket, Soham, Ely</td>
<td>-</td>
<td>2*</td>
<td>n/a</td>
<td>4*</td>
<td>D</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Note: All trains run hourly. Services that continue outside the Anglia area are not shown beyond Peterborough. Connections are deemed not applicable if a better connection between trains serving the same stops exists, or the connection results in doubling back. Minimum interchange time: five minutes (a reduced minimum interchange time of two minutes is permitted for cross-platform connections). Some trains split and join at Ely North.
3 Principles

Principle 2 in use today

3.2.11 Passengers connecting with the Braintree branch may be familiar with this principle of operation on Sundays. Figure 3.9 shows the arrivals and departures at Witham in the existing timetable. The Braintree branch train arrives at Witham at 16 minutes past the hour. A main line train then calls in each direction providing good connections to London or Clacton-on-Sea. The branch train returns to Braintree at 25 minutes past the hour.

3.2.12 The main line trains to and from Clacton also make cross-platform connections at Thorpe-le-Soken for Walton-on-the-Naze. However, as cross-platform interchange does not yet exist at Colchester or Manningtree, connections are unbalanced for services to Harwich, Ipswich and beyond. Applying Principle 2 in isolation from Principle 1 does not allow full connectivity potential to be realised.

3.3 Principle 3

3.3.1 Principle 3 is a method of constructing a consistent timetable with sufficient flexibility to respond to variations in demand. The resulting timetable comprises a Core service, as its basic skeleton, with additional trains overlaid as required.

3.3.2 This could bring an end to the current practice of running separate timetables for different days of the week, with further variations according to the time of day. Every day of the week, from start to close of service, the timetable is based around the same Core service.

The Core service

3.3.3 The Core service uses Principles 1 and 2 to maximise connectivity while minimising the number of train paths required. When the Core service alone is sufficient, rolling stock mileage, fuel consumption, train-crew requirements and infrastructure wear and tear are reduced. More efficient use of infrastructure in this way provides opportunities to expand the freight market.

3.3.4 Minimising the number of train-paths should result in a resilient Core service capable of rapid recovery from incidents. Passengers travelling at all times of day benefit: good performance at busier times is far more achievable if the service is less likely to be recovering from earlier disruption. Furthermore, if a major incident occurs during busier operating periods, the option exists to pare the timetable back to the Core service. Regular passengers should be able to identify which trains are Core and which are additional, thereby providing a greater level of reassurance in periods of disruption.

3.3.5 The Core service would not necessarily use all the infrastructure all of the time and may offer the opportunity to increase safe access for maintenance. Efficiency of night-time possessions might be enhanced if the Core service enabled one or more lines to be taken prior to, and handed back after, the main possession. This principle could form the basis of a new maintenance strategy for each route.
The full off-peak service

3.3.6 The full off-peak service is built up using the Core service overlaid with additional trains. It represents the maximum passenger service which can be sustained over long periods and is to be operated at busier off-peak times. The Anglia full off-peak service has also been devised to facilitate freight, in particular on cross-country routes to Felixstowe.

3.3.7 There are two different ways additional trains are overlaid on the Core service. In the first example, frequencies are increased. In the second, faster trains are overlaid to reduce journey times. In both instances, more on-train capacity is provided.

3.3.8 Section 3.1 described how a traditional service pattern on the Ipswich – Cambridge / Peterborough route (Figure 3.10) could be simplified using Principle 1 (Figure 3.11).

3.3.9 If the frequency of the simplified service pattern were doubled, this would result in the service pattern shown in Figure 3.12. Beside the obvious benefit of a half-hourly service, it will be seen that the overall train miles are only 30 per cent more than the traditional hourly service using direct trains and no more train paths are required through Bury St Edmunds.

For details of this service pattern, see Figure 3.2, *train miles east of Cambridge and Ely per hourly cycle.
3.3.10 The additional trains considered above had identical stopping patterns to the Core service; they were overlaid in order to increase service frequency. The additional trains shown below are express trains, overlaid to reduce journey times.

3.3.11 Two express services are proposed on the West Anglia Main Line: Kings Cross – Norwich via Cambridge and a cross-country service from Stansted via Peterborough. These express trains make cross-platform interchanges with slower services at Cambridge, as shown in Figure 3.13.

3.3.12 This service pattern allows express trains to make long, non-stop runs, while intermediate stations are served with connecting trains. As all routes served by these express trains are also served by slower trains, the expresses need only run at times when demand is sufficient to warrant their operation. Further benefits could be gained if the principle were used in the planning of new high speed lines: high speed services could be fully integrated into local and regional rail networks.

The peak service

3.3.13 The full off-peak service does not necessarily represent the maximum possible number of paths. During the morning and evening peak, it is intended that sufficient paths will be overlaid on the full off-peak service to enable existing peak time frequencies to be matched or even improved. Overlaying the additional peak trains in this way, retains all the connectivity benefits of the off-peak service, while meeting capacity needs at peak times.

Flexibility

3.3.14 The full off-peak service and peak services need not necessarily be rigidly defined and it may be appropriate to run a service part-way between the various levels of service. Overall, Principle 3 allows the timetable to be tailored to fluctuations in demand, enabling operators to make the most of opportunities offered by the market. Consistency is assured, even through long-term variations in economic conditions.
4 Outputs and trade-offs

4.1 Table 4.1 gives an overview of the effect the Anglia case study has on the service offered. It compares the existing timetable with the full off-peak service developed in the case study and shows the change in combined average travel and waiting time between a selection of the largest centres of population in Anglia. Travel in both directions is included as the existing timetable is asymmetric.

4.2 Each figure shown is a combination of average travel time and average waiting time. In the case of a journey from Kings Lynn to Great Yarmouth, it means a passenger who turns up at Kings Lynn, without having consulted the timetable, will, on average, arrive at Great Yarmouth 79 minutes earlier with the proposed timetable than with the existing timetable. Similarly, a passenger who wishes to arrive at Great Yarmouth at a specific time, would, on average, be able to set out from Kings Lynn 79 minutes later. In this instance, the improvement is achieved through a 64 minute reduction in travel time and increase in service frequency from hourly to half-hourly.

4.3 Many of the improvements are transformative, with a significant number of savings in excess of 45 minutes. In a few cases, journey times increase owing to changes to stopping patterns; generally, this is to achieve reductions elsewhere. On routes serving short to middle distance markets, providing frequent trains at regular 15 or 30 minute intervals has taken precedence over improving journey time. Although this improves the overall service through a net reduction in the combined average travel and waiting time, there will be occasions when the travel time component increases.

4.4 The case study service cannot be achieved with the existing infrastructure. Infrastructure alterations follow two themes: remodelling at stations to achieve cross-platform interchange and upgrading between interchange hubs to achieve the necessary running times. The extent of these alterations will vary from route to route. The initial estimate of infrastructure costs for the whole area north of Cambridge and Ipswich is in the region of £1billion. An overview of the Anglia infrastructure requirements from the case study is included in Appendix A.

### Combined average travel and waiting time

Combined average travel and waiting time is calculated as follows:

\[
\text{combined average travel and waiting time} = \text{average travel time} + \text{average waiting time}
\]

where average waiting time = \( \frac{i}{2} \) and \( i \) = the service interval.

In cases where a number of different journey opportunities exist with different travel times and at different intervals:

\[
\text{average travel time} = \sum P_i \text{(train taken)} \left( \text{travel time} \right)_i \quad \text{and} \quad \text{average waiting time} = \sum P_i \text{(train taken)} \left( \frac{i_d + i_{d+1}}{2} \right)
\]

where \( P_i \text{(train taken)} = \frac{i_d + i_{d+1}}{2} \)

\( i_d \) = interval preceding the departure of a particular train at the origin station

\( i_{d+1} \) = interval following the arrival of a particular train at the destination station

\( t \) = the time period of the analysis. In most cases, this is 60 minutes. However, where the service operates on 2-hourly cycles or runs at irregular intervals, longer time periods have been considered.
Table 4.1: Reduction in combined average travel and waiting time between major centres of population in Anglia

<table>
<thead>
<tr>
<th>From \ To</th>
<th>London (terminal)</th>
<th>Cambridge</th>
<th>Chelmsford</th>
<th>Clacton-on-Sea</th>
<th>Colchester</th>
<th>Great Yarmouth</th>
<th>Harlow Town</th>
<th>Ipswich</th>
<th>Kings Lynn</th>
<th>Lowestoft</th>
<th>Norwich</th>
<th>P’borough</th>
<th>Romford</th>
<th>Southend (Victoria)</th>
<th>Stansted Airport</th>
<th>Stratford</th>
<th>Tottenham Hale</th>
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</table>

- Reduction of up to 45 minutes
- Reduction in excess of 45 minutes
- Increase

No change or not applicable. Off-route journeys are excluded apart from those involving fast trains between Cambridge and Kings Cross. The change between London and Stratford has not been calculated as the imminent implementation of Crossrail is likely to have more profound impact than this project.
5  Turning the vision into reality

5.1  This innovative approach to improving connectivity across the network will require a change to both how the industry and the public consider and plan for changing trains. Journeys requiring an interchange today are often considered negative owing to the amount of waiting time, risk of missing onward connections and lack of information. The following section examines how planning processes and technology could help support more positive attitudes towards changing trains.

