3. Service Pattern Development

3.1. Introduction

The business case timetable development builds on the previous Midland Main Line timetabling work undertaken by Atkins in 2014. This commission has concentrated on timetabling 6 long distance paths per hour, 2 freight paths per hour and integrating these with the GTR's proposed 2018 timetable south of Bedford. Two principal scenarios were considered: the 2023 'central case' (with full electrification) and the 2019 case (with electrification between St Pancras and Corby only). For each case, a standard AM peak, PM peak and off-peak hour was produced.

A table of assumptions together with any non-compliances which could not be resolved within the timescale of this project have been included in Appendix A. Working timetables and St Pancras platform working have been recorded in a separate Technical Note[1]. The timetables developed by Atkins were checked by Network Rail Capability & Capacity Analysis and shared with the relevant train operators. Network Rail responded on the 2nd August 2016 stating the timetables were suitable for the purpose of business case analysis, subject to the recorded non-compliances being resolved during future stages.

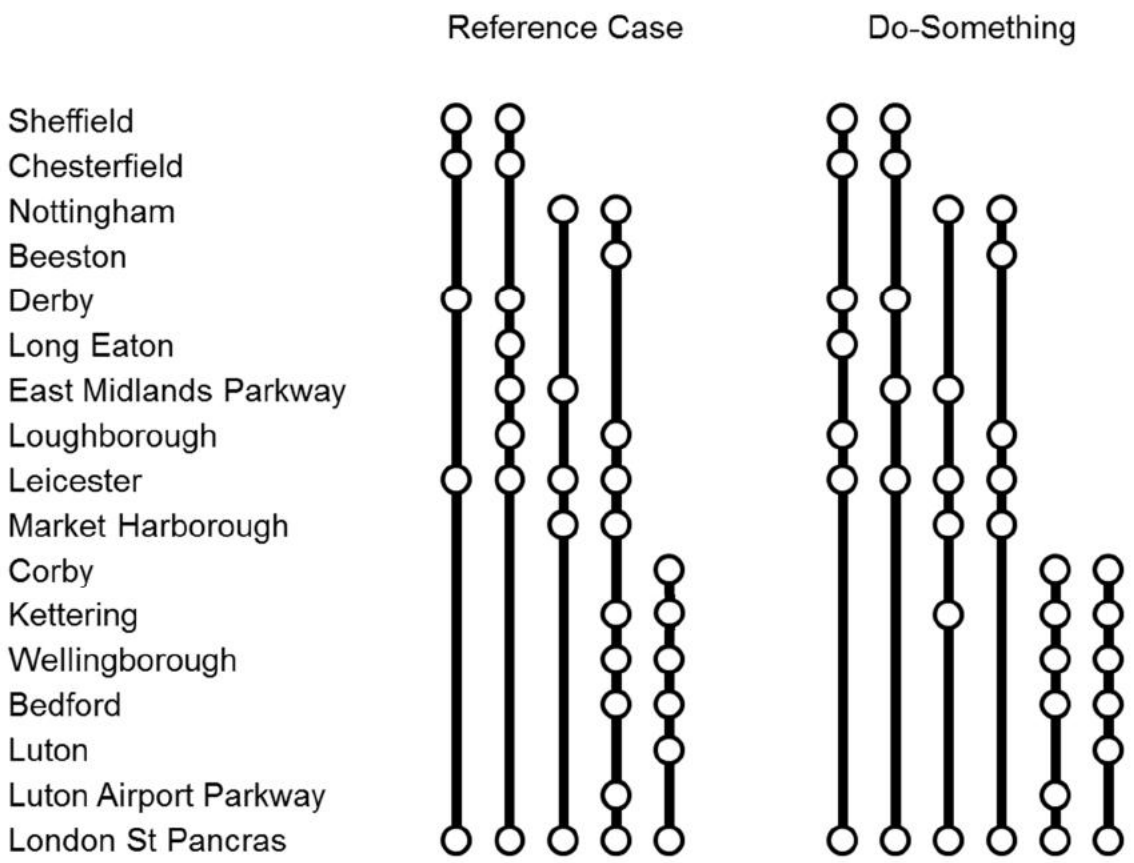
In addition to the 2019 and 2023 scenarios, the business case involved a number of sensitivity tests and a baseline timetable whereby the existing Midland Main Line service specification would be integrated into the proposed GTR timetable. In each case, sufficient timetabling work was undertaken to determine the likely impact on journey times and inform the business case, but did not extend to producing a compliant timetable for each test.