Passenger Information in a Digital Railway

5.2  Many examples exist of excellent dissemination of information by train crew and platform staff. All too often, however, such announcements are left to generic, automated systems. These announcements usually inform passengers to change trains without providing detailed platform, calling pattern and departure time information. There is little point in timetabling cross-platform connections if passengers are not suitably informed: by the time an uninformed passenger has found a departure board, only to be directed back to the same platform, the connection will have been missed.

5.3  Problems arising from generic announcements often become exacerbated when planned closures take place or during disruption. They can mislead passengers by announcing a connection where none is actually available, and are not presently capable of suggesting alternative routes. Without correct, up-to-date information, passengers can find changing trains a daunting prospect.

5.4  In a digital age where many people carry smart phones and tablets, direct communication with passengers should supplement improvements to traditional means of disseminating information. This could include details of planned connections and updates advising what alternatives exist in the event of circumstances changing.

Performance measurement

5.5  The industry currently measures performance using the Public Performance Measure (PPM). This is based on a train’s arrival time at final destination, which neither reflects the experience of passengers who left the service en-route, nor those changing trains who missed a connection. Often, connections are not held for a late arriving train owing to the pressure created by a performance system which is focused on arrival at end destination. As good connections are at the forefront of this new approach, a new performance regime, that reflects the experience of all passengers, would be required.

Industry structure and allocation of train paths

5.6  Defining train paths much earlier in the planning process will change the way capacity is allocated. Implementing Improving Connectivity through the existing DfT franchise Service Level Commitment process is unlikely to succeed due to connectivity being driven through stipulated train paths. An opportunity may exist to base future minimum service specifications on allocating the paths required to run the Core service: maximum connectivity using a minimum number of trains.
5 Turning the vision into reality

Project process

5.7 The process for devising and the early stage development of any use of this alternative approach is outlined in the flow chart shown in Figure 5.2. In the case of the Anglia case study, the first stage of this process has been completed.

5.8 Current industry methods of business case appraisal may not fully quantify the benefits of the Improving Connectivity approach. Journeys involving a change of trains are perceived to be considerably less attractive than journeys using only a direct train. No distinction is made between different types of interchange: a simple, cross-platform connection, where trains are held in the event of slight late running, will have the same penalty as an interchange involving a long walk up and down stairs with no guarantee of the connection being held. This may not accurately reflect passengers’ attitudes and the outcome of this consultation exercise will help indicate whether existing penalties should be reviewed.

5.9 Elasticity demand models are very suitable for measuring the effect of small changes in journey time and frequency. They are less well suited to modelling the impact of transformative changes, especially on routes where existing demand is low. We would welcome suggestions through this consultation on how the value of this approach can be quantified.

5.10 Suitable performance modelling will be necessary to fully understand the impact of implementing a Core structure.
Improving Connectivity is a long-term proposal to deliver substantially improved rail connectivity across Britain. To achieve this requires a different approach to planning both the network capability and the train service which operates on it. This document has set out the key principles of this approach, challenges and trade-offs which would need to be made.

We are seeking your views and would welcome your participation in this consultation. The consultation is taking place before detailed development work is undertaken to understand your opinion on this different approach to planning the rail service. An online version is also available (link)

1. Do you think there is potential in this approach and agree that further development work should be undertaken to understand costs (operational and infrastructure) and benefits?

2. What is your opinion on the trade-offs described in this document?

3. What is your opinion on having to change trains on a journey?

4. Would your opinion on changing train alter if the principles in this study were adopted such as cross platform interchange, better passenger information, shortened waiting times and holding connections in the event of minor delays?

5. Do you have any ideas of further improvements which could be implemented which would improve your opinion of changing trains on a journey?

6. What parts of the British rail network do you believe would benefit from this approach?

7. Do you have any concerns about the approach and principles described in this study?

8. Do you have any ideas for how the approach described in this study can be improved or developed?

How to respond

A wide range of views will help to develop and take forward this idea. If you wish to respond to any of the ideas and interventions set out within this consultation document, please use the online survey (link), email your comments to the following email address improvingconnectivity@networkrail.co.uk

Or write to the address below:

Improving Connectivity Consultation
Strategy & Planning Assistant
Network Rail
The Cottons Centre
Cottons Lane
London Bridge
London
SE1 2QG

This study is only being published on the Network Rail website. If you would like a printed copy please contact the address above.

Respondents should indicate clearly if they wish all or part of their response to remain confidential. Otherwise, it is expected that the responses will be published on the Network Rail website and may be quoted in future. Where a response is made in confidence, it should be accompanied by a copy excluding the confidential information that can be treated as above. The names of respondents may be published in future documents or on the website, unless a respondent indicates that their name should be withheld.

The consultation will be open until 28th February 2015.
7.1 Great Eastern Main Line (GEML) North

A half hourly local service is proposed between Norwich and almost all stations within this area. Arrivals and departures at Norwich have been timed to maximise connectivity both between local services and with longer distance trains. In addition, a direct service is proposed between Great Yarmouth and Lowestoft for the first time since the 1970s. This is a direct train to and from Ipswich via the East Suffolk line.

Connectivity with other areas is improved through the introduction of two new expresses. The cross-country express cuts the Norwich - Peterborough journey time to 1 hour 15 minutes. The London express runs via Cambridge and reduces the Norwich - Cambridge journey time to 55 minutes and the Norwich - London journey time to 1 hour 46 minutes.

The London expresses impose no more paths on the East Coast Main Line than the existing service as they substitute existing London – Cambridge trains which currently terminate at Cambridge. A stop at Finsbury Park has been included, assuming the necessary infrastructure is provided: Gatwick Airport and many destinations on the Thameslink network south of London could become a single cross-platform change away from the Norfolk area. In addition to these expresses, a direct, hourly service to Stansted Airport is proposed.

Direct services to London Liverpool Street would continue to run via the GEML. The opportunity has been taken to normalise stopping patterns to provide a more regular and constant service at stations such as Stowmarket and Needham Market. This improvement at intermediate stations introduces a trade-off: some journey times between Norwich and stations on the GEML increase slightly, as can be seen in Figure 7.1.

Good onward connections are provided at many interchange hubs outside the area, such as Ipswich, Ely, Cambridge and Colchester. Integration of East West Rail into connections at Cambridge would transform onward connectivity to many parts of the Midlands and South West England.

Examples of how connectivity would change as a result of this case study are shown in Figure 7.1. Connectivity has been measured as combined average travel and waiting time, as described in Chapter 4.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in Table 7.2.
7.2 West Anglia Main Line (WAML) North

Ely North is a proposed hub station in the vicinity of Ely North Junction. It has been sited to maximise connectivity between all lines converging on the Ely area and to serve proposed and recently built housing in North Ely. Abolition of level crossings and increased freight capacity are included in the Ely North station scheme.

Cambridge also becomes an interchange hub with services timed to connect in all directions. Arrivals and departures are ordered so that possible future connections could be integrated at a later date. These might include East West Rail or other reopenings such as to Marks Tey or Huntingdon.

A half hourly service is proposed to almost all stations in the area, doubling, and in some cases quadrupling, existing frequencies. These services continue to Peterborough, Kings Lynn, Norwich, London, Manningtree and Stansted Airport. A new direct half hourly service is proposed between Newmarket and Peterborough to replace the existing service every two hours between Ipswich and Peterborough. A cross platform connection at Newmarket is provided for Ipswich passengers.

New fast trains are overlaid, reducing the Cambridge – Norwich journey time to 55 minutes and the Cambridge – Ipswich journey time to 57 minutes. Ely North will gain fast services to Norwich and Peterborough.

Good onward connections are provided at many interchange hubs outside the area, such as Ipswich, Norwich, Colchester and Stansted Airport. Fast London services have been timed to call at Finsbury Park, assuming the necessary infrastructure is provided: Gatwick Airport and many destinations on the Thameslink network south of London could become a single cross-platform change away from the Cambridgeshire area.

Examples of how connectivity would change as a result of this case study are shown in **Figure 7.2**. Connectivity has been measured as combined average travel and waiting time, as described in **Chapter 4**.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in **Table 7.2**.
7.3 Great Eastern Main Line (GEML) Centre

Proposed services on the GEML between Ipswich and Norwich have been timetabled to call at all stations. This substantially improves the service at intermediate stations such as Stowmarket and Needham Market, but introduces a trade-off: journey times between Ipswich and Norwich increase slightly, as can be seen in Figure 7.3. Journey times to London will remain similar to the existing service. However, more consistent stopping patterns and better connection at intermediate stations are proposed.

A half hourly, direct semi-fast service is proposed between Manningtree and Cambridge, reducing the Ipswich – Cambridge journey time to 57 minutes. This service makes a cross-platform connection at Newmarket for a half hourly Peterborough service. The existing Ipswich – Cambridge stopping service becomes a Stowmarket – Cambridge stopping service, with connections to GEML trains at Stowmarket.

On the Felixstowe branch, significant infrastructure constraints complicate the provision of good connections at Ipswich. The existing railway circumnavigates Ipswich town centre via Westerfield. There may be a case for diverting passenger services on a more direct line of route, improving connectivity and avoiding some of the more constrained sections of the branch. One solution might be a new tram-train service with some street running across Ipswich. Partial doubling of the Felixstowe branch will be required to accommodate this frequent tram-train service and an increase in freight paths. This solution is an undeveloped concept that may merit further consideration.

A half hourly service is proposed on the East Suffolk line between Ipswich and Saxmundham, with one train per hour continuing to Great Yarmouth via Lowestoft.

Ipswich becomes an interchange hub, maximising connectivity between services in all directions.

Good onward connections are provided at many interchange hubs outside the area, such as Norwich, Cambridge, Manningtree, Witham and Colchester. Continuation of the Manningtree – Cambridge service onto East West Rail would transform onward connectivity to many parts of the Midlands and South West England.

Examples of how connectivity would change as a result of this case study are shown in Figure 7.3. Connectivity has been measured as combined average travel and waiting time, as described in Chapter 4.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in Table 7.2.

![Figure 7.3: Proposed change in connectivity (mins)](image)
7.4 Great Eastern Main Line (GEML) South

A revised main line service, with more consistent stopping patterns and better connections with each branch line, is proposed. Half-hourly services are proposed on the Southminster, Braintree, Walton-on-the-Naze and Harwich branches. 15-minute interval services are proposed on the Southend, Colchester Town and Clacton Branches. With cross-platform interchange at Hythe, a 15-minute interval service between Colchester Town and Clacton is offered. Local connectivity between Clacton and Walton-on-the-Naze is significantly improved through better connections at Thorpe-le-Soken.

Good onward connections are provided at many interchange hubs outside the area, such as Ipswich, Norwich, and Cambridge. Connectivity with outer parts of East London is improved by the development a hub station at Romford. This is discussed in greater detail in the London section.

The full-off-peak service maximises use of available track capacity between London and Shenfield. An alternative option that provides greater freight capacity on this section of the GEML is also under development.

The geography of the GEML and its branches limits the possibilities for providing wider connectivity to and within this area. Rail journeys such as Chelmsford to Southend, or those towards Cambridge and Stansted Airport, involve lengthy detours and therefore remain uncompetitive. New and reopened lines, such as: Sudbury to Cambridge, Braintree to Stansted Airport, Chelmsford to Stansted Airport and Chelmsford to Wickford (with possible extension to Thames Haven) would transform many of these uncompetitive journeys. This case study has been designed to allow these possible future schemes to be integrated into the timetable, in the event sufficient interest is shown for them to be taken forward.

Examples of how connectivity would change as a result of this case study are shown in Figure 7.4. Connectivity has been measured as combined average travel and waiting time, as described in Chapter 4.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in Table 7.2.
7.5 West Anglia Main Line (WAML) South and Stansted Airport

The approach for the WAML is driven by the need to offer a more competitive service to Stansted Airport and the need to accompany regeneration of the Lea Valley with better rail connectivity. Two significant infrastructure interventions are necessary to achieve this: partial 4-tracking of the WAML and a scheme to relieve the existing single track Stansted tunnel.

A dedicated Stansted Express service is proposed, with intermediate stops at Stratford and Tottenham Hale. This is to provide the necessary off-peak capacity for the Stansted Express to compete with the London – Stansted coach market. At Liverpool Street, the Stansted Express has been timetabled to use platform 10, with the intention that the adjacent taxi rank will be opened up to provide a new airport pick-up and drop-off point along the length of the platform.

Two options are considered for relieving the single track Stansted Tunnel. The journey times offered by each option are shown in Table 7.1.

Option 1 comprises a second bore adjacent to the existing tunnel (as mentioned in the Anglia Route Study).

Option 2 comprises a new southern access link diverging from the WAML between Harlow Mill and Sawbridgeworth and no alterations to the existing tunnel. The greater journey time improvement from Option 2 is gained from the larger investment in new infrastructure required.

A 15-minute interval service is proposed at all stations south of Harlow Town, including those on the Hertford East branch. Cross-platform interchange is proposed at Tottenham Hale to allow access to both Liverpool Street and Stratford. A 15-minute interval express service between Liverpool Street and Bishops Stortford is proposed. This service continues to Cambridge calling at all stations (half hourly) or Cambridge semi-fast (half hourly).

Frequent, direct, local services to Stansted Airport are proposed. Many other stations which do not receive a direct train are a single cross-platform change away from Stansted. Connections at Stansted Mountfitchet have been improved to connect Stansted Airport and other parts of Uttlesford.

Examples of how connectivity would change as a result of this case study are shown in Figure 7.5. Connectivity has been measured as combined average travel and waiting time, as described in Chapter 4. Option 2 has been assumed in this comparison.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in Table 7.2.

### Table 7.1: Proposed Stansted Express journey times for each option

<table>
<thead>
<tr>
<th>Between Stansted Airport and:</th>
<th>Existing journey time</th>
<th>Second tunnel option journey time</th>
<th>New southern access link option journey time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool Street</td>
<td>65 – 49 minutes</td>
<td>46 minutes</td>
<td>36 minutes</td>
</tr>
<tr>
<td>Stratford</td>
<td>n/a</td>
<td>39 minutes</td>
<td>29 minutes</td>
</tr>
<tr>
<td>Tottenham Hale</td>
<td>31 – 37 minutes</td>
<td>32 minutes</td>
<td>22 minutes</td>
</tr>
</tbody>
</table>