The timetable development process and outputs is outlined below. Further details can be found in Appendices A.

3.2. Timetable Development Process

The timetable development process focused on the design of a single "core specification", enabling the different rolling stock options and subsequent sensitivity tests to be conducted on a like-for-like basis. The core timetable was developed initially using timings for Class 222 (diesel) rolling stock to current train planning rules and principles, with journey times subsequently adjusted to reflect different types of rolling stock. The service specification for the timetable development was provided by the Department and builds upon the specification from the original business case in 2014. The figure below presents the notional standard off-peak service pattern for the Baseline and the Central Case timetable.

Figure 3-1 Notional Off-Peak Service Pattern



The new service pattern assumes a standardised stopping pattern across the whole day. In contrast, the Baseline timetable provides additional peak calls at Kettering and Wellingborough to cater for high peak demand, particularly in the AM peak where high flows into London are concentrated into a relatively short time-scale, as shown in the table below.

Table 3-1 Baseline Timetable: Southern MML Stations Calling Pattern – Trains per Hour (East Midlands Trains Services Only)

Station	Baseline			Do-Something (all day pattern)
	Off-Peak	AM Peak (0700-0800)	PM Peak (1700-1800)	
Kettering	2	5	3	3
Wellingborough	2	5	3	2
Bedford	2	2	2	2
Luton	1	2	1	1
Luton Airport Parkway	1	2	1	1

The 2023 service specification is replicated in Table 3-2 below:

Table 3-2 2023 Service Specification

From	To	Service Group	Peak/Off Peak Variations	Assumed Stock Type	Calling Pattern	Peak Pattern
Sheffield (fast)	St Pancras	MML long distance	All day	125mph EMU	Chesterfield, Derby, Long Eaton, Loughborough, Leicester	30 min interval
Sheffield (fast)	St Pancras	MML long distance	All day	125mph EMU	Chesterfield, Derby, East Midlands Parkway, Leicester	
Nottingham (fast)	St Pancras	MML long distance	All day	125mph EMU	East Mids Parkway, Leicester, Market Harborough, Kettering	30 min interval
Nottingham (fast)	St Pancras	MML long distance	All day	125mph EMU	Beeston, Loughborough, Leicester, Market Harborough	
Corby (semi-fast)	St Pancras	MML outer	All day	110mph EMU	Kettering, Wellingborough, Bedford and Luton	30 min interval
Corby (semi-fast)	St Pancras	MML outer	All day	110mph EMU	Kettering, Wellingborough, Bedford and Luton Airport Parkway	

The 2019 service specification assumes the same stopping patterns although in advance of electrification:

- Both Sheffield services are operated by Class 222s
- The first Nottingham service is operated by Class 222s with the continued use of HSTs on the second service.

3.2.1. Timetable Development Principles

The timetable was developed for a standard weekday using 2017 Train Planning Rules for the East Midlands route. Timetables were developed for AM Peak, PM Peak and Off-Peak hours in both directions matching formats supplied for the Thameslink timetable.

For appraisal purposes the:

- The AM peak is assumed to operate for 0700-0959 arrivals into London;
- The PM peak is assumed to operate for 16:00-1859 departures from London;
- The off-peak operates at all other times.