### Figure 7.5: Proposed change in connectivity (mins)

<table>
<thead>
<tr>
<th>Route</th>
<th>Proposed</th>
<th>Existing</th>
<th>Improvement in average travel and waiting time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harlow Town - Cambridge</td>
<td>10 mins</td>
<td>16 mins</td>
<td>6 mins</td>
</tr>
<tr>
<td>Harlow Town - Peterborough</td>
<td>7 mins</td>
<td>18 mins</td>
<td>11 mins</td>
</tr>
<tr>
<td>Harlow Town - London</td>
<td>5 mins</td>
<td>18 mins</td>
<td>13 mins</td>
</tr>
<tr>
<td>Harlow Town - Great Yarmouth</td>
<td>3 mins</td>
<td>20 mins</td>
<td>17 mins</td>
</tr>
<tr>
<td>Harlow Town - Kings Lynn</td>
<td>9 mins</td>
<td>28 mins</td>
<td>19 mins</td>
</tr>
<tr>
<td>Harlow Town - Stansted Airport</td>
<td>7 mins</td>
<td>47 mins</td>
<td>39 mins</td>
</tr>
<tr>
<td>Stansted Airport - Cambridge</td>
<td>9 mins</td>
<td>47 mins</td>
<td>38 mins</td>
</tr>
<tr>
<td>Stansted Airport - Peterborough</td>
<td>7 mins</td>
<td>59 mins</td>
<td>52 mins</td>
</tr>
<tr>
<td>Stansted Airport - London</td>
<td>5 mins</td>
<td>67 mins</td>
<td>62 mins</td>
</tr>
<tr>
<td>Stansted Airport - Stratford</td>
<td>3 mins</td>
<td>64 mins</td>
<td>61 mins</td>
</tr>
<tr>
<td>Stansted Airport - Norwich</td>
<td>3 mins</td>
<td>66 mins</td>
<td>63 mins</td>
</tr>
<tr>
<td>Stansted Airport - Tottenhall</td>
<td>5 mins</td>
<td>75 mins</td>
<td>70 mins</td>
</tr>
<tr>
<td>Bishops Stortford - Cambridge</td>
<td>9 mins</td>
<td>85 mins</td>
<td>76 mins</td>
</tr>
<tr>
<td>Bishops Stortford - London</td>
<td>9 mins</td>
<td>94 mins</td>
<td>84 mins</td>
</tr>
<tr>
<td>Bishops Stortford - Stratford</td>
<td>21 mins</td>
<td>115 mins</td>
<td>94 mins</td>
</tr>
<tr>
<td>Hertford East - Stansted Airport</td>
<td>16 mins</td>
<td>131 mins</td>
<td>115 mins</td>
</tr>
<tr>
<td>Hertford East - London</td>
<td>16 mins</td>
<td>147 mins</td>
<td>131 mins</td>
</tr>
<tr>
<td>Hertford East - Stratford</td>
<td>16 mins</td>
<td>163 mins</td>
<td>147 mins</td>
</tr>
<tr>
<td>Waltham Cross - Stratford</td>
<td>7 mins</td>
<td>170 mins</td>
<td>163 mins</td>
</tr>
<tr>
<td>Waltham Cross - Cambridge</td>
<td>9 mins</td>
<td>179 mins</td>
<td>170 mins</td>
</tr>
</tbody>
</table>
7.6 London
Stratford and Tottenham Hale connect densely populated parts of London with the rest of the Anglia network, without requiring passengers to travel into Liverpool Street then backtrack to their destination.

Further development of Stratford is proposed, with all Great Eastern Main Line (GEML) trains calling. In addition, West Anglia Main Line (WAML) connectivity to Stratford is improved, with all Stansted Expresses routed via Stratford. 15 minute interval services to the Lea Valley and introduction of local services to Chingford.

In response to redevelopment in the Lea Valley, possible future implementation of Crossrail 2 and the need for greater off-peak capacity between London and Stansted (discussed in the WAML section), 4-tracking is proposed between Tottenham Hale and Harlow Town. This will enable a 15 minute interval local service in the Lea Valley. In the event of Crossrail 2 being constructed, the proposed layout at Tottenham Hale would allow cross platform interchange between Crossrail and fast trains, including the Stansted Express.

It is proposed that all trains call at Romford, the fourth busiest station on the GEML after Liverpool Street, Stratford and Chelmsford. Romford is well-placed to become a hub station for Area C shown in Figure 7.6. As well as providing an interchange with stopping trains (soon to be taken over by Crossrail), the branch to Upminster has the potential to become an important link to Thurrock. Local buses connect areas such as Barking, Dagenham and Redbridge. Like Stratford and Docklands in the 1990s, much of this area is undergoing major redevelopment as it lies within the extensive Thames Gateway regeneration area. Just as new DLR and Underground links have been constructed to Stratford during the past 20 years, development of Romford as a hub station has the potential to act as a catalyst for improved local transport links.

According to the 2011 census, approximately the same number of people commute from the catchment area of the GEML beyond Shenfield to Areas B and C. Just 9% of commuters to Area C take the train: much of this densely populated area is awkward to reach as Main Line trains run non-stop through it on their way to Stratford and Liverpool Street.
The peak service has not yet been developed. However, it is anticipated that infrastructure work required for the off-peak service, such as 4 tracking of the Lea Valley and grade separation of Bow Junction to enable Stansted Expresses to run via Stratford, will deliver improved peak capacity.

Examples of how connectivity would change as a result of this case study are shown in Figure 7.7. Connectivity has been measured as combined average travel and waiting time, as described in Chapter 4.

Service changes within the area that cannot be accommodated on the existing infrastructure, together with an outline of the proposed infrastructure alterations, are shown in Table 7.2.
Figure 7.8: Anglia full off-peak service (draft)

Notes:
1. Service at: Berney Arms, Eccles Road, Harling Road, Lakenheath, Shippea Hill and Spooner Row has not yet been determined.
2. Some trains split and join at Ely North.
3. The option of converting the Felixstowe branch to tram-train operation is under consideration.

Cross-platform connection between trains travelling in the same direction
Cross-platform connection between trains travelling in the opposite direction
Cross-platform connection between trains travelling in the same and the opposite direction

Not all trains in this area are shown
Table 7.2: Proposed infrastructure alterations

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Timetable output</th>
<th>Infrastructure required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Eastern Main Line (GEML) North</td>
<td></td>
<td>To facilitate this type of operation, construction of three new platform faces with</td>
</tr>
<tr>
<td>West Anglia Main Line (WAML) North</td>
<td></td>
<td>associated signalling will be required at Norwich.</td>
</tr>
<tr>
<td>Great Eastern Main Line (GEML) Centre</td>
<td></td>
<td>The following track and signalling alterations are required to allow parallel arrival and</td>
</tr>
<tr>
<td>Great Eastern Main Line (GEML) South</td>
<td></td>
<td>departure of trains:</td>
</tr>
<tr>
<td>West Anglia Main Line (WAML) South and Stansted Airport</td>
<td></td>
<td>• Remodel Whittingham Junction and re-signal the Up and Down lines between Norwich and</td>
</tr>
<tr>
<td>London</td>
<td></td>
<td>Whittingham Junction to allow bi-directional operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A new link into platform 6 will allow the Up Sheringham service to arrive at the same</td>
</tr>
<tr>
<td></td>
<td></td>
<td>time as the Up Lowestoft service arrives in platform 4.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This type of operation – a series of arrivals just after set points in the hour, followed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>by a series of departures just after set points in the hour – removes any need for trains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to pass one another on Trowse Swing Bridge just outside Norwich, and removes any</td>
</tr>
<tr>
<td></td>
<td></td>
<td>requirement to double the existing single line on the bridge.</td>
</tr>
</tbody>
</table>
Sheringham branch

At Norwich, trains will arrive just before and depart just after a set point in the hour, thus providing excellent connectivity right across the region. This provides the opportunity to develop the service patterns on the Norwich to Sheringham corridor.

Improving Connectivity has also looked at opportunities to improve existing frequencies: 1 To provide an hourly service with maximum connectivity benefit at Norwich. 2 To provide a half-hourly service with maximum connectivity benefit at Norwich. Both with consistent stopping patterns.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

To provide an hourly service with maximum connectivity benefit at Norwich the following linespeed upgrade would be required, (based upon performance modelling for a class 150 timing load):

- Whitlingham Junction: raise linespeed from 25 mph to 50 mph during remodelling as part of the Norwich area works
- Whitlingham Junction – Salhouse: raise linespeed on Down line to match Up line
- North Walsham passing loop: raise exit speed from 20mph to 40mph
- North Walsham – 23m 65ch (Roughton Road): raise linespeed to 75mph
- 11m 58ch (Roughton Road) – 13m 10ch: raise linespeed to 60mph
- Raise linespeed between Cromer and West Runton to 75mph. Down trains to use Platform 2 at Cromer, Up trains to use Platform 1.

To allow a second train in the hour, two options exist in addition to the infrastructure work outlined above:

- extension of the loop at North Walsham at the country end. The second train will not call at Gunton or Worstead
- re-doubling the approaches to Cromer, including remodelling of Cromer Junction. Both trains may call at all stations.
Great Yarmouth and Lowestoft branches

At Norwich, trains will arrive just before and depart just after a set point in the hour, thus providing excellent connectivity right across the region. This provides the opportunity to develop the service patterns on the Norwich to Great Yarmouth and Norwich to Lowestoft corridors, whilst considering the reality of the area’s cost restraints both in terms of operation and major infrastructure works.

Improving Connectivity has looked at journeys between Great Yarmouth and Lowestoft and onwards towards Ipswich. Great Yarmouth is the largest town on the East Suffolk coastline north of Ipswich, yet accessing other towns along this corridor by rail involves either a convoluted rail journey via Brundall or a bus journey of around 40 – 45 minutes between Great Yarmouth and Lowestoft before the rail network can be joined at the latter station.

The direct Great Yarmouth to Lowestoft railway line closed in 1970 and much of the alignment has now been built upon. Improving Connectivity proposes extending Ipswich to Lowestoft trains through to Great Yarmouth via a reopened spur at Reedham (running time approximately 33 minutes by semi-fast service). Excellent connectivity will be provided at Ipswich, Reedham (for Norwich) and Great Yarmouth (for Acle) and a direct train once again provided between Lowestoft and Great Yarmouth.

Improving Connectivity has also looked at opportunities to improve existing frequencies. Use of connections at Reedham doubles the frequency of trains to two per hour on the Norwich to Great Yarmouth and Norwich to Lowestoft corridors without the requirement to run additional through services. A further path is available to provide peak hour capacity between Great Yarmouth and Norwich via Acle as required.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

The extent of service provision at Berney Arms is under consideration.

Provision of an additional signal section between Whitlingham Junction and Brundall.

At Reedham, reinstatement of the abandoned north/south alignment of the former triangle, approximately 34 chains in length, with associated signalling.

Relocate Reedham station approximately 1250 yards east to a location at the new junction of the reinstated alignment, immediately north of Holly Farm Road. The station should be a single, island platform to allow cross-platform interchange between trains.

Retention of the existing north/west curve at Reedham (existing Reedham towards Berney Arms) for use as diversion and excursion route. Possible ‘network change of use’ dependent on outcome of a Berney Arms review.

Except as described above, the new timetable uses existing signalling, single lines and other infrastructure. Work at Norwich as part of the introduction of a connectivity hub at that location will include reversible lines to Whitlingham Junction.
Norwich to Ely

To improve connections across the Anglia network, Improving Connectivity proposes introducing interchange hubs at Norwich, Ely North and Cambridge. This necessitates a running time between Ely North and Norwich of around 50 minutes (excluding allowances) for semi-fast services, and around 37 minutes (excluding allowances) for fast services.

To prevent excessively complicated operation at Ely North, maximise cross-platform connectivity and provide regular direct trains between London and towns along the route, it is proposed that the principal semi-fast service between Ely North and Norwich be a portion of London to Kings Lynn services, with splitting and joining at Ely North.

To reduce journey times between London and Norwich and between Cambridge and Norwich, a fast London – Norwich via Cambridge service is proposed.

An upgrade of this line would also allow introduction of a network of fast express services to Stansted Airport and to Peterborough and beyond.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

Attleborough, Thetford and Brandon will receive a regular service. The extent of service provision at Shippea Hill, Lakenheath, Harling Road, Eccles Road and Spooner Row is under consideration.

To achieve these proposals, it is necessary for this section of line to be electrified with 25kV overhead line equipment (OLE).

There is currently a maximum linespeed of 90mph, with numerous permanent speed restrictions. The line was recently resignalled with track circuit block signalling (axle counters); however, the long signal sections and restrictive planning headways of the previous absolute block signalling remain. Provision of improved headways would be required and should be considered as part of signalling upgrade-work associated with OLE.
**Kings Lynn branch**

To maximise cross-platform connectivity, provide regular direct trains between London and towns along the route and to prevent excessively complicated operation at Ely North, it is proposed that the principal semi-fast service between Kings Lynn and London be a portion of the Ely North and Norwich service, with splitting and joining at Ely North.

A half hourly service is proposed.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

It is anticipated that the proposed alterations at Downham Market can be developed in conjunction with the Anglia Technical Working Group Project: Kings Lynn Single Line Doubling.

The Improving Connectivity proposal, with a half hourly passenger service and freight services to Middleton Towers, cannot operate over the single track section between Littleport and Downham Market. In accordance with the conclusions of the Anglia Technical Working Group, full or partial doubling of this single line section is required. If partial doubling is considered the preferred option, this should be at the Downham Market end of the single line.

The Watlington to Kings Lynn single line is capable of supporting the proposed Improving Connectivity service pattern and no alteration to the existing infrastructure is required.

Possible extra platform at Kings Lynn, to be confirmed once stock working has been determined.

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**Ely North to Peterborough**

The existing service, every two hours, between Peterborough and Ipswich is to be replaced by an hourly (or half-hourly at times of higher demand) service between Peterborough and Newmarket via the reopened Warren Hill Junction and Snailwell Junction chord.

At Newmarket, cross platform interchange is to be provided with Cambridge – Ipswich services. Good connections are also provided at Ely North interchange hub.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

No infrastructure works are required on this section of line.
### Ely/Ely North

To facilitate good connections between services across north Cambridgeshire, an interchange hub is created in the Ely area. The present Ely station's position to Cambridge, Norwich and Peterborough is sub-optimal for interchange hub operation and the existing layout is cramped and congested. Improved connectivity would be achieved if the point of interchange were a little to the North of Ely and a new station is proposed at the site of the existing Ely North junctions.

Trains will arrive just before and depart just after set points in the hour.

There will no longer be a requirement for through services between Peterborough & Norwich to reverse at Ely: these trains would serve the new station with connections to other parts of the region.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight capacity is much improved through less congestion at Ely, though capacity on the single line section between Ely Dock Junction towards Soham remains a constraint.

The new station will serve proposed new housing in the north Ely area.

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New junction layout and associated signalling alterations are required, including grade separation of Up trains from Peterborough and Down trains to Norwich & Kings Lynn and new chords connecting this new junction with the existing Norwich and Peterborough lines.

A new four-platform station at Ely North to be an interchange hub.

Construction of a new underbridge adjacent to Queen Adelaide (Kings Lynn branch) AHB and abolition of all three AHB crossings on Queen Adelaide Road.

Bidirectional signalling on the Ely West Curve.

No requirement for infrastructure intervention at the existing Ely station. (Assumes existing proposal to improve linespeed, particularly for freight, between Ely and Ely North junction is completed)
**Ely Dock Jn (Ely) to Warren Hill Jn (Newmarket)**

The existing service, every two hours, between Peterborough and Ipswich is to be replaced by an hourly (or half-hourly at times of higher demand) service between Peterborough and Newmarket via the reopened Warren Hill Junction and Snailwell Junction chord.

At Newmarket, cross platform interchange is to be provided with Cambridge – Ipswich services. Good connections are also provided at Ely North interchange hub.

The route passes the town of Soham. A station once existed but closed. *Improving Connectivity* proposes reopening Soham station.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight capacity is much improved through less congestion at Ely, a line upgrade between Coldham Lane Junction/Chippenham Junction and Haughley Junction (see separate section) and recasting of the passenger timetable. Capacity on the single line section between Ely Dock Junction towards Soham remains a constraint.

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**Cambridge**

To facilitate good connections between services across Cambridgeshire, Cambridge becomes a major interchange hub.

Trains will arrive just before and depart just after set points in the hour.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

To facilitate this type of operation at Cambridge, reconstruction of the existing platforms 1 to 6 with associated signalling is required to provide:

- A through island platform,
- One country end bay
- Two London end bays (with passive provision for a third in connection with East-West rail proposed reopening).

A new island platform at the east side of the station will also be required.

To allow parallel arrivals and departures of trains, remodelling between Shepreth Branch Junction and Coldham Lane Junction is required.
Coldham Lane Jn (Cambridge) to Haughley Jn (Stowmarket)

Strong road demand exists on the Ipswich – Cambridge corridor. In contrast, the rail service is slow and infrequent and usage is low. At present, two passenger services operate on the route:

- Ipswich – Cambridge all stations (sometimes alternately omitting Dullingham and Kennett). This service generally runs hourly Monday – Saturday and every 2 hours on Sunday. The end-to-end journey time is between 1h 16mins and 1h 24 mins. Online journey planners estimate the equivalent journey by road to take a little over 1 hour.
- Ipswich – Peterborough: semi fast between Ipswich and Ely and all stations between Ely and Peterborough. This service runs every two hours. An aspiration exists to increase this service to hourly; however, some doubt may currently exist over the demand for this increase.

The route is an important freight corridor. Substantial growth is anticipated together with an increasing number of freight trains being diverted away from London and on to cross country routes.

Improving Connectivity proposes developing passenger services on the Ipswich – Cambridge corridor to increase rail’s market share through a combination of reduced journey times, improved frequencies and improved connections. These improvements are to be achieved with a simplified service pattern that avoids duplication of services on each route. Interchange hubs are proposed at Ipswich and Cambridge to facilitate good connections.

New stations are proposed at Cherry Hinton and Fulbourn to serve these satellite towns of Cambridge.