At the start and end of the day, service levels were reduced slightly, broadly in line with Atkins' previous Midland Main Line timetabling work and with the current timetable. The assumptions on infrastructure and rolling stock are outlined below and, where necessary, the application of the planning rules was amended to suit.

3.2.1.1. Infrastructure

The timetable development process has considered the current and future state of the infrastructure in the Midland Main Line scope area. The assumptions that have been used to undertake this work are listed below:

- Completion of full-four tracking between Sharnbrook and Kettering North junctions, with double-tracking completed through to Corby station. Signalling Scheme Plans were provided by Network Rail.

- Derby station would be remodelled and Signalling Scheme plans were provided by Network Rail, together with the Derby Proposed Option Performance Modelling Report[2] This stated the new track layout would deliver a total saving of 2.5 minutes in the Down direction and 1.5 minutes in the Up direction for services to and from London. Additional journey time savings are planned for Cross Country services, but these have not been quantified in this appraisal.
  - It was assumed the linespeed through Market Harborough would be increased, saving 0.5 minutes for all non-stop services, and Leicester South Junction would be remodelled, saving 0.5 minutes for all services. These assumptions were agreed with Network Rail and the DfT at the start of the commission.
- It was agreed with Network Rail and the DfT that a 0.5 minute saving would be assumed for the Derby North PJIF on this section in the 2023 scenario only.
- Prior to 2023, no modifications will be made to existing Overhead Line Equipment south of Bedford and electric trains will be limited to a maximum of 100mph (the maximum speed of EMUs operating on the route today). This will restrict the capabilities of 110mph Corby EMUs in the 2019 case. Atkins used Network Rail's RouteRunner programme to estimate the impact of this and concluded that it extended running times by up to 1 minute in each direction.

3.2.1.2. Other operators' services

The timetable development for East Midlands Trains has considered its interaction with other operators on the route, as the future timetable(s) have to be integrated with other services according to the planning rules set out above. Below are the assumptions that have been made with regards to other operators' services:

- South of Wigston North Junction, all trains were timetabled in full. To the North of Wigston North Junction, only Midland Main Line long distance services were timetabled, with the assumption that other services could be altered to suit. For information, today's Cross-Country services between Derby and Sheffield, and also via Leicester, were shown in the timetable to identify potential conflicts and inform future timetabling work.
- The principal constraint on the Midland Main Line timetable was the need to integrate long distance services into the proposed GTR timetable. GTR supplied standard Peak and Off-peak hour timetables which already had long distance paths shown. A small number of conflicts were identified by Atkins. Some of these could be easily resolved, but others required reworking by GTR. The most serious occur in the PM peak between Up Midland Main Line services and Down Thameslink trains making crossing moves at Carlton Road and Harpenden. Resolving these would inevitably impact on GTR services through the Thameslink Core and, therefore, fell outside the scope of this work. GTR were already aware of these issues and are working on resolving them. Owing to GTR's likely timescales, the business case work was progressed with these conflicts still in the timetable.
- Freight SRTs were supplied by Network Rail from b-plan and paths were timetabled for the following Class 6 freight services each hour:

Table 3-3 Freight Services

	Down	Up
Via Market Harborough	1 No. 2200t 1 No. 800t	2 No. 2200t
Sheffield via Corby	1 No. 2200t* 1 No. 800t*	1 No. 2200t* 1 No. 2600t*

* South of Kettering, these services would use the same path as freight routed via Market Harborough.