To achieve these proposals, it is necessary for this section of line to be electrified with 25kV overhead line equipment (OLE). Bi-directional signalling is to be provided on both lines. Line-speed upgrade to a maximum of 100mph, to achieve an Ipswich – Cambridge semi fast journey time of 57 minutes. Redoubling between Coldham Lane Junction and Chippenham Junction (except Newmarket tunnel) Reconstruction of the Warren Hill Junction – Snailwell Junction chord (See Ely to Newmarket alterations) Platform extensions may be required if demand significantly improves and/or longer types of unit (train) operate the proposed service. Newmarket station is to be reconstructed with a single island platform to allow cross platform interchange, and a turnback siding to the Cambridge end. The existing station site at Newmarket is extremely constrained. There may be sufficient room for the station to be reconstructed on its existing site; however, alternative locations for the reconstructed station may need to be investigated.

New stations at Cherry Hinton and Fulbourn
Currently, the main east-west freight corridor is via Peterborough and Leicester. With reopening between Cambridge and Bicester, the opportunity should exist to develop alternative cross country freight routes, such as via Bletchley. Further reopening, between Bedford and Northampton, would provide a considerably shorter, and already partially electrified, cross country route to the West Midlands. Reopening between Cambridge and Huntingdon, with a north chord at Coldham Lane, could provide an electrified alternative to the route via Ely. These routes would necessitate freight trains to be routed via Newmarket, and in the long term, the single track Newmarket Tunnel is likely to become a capacity constraint.

The following service patterns are proposed:

- Cambridge – Ipswich semi-fast. Up to half hourly. Timed to continue via East-West Rail when opened.
- Cambridge – Stowmarket stopping. Hourly
- Cambridge – Newmarket stopping (except Dullingham). Hourly when required
- Newmarket – Peterborough. Up to half hourly

Full off-peak passenger service frequencies are shown in the Service Diagram. The freight paths shown below are also available.

Via Soham (Core service): 4 per hour
Via Soham (Full off-peak service): 4 per hour
Via Newmarket (Core service): 3 per hour
Via Newmarket (full off-peak service): 0 per hour

These freight paths use a conservative timing load and include a mixture of Class 4 and Class 6 trains. Further analysis is to be undertaken.
### Stowmarket

As part of wider improvements to service patterns and to avoid duplication of train paths on the busy GEML, it is proposed terminating the existing Cambridge to Ipswich stopping service at Stowmarket, with a same-platform connection for Ipswich. (A new, faster service with fewer stops will supplement this stopping train between Ipswich and Cambridge).

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

The current infrastructure at Stowmarket does not allow trains to shunt at the London end, clear of the main line. Provision of a new facing crossover and turnback siding on the down side at the London End of Stowmarket station is required.

### Ipswich

To facilitate good connections between services across Suffolk, Ipswich becomes an interchange hub.

Trains will arrive just before and depart just after set points in the hour. The exception to this will be departures to and from the Felixstowe branch. The nature of the existing single line sections on the branch, plus heavy freight traffic, prohibit full connectivity: the Felixstowe branch turnaround times are so tight that the train could not remain at Ipswich long enough to enable the full range of connections to be made. Improving Connectivity propose an imaginative solution outlined in the Felixstowe Branch section.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

No infrastructure alterations are required at Ipswich to facilitate this type of operation. (This assumes Felixstowe branch passenger operations become separate to existing rail operations or Felixstowe branch passenger operations are timetabled to use vacant platforms outside of the main connectivity cycle at Ipswich).
Felixstowe

The railway between Westerfield and Felixstowe is single track with a passing loop at Derby Road. An intensive freight service operates over the branch to and from the Port of Felixstowe. There are long term aspirations to increase these freight services and the existing single line is unlikely to be capable of accommodating this expansion without some infrastructure intervention.

The existing passenger service (approximately hourly) runs between Ipswich and Felixstowe (Town), with varying lengths of wait for main line connections at Ipswich.

Improving Connectivity proposes interchange hub operation at Ipswich. However, the Felixstowe branch turnaround times are so tight that the train could not remain at Ipswich long enough to enable the full range of connections to be made.

The Felixstowe branch circumnavigates Ipswich town centre, taking a circuitous route via Westerfield. Competing bus services, although slower, run every 15 minutes and serve the town centre. According to the 2011 Census, only 2.7% of people commuting from Felixstowe to Ipswich took the train.

- 2.7% train
- 7.5% bus
- 84.2% car / van
- 5.6% other

To provide an attractive alternative, it is likely that the railway would have to provide a much more frequent passenger service that also served Ipswich town centre.

The option of tram-train operation could be investigated. The Felixstowe end of the branch would be doubled and shared by freight trains and tram-trains. At the Ipswich end of the branch, freight trains would use the existing route via Westerfield. The tram-trains would diverge from the existing branch, with some street running, to Ipswich station, avoiding the constraints around Spring Road viaduct.

Partial doubling of the Felixstowe branch, adaptation of the route for tram-train operation and construction of a new tram route across Ipswich town centre, should this idea be developed.

When mixing tram-trains with heavy rail, consideration will need to be given to satisfying safety requirements, in particular:

- Crashworthiness of tram-trains.
- Enhanced control/signalling systems.

Full development and costing would require to be undertaken.
The tram-trains could provide a considerably faster service than other existing modes, significantly improving the general standard of public transport available between Ipswich and Felixstowe. They would also provide a connection between trains at Ipswich station and Ipswich town centre.

The part of the branch not shared by tram-trains would become freight-only, either fully or partially single track.

<table>
<thead>
<tr>
<th>East Suffolk line</th>
</tr>
</thead>
</table>
| The existing East Suffolk line service calls at all stations between Ipswich and Lowestoft, running hourly through most of the day but with varying connectivity at Ipswich or Lowestoft. No change will be made to the hourly frequency of through services but timings will be altered to provide improved connections. It is also proposed that this service should be extended through to Great Yarmouth, (see connectivity in Norfolk section).

As the southern end of the East Suffolk line is the most built-up, Improving Connectivity proposes doubling the service frequency to two train paths per hour between Saxmundham and the interchange hub at Ipswich.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

<table>
<thead>
<tr>
<th>Manningtree</th>
</tr>
</thead>
</table>
| To facilitate good connections between Main line and Harwich line trains, Manningtree becomes an interchange hub. The existing bay platforms will become through lines, creating two island platforms for cross platform connections between Cambridge – Manningtree and London – Harwich services.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>----------------------------------</td>
</tr>
</tbody>
</table>
| The existing passing loop at Becles and the double line section between Saxmundham and Halesworth do not allow trains to be timed to make usable connections at Great Yarmouth, Reedham (thence into the interchange hub at Norwich) or into the interchange hub at Ipswich or Lowestoft. To enable the new Great Yarmouth, Lowestoft and Ipswich service to maintain maximum connectivity and for an increase in service frequency south of Saxmundham, trains will require to pass one-another on the existing single line between Melton and Wickham Market, requiring redoubling of this section of line.

Facilities at Saxmundham will be required to shunt the terminating service at Saxmundham.

No infrastructure works will be required at Lowestoft or Ipswich for the introduction of this service.

Exiting bay platform 1 and the Down Refuge Siding will become through lines, with associated track and signalling alterations and station building work.

A revised track layout is required to provide a London end turn-back siding. |
To facilitate good connections between Main line and Clacton line trains, Colchester becomes an interchange hub. Island platforms 1 and 2 will be used for cross platform connections, facilitating interchange between alternating London – Clacton and London – Harwich services. A direct service that does not currently exist is created, with improved frequencies to both the Harwich and Clacton branches.

At Colchester, two existing low speed crossovers shall be replaced with higher speed crossovers. It is assumed that routing an Up train into Platform 2 at the higher linespeed will not foul the overlap of the Up starter signal on Platform 1. If this overlap is fouled, further work may be necessary.

Clacton line trains shall use Platform 1 and run via the Down Avoiding line in both directions. The Down Avoiding line requires reversible signalling. A 40mph crossover will be required to allow Up trains to access the Down Avoiding line at Hunwick Junction.

The revised layout will not allow trains approaching Colchester on the Up line to access platform 1 or the Up Goods.
Dependent on demand, additional trains may run between Colchester and Clacton-on-Sea, providing a frequency up to every 15 minutes.

Full off-peak passenger service frequencies are shown in the Service Diagram. Freight paths are also available.

<table>
<thead>
<tr>
<th>Colchester Town</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving Connectivity has taken a fresh look at both suburban and wider connectivity around Colchester.</td>
</tr>
<tr>
<td>A new through shuttle service, running up to every 15 minutes dependent on demand, is proposed between Colchester – Colchester Town – Hythe. Colchester town centre gains a regular service to and from the main line interchange hub at Colchester, and to and from a cross-platform interchange at Hythe on the Clacton branch.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hythe</th>
</tr>
</thead>
<tbody>
<tr>
<td>A cross platform interchange at Hythe provides connections between the Colchester Town shuttle and the Clacton service which runs directly to and from Colchester (main line).</td>
</tr>
<tr>
<td>A further interchange is available at Thorpe-le-Soken for services to and from Walton-on-the-Naze.</td>
</tr>
<tr>
<td>Full off-peak passenger service frequencies are shown in the Service Diagram.</td>
</tr>
</tbody>
</table>

A reduction in running time of 1 minute is required in the following sections:

- Colchester – Colchester Town (Down direction only)
- Colchester Town – Hythe (both directions).

It is expected that the necessary capacity and journey time savings between Colchester, Colchester Town and Hythe can be achieved by the following interventions:

- Increase in linespeed between East Gate Junction and Colne Junction (inclusive) to 20mph on both lines.
- Sole use of 4-car units. Analysis suggests that 4-car trains are over ½ minute quicker than 12-car trains owing to the reduced time required to clear the numerous speed restrictions. It is proposed that the route be operated by a shuttle service, formed of 4-car units, rather than through main-line trains. A special timing load should be created for 4-car 321 units on this route.
- Construction of a new 4 car bay platform on the Down side of the existing platform line at Colchester Town. New facing and trailing crossovers are required on approach to the station. It is intended that the facing crossover be min 15mph and the trailing crossover be min 30mph.
- Increase in linespeed between Colchester Town and Hythe to 40mph.
- A new Up side bay platform is required at Hythe with alterations to the track layout between Hythe and Hythe Junction. Hythe Junction to be 30mph.
<table>
<thead>
<tr>
<th>Thorpe-le-Soken, Clacton-on-Sea &amp; Walton-on-the-Naze</th>
<th>Marks Tey and the Sudbury branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>To facilitate good connections between Clacton line trains and the Walton-on-the-Naze branch, Thorpe-le-Soken becomes an interchange hub.</td>
<td>To facilitate good connections between main line trains and the Sudbury branch, Marks Tey becomes an interchange hub.</td>
</tr>
<tr>
<td>Trains will arrive just before and depart just after set points in the hour.</td>
<td>Trains will arrive just before and depart just after set points in the hour.</td>
</tr>
<tr>
<td>Full off-peak passenger service frequencies are shown in the Service Diagram.</td>
<td>Full off-peak passenger service frequencies are shown in the Service Diagram.</td>
</tr>
</tbody>
</table>

A terminal bay platform, within an island platform, will be provided for the Walton-on-the-Naze train to make cross platform connections to the Clacton line in all directions. Grade separation of the junction is also required. Track and signalling alterations and station building work will be required.

No alterations to the existing infrastructure at Marks Tey are required.
Witham and the Braintree branch

To facilitate good connections between services on the Braintree branch and other GEML stations, Witham becomes an interchange hub. Trains will arrive just before and depart just after set points in the hour.

Cross platform interchange is required at Witham between main line and Braintree branch services. This is currently possible in the Down direction, but the lack of connection from the branch to platforms 1 or 2 preclude it occurring in the Up direction. In the past, a connection did exist from the branch to platform 2; while it may be possible to reinstate this connection, Up trains crossing from the branch would foul the overlaps of the Down starter signals on platforms 3 and 4. Two options are explored opposite.

The Braintree branch is single track with no passing loops. To enable a half hourly service to operate, it will be necessary for trains to pass in the vicinity of Braintree Freeport.

A further, long-term proposal would see the Braintree branch extended to Stansted Airport, providing a useful link between the GEML and Stansted.

Full off-peak passenger service frequencies are shown in the Service Diagram. GEML freight paths are also available.

At Witham, two options are suggested:

- Option 1 recreates the former connection to platform 2. It is assumed that the platform 4 starter overlap can be swung onto the branch while an up train arrives. The platform 3 overlap will be fouled. While it is possible to operate the timetable, this creates a potential performance risk. Space is extremely constrained and the viability of this option is subject to further p-way design.

- Option 2 involves diverting the Braintree branch to the north, avoiding the starter signal overlaps and removing the need for awkward track geometry. The existing Witham Junction at 38m 55ch would be abolished and replaced with Witham New Junction around 38m 65ch. A new 3 km (approx) connection is required between Witham New Junction and the existing alignment of the Braintree Branch. The redundant section of the existing branch would be closed. Witham New Junction would be grade separated with minimum linespeed 50mph. It would be possible to add a north chord to Witham New Junction for future Colchester – Stansted services. Motts Lane level crossing would be abolished.

A new dynamic passing loop is to be constructed at Braintree Freeport. All schemes shall make passive provision for future doubling of the branch.

Beaulieu Park

A proposal already exists for a new station at Beaulieu Park and this has been incorporated in the Improving Connectivity timetable.

The infrastructure works required are already under development outside this project.
To facilitate good connections between Southend trains and the Southminster branch, Wickford becomes an interchange hub.

Trains will arrive just before and depart just after set points in the hour.

Full off-peak passenger service frequencies are shown in the Service Diagram.

At Wickford, two crossovers and associated signalling are required to allow Southend trains to use the existing down platform in both directions. Connections are made with the Southminster service which uses the down bay platform.
Stansted Airport

In developing proposals to improve Stansted Airport connectivity to as large a region as possible in all directions, Improving Connectivity looked at existing infrastructure constraints to service pattern development.

Rail access to the airport is via a triangular junction from the WAML just north of Stansted Mountfitchet. Trains must pass through a single bore tunnel, which passes under part of the runway access, before reaching the airport station adjacent to the terminal building.

A separate study is exploring the feasibility of building a second tunnel bore adjacent to the existing tunnel. Improving Connectivity looked at the effect building a second tunnel would have on capacity and connectivity and has built up a service pattern using timetable principles set out earlier in this document. However, even if a second tunnel were built, it would not be possible to create a true interchange hub with connections at Stansted Airport, due in part to the time penalty imposed by travelling from the main line to the airport and back again. Grade separation of Tye Green Junction near to Stansted Airport Tunnel would also be necessary.

Improving Connectivity has outline developed an alternative option. This comprises a new southern access link diverging from the WAML between Harlow Mill and Sawbridgeworth direct to the Airport, completely by-passing Bishops Stortford. There should be a number of benefits from building a new southern access link, especially when coupled with possible 4-tracking of the lower end of the WAML:

- Significant journey time savings could be achieved between the Airport and London.
- Stansted Airport would become an interchange hub facilitating good connections between services across Cambridgeshire, Norfolk, Suffolk, East London and the Midlands.

A new surface rail link (approx 8 km) is required, diverging from the WAML between Harlow Town and Sawbridgeworth

A minimum of two new platforms are required at Stansted Airport.

The existing chord between Stansted North Junction and Stansted East Junction would be replaced by a new higher speed chord to the east of the M11 motorway.
Stansted Express trains would largely be segregated from WAML stopping trains.

An opportunity may be created for maintenance access on one pair of lines, whilst still maintaining a service on the other pair. In turn, this may pave the way for introduction of 24 hour operation.

No alterations to the existing tunnel would be required.

The anticipated journey times offered by each option are shown below. These journey time reductions may stimulate further growth between central London Stansted Airport, benefitting both the airport and the Stansted Express. In addition to the Stansted Express, frequent local services to Stansted are proposed.

<table>
<thead>
<tr>
<th>Between Stansted Airport and:</th>
<th>Existing journey time</th>
<th>Second tunnel option journey time</th>
<th>New southern access link option journey time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool Street</td>
<td>45 – 49 minutes</td>
<td>46 minutes</td>
<td>36 minutes</td>
</tr>
<tr>
<td>Stratford</td>
<td>n/a</td>
<td>39 minutes</td>
<td>29 minutes</td>
</tr>
<tr>
<td>Tottenham Hale</td>
<td>31 – 37 minutes</td>
<td>32 minutes</td>
<td>22 minutes</td>
</tr>
</tbody>
</table>

Details of the 4-tracking of the lower end of the WAML are provided in the WAML Lea Valley section.