[2] Version 0.8

3.2.1.3. Rolling stock

The assumptions for rolling stock with regards to timetabling are listed below, to reflect the performance of each rolling stock category and how this affects the timetable development:

- Existing Class 222 SRTs were used as a basis for all new trains, adjusted where appropriate. RailSys analysis undertaken for the previous timetabling work showed that the performance of 125mph EMU stock is very similar to Class 222s; therefore, only very minor adjustments were made to Class 222 SRTs, amounting to no more than a 1 minute saving between London and Nottingham / Sheffield in each direction.
- RailSys analysis was also undertaken during the previous phase using 110mph EMUs (with maximum speed increased to 110mph) to generate SRTs for the proposed Corby EMUs. Again, their performance was similar to that of a Class 222, being only 1 minute slower in the Down direction and no different in the Up direction.
- It was assumed that Class 222 planning rules for dwell times and turnarounds were applicable to 125mph EMU stock owing to them both being end loaded via single leaf doors. For Corby EMUs, EMU planning rules were used south of Bedford and DMU planning rules were used north of Bedford. Generally, dwell times for the proposed 125mph EMUs were ½ a minute longer than for the proposed 110mph EMUs.
- Although there are no set planning rules necessitating differentials to be applied between the Working and Public timetables, it appears these do exist between arrival times in today's timetable and Atkins sought replicate these. They are not always applied consistently; however, Atkins judged the following values to be a reasonable and fair reflection of the situation today. St Pancras International: 1 minute (increasing to 2 minutes at peak times), Nottingham: 2 minutes and Sheffield: 1 minute.

3.2.1.4. Depots and empty coaching stock (ECS) moves

Additionally, assumptions around depot use and Empty Coaching Stock moves for timetable development are listed below:

- It was assumed that 125mph EMU stock would be based at a new deport in the Derby area[3] and the suburban EMUs would be based at Kettering. In the 2019 case, it was assumed that HSTs would continue to be based at Neville Hill. Cricklewood depot would also be used for stabling.
- As the supplied GTR timetable does not include a specific counter-peak direction timetable, Atkins were not able to timetable ECS moves into and out of Cricklewood depot in the peak and shoulder peak periods. However, it was agreed with GTR at a workshop held on 20th July 2016 that it would be reasonable to assume up to 2 ECS paths per hour between St Pancras and Cricklewood.
- This restriction on the number of ECS moves prevents every train being split down at St Pancras between the peaks. In cases where 125mph EMU sets are split down at St Pancras (i.e. in all but the 'fixed formation' sensitivity), there will be insufficient capacity to split down 110mph EMUs at St Pancras at the same time. Therefore, 110mph EMU stock will have to be split down at Kettering instead. The additional time necessary to undertake this split at Kettering was not included in the timetable (as the affected services were not identified until loadings were calculated, after the timetable was complete), but will add a journey time penalty of up to 2 minutes between Kettering and Corby. As this only applies to a small number of counter-peak services, it has been assumed to have negligible impact on the economic benefits calculated in this study.

3.2.1.5. Freight

Finally, freight services have been considered in the timetable development process to account for the interaction between the passenger and freight service paths. The assumption with regards to freight services are listed below:

- At off-peak times, all the specified freight paths were accommodated. However, while being compliant with the rules (where determined), there were a number of locations where timings were tight. Some

[3] The capital costs of a Derby Deport are not included in the appraisal work below. An estimated capital expenditure estimated at [redacted] is not considered to be material to the overall business case.

passenger trains have had pathing time (not usually more than 1 minute) added to achieve the freight specification. For instance, in some trains, the 0.5 minute saving achieved by infrastructure enhancement at Market Harborough is negated by the addition of pathing time for freight.

- Between Kettering North Junction and Kilby Bridge Junction, freight will generally run at minimum headways and it will be necessary for trains to recess at Kilby Bridge in both directions. Depending on the origin and destination of these trains, the limited capacity of the Up & Down Slow single line may restrict the overall number of freight trains that can run. During future development of the Midland Main Line timetable, a more detailed review of freight SRTs and routeing north of Wigston would improve the understanding of the feasibility of the specification in this area.
- At Corby, passenger trains reoccupy the up platform in 7 minutes, leaving only a small margin for through freight to pass in the Up direction. Currently no specific rules exist for minimum platform reoccupation times here as the infrastructure is still being designed, but it may transpire that this margin is insufficient. If that is the case, passenger services would need pathing