Full off-peak passenger service frequencies are shown in the Service Diagram.
Stansted Airport is an important generator of demand on the WAML corridor. Passenger loadings on the Stansted Express are consistent throughout the day, with demand during the morning and evening peaks being predominantly in the contra-peak direction (ref: passenger counts 19th May – 7th December 2013).

The existing modal split of airport passengers travelling between central London and Stansted Airport:*  
- Bus/coach 49%  
- Rail 41%  
- Other 10%

Conversely, the rail market share is in excess of 80% between Gatwick Airport and a number of central London boroughs.**

Currently, three coach operators run a total of seven routes between London and Stansted, with fare structures clearly reflecting a competitive market. This suggests there may be an opportunity to capture market share through adopting a similar fares policy.

Irrespective of any future growth at Stansted Airport, a dedicated service, without intermediate stops outside London, is predicted to be necessary if market share were increased significantly. In turn, additional services would be needed to serve intermediate stops.

Improving Connectivity looked at developing the best possible range of connectivity and interchange along the Lea Valley route. It quickly became apparent that mixing fast services to Stansted Airport, long distance Cambridge services and semi-fast and stopping intermediate services did not provide the basis for optimum connectivity. Therefore, allied with the aspiration to accompany regeneration of the Lea Valley with high-frequency stopping services and the possibility of Crossrail 2 being built, Improving Connectivity propose an expansion of capacity on the WAML.

* CAA passenger survey 2013. Central London defined as Westminster, City of London, Camden and Kensington & Chelsea  
** CAA passenger survey 2012
4-tracking is proposed between Tottenham Hale and Harlow Town; beyond Harlow Town, the proposed new Stansted Airport southern access link would diverge from the WAML. In the event of Crossrail 2 being constructed, the preferred track layout at Tottenham Hale would enable cross-platform interchange between Crossrail 2 and Stansted Express, (see Tottenham Hale section).

WAML interchanges are proposed between stopping services and semi-fast services connecting London, Cambridge, Hertford, services via Seven Sisters and Stansted Airport at the following stations, some of which would be cross platform:

- Bishops Stortford
- Broxbourne
- Cheshunt
- Tottenham Hale

Connections are also available at Stansted Mountfitchet between stopping services serving the Uttlesford area and Stansted Airport.

Using interchange in this way facilitates connectivity between smaller stations and longer distance/faster services.

### Edmonton Green

To facilitate good connections between all services, Edmonton Green becomes an interchange hub. Trains will arrive just before and depart just after set points in the hour.

Trains run between London Liverpool Street and Cheshunt via Seven Sisters and Edmonton Green with cross platform connections to and from Enfield Town. Utilising this type of operation, four full off-peak paths are provided on each section of line.

Reconstruction of the station, with associated track and signalling work will be required to facilitate this type of operation.
Romford, the fourth busiest station on the GEML after Liverpool Street, Stratford and Chelmsford, is well-placed to become a connectivity hub station. As well as providing an interchange with stopping trains (soon to be taken over by Crossrail), the branch to Upminster has the potential to become an important link to Thurrock. Local buses connect areas such as Barking, Dagenham and Redbridge. Like Stratford and Docklands in the 1990s, much of this area is undergoing major redevelopment as it lies within the extensive Thames Gateway regeneration area.

Much of this densely populated area is awkward to reach as Main Line trains run non-stop through Romford on their way to Stratford and Liverpool Street. Passengers wishing to travel here have to make the lengthy detour via Stratford or make multiple changes onto stopping trains.

A third GEML London connectivity hub is required to serve this substantial existing market and to fulfil the area’s future needs for sustainable transport. To develop Romford as a third London hub on the GEML, all trains have been timetabled to call.

Full off-peak passenger service frequencies are shown in the Service Diagram. GEML freight paths are also available.

This necessitates an additional Main Line platform, with associated signalling and track modifications.
## Stratford – Tottenham Hale

During the past twenty years, Stratford evolved into a second GEML London connectivity hub. In 1995, just three of the twenty-two Main Line arrivals between 08:00 and 09:00 at Liverpool Street called at Stratford. By 2011 this had increased to twelve. Westfield shopping centre opened in Autumn 2011 and substantial redevelopment has occurred in connection with the 2012 Olympics. Today, twenty of these twenty-two arrivals call at Stratford.

Improving Connectivity proposes continuing the development of this hub. To improve connectivity further and avoid the reduction in capacity that results from trains having varying stopping patterns, all GEML trains would call at Stratford. Stratford also has the potential to act as a WAML hub and new local and express services are proposed to connect Stratford with Stansted Airport, the Lea Valley and Waltham Forest.

Full off-peak passenger service frequencies are shown in the Service Diagram. GEML freight paths are also available.

Grade separation of Bow Junction, a linespeed upgrade between Stratford and Tottenham Hale, two additional bay platforms and remodelling at Stratford are necessary to provide these services.

Reopening of the Hall Farm curve is included in this scheme.

## Tottenham Hale

All trains currently call at Tottenham Hale. To develop this hub further, Improving Connectivity proposes an ambitious WAML 4-tracking scheme, with cross-platform interchange between trains via Hackney and trains via Stratford.

In the event of Crossrail 2 being constructed, this layout would allow cross platform interchange between Crossrail and fast trains, including the Stansted Express. Under normal running, Crossrail trains could have exclusive use of the slow lines. The feasibility of improving access to the Victoria line by providing a sub-surface circulating area accessed directly from both platforms will be investigated.

Included in the WAML 4-tracking scheme.
<table>
<thead>
<tr>
<th><strong>Hackney Downs</strong></th>
<th>No alterations to the existing infrastructure would be required.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The inner London Boroughs of Hackney and Islington are important employment centres. Hackney Downs has the potential to act as a connectivity hub for these areas, especially if interchange with the North London line is improved. Owing to the geometry of the track immediately to the north of the station, trains pass through Hackney Downs at no more than 30mph. The time penalty for stopping all trains here is minimal.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Finsbury Park</strong></th>
<th>Infrastructure work is likely to be required at Finsbury Park to develop a hub station. This has not been investigated as is outside the scope of this initial study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is proposed that a small number of trains to and from Anglia use Kings Cross rather than Liverpool Street. These trains fall under the ‘cross-boundary’ category and have not been fully timetabled beyond the boundary of Anglia route. However, where journey times have been quoted, a stop at Finsbury Park has been assumed. Finsbury Park could become a North London interchange hub: the City (Moorgate), Gatwick Airport and many destinations on the Thameslink network south of London could become a single cross-platform change away from Anglia.</td>
<td></td>
</tr>
</tbody>
</table>
Bow Junction

It is proposed that the Stansted Express be diverted via Stratford in order to provide a fast, direct service between Stratford and Stansted Airport, without requiring additional paths on the WAML. However, at peak times, there is insufficient capacity on the Main lines between Stratford and Liverpool Street for the Stansted Express. Furthermore, the flat-junction crossing moves necessitated by both the existing Bow Junction layout would represent a major timetabling constraint and a performance risk. Operation would be further complicated by the empty rolling-stock movements to and from Orient Way siding.

Crossrail 1 will remove almost all trains from the Up and Down Electric lines between Pudding Mill Lane and London Liverpool Street. This creates the opportunity to divert some GEML services from the Main lines to the Electric lines. This would provide additional capacity for GEML trains and vacate sufficient paths on the Main lines to accommodate the Stansted Express.

The redevelopment of the area surrounding Bow Junction presents a unique opportunity to grade separate the junction. In the future, once redevelopment has taken place, the space is unlikely to exist for such an intervention.

The proposed track layout and grade separation enables the following:

- A route from platforms 13 – 18 at Liverpool Street to the Down Main via the Down Electric without conflict with the Up Main.
- A route from platforms 13 – 18 to the Down Temple Mills and Orient Way sidings without conflict with the Up or Down Main.

This scheme involves grade separation of Bow Junction with a two track flyover across the Up and Down Main. The proposed track layout is shown below.

The existing track layout at the London end of Stratford station will require alteration to keep the Temple Mills lines separate from the Main lines, including the Platform 10A loop.
<table>
<thead>
<tr>
<th>London Liverpool Street</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulation of trains at hub stations combined with larger margins between conflicting moves is expected to improve operational robustness and performance.</strong></td>
</tr>
<tr>
<td><strong>At Liverpool Street, Improving Connectivity propose the existing platform 10 and adjacent taxi rank shall be opened up to provide a new airport pick-up and drop-off point along its length. All Stansted Express services would use this platform, with platform 11 held as spare.</strong></td>
</tr>
</tbody>
</table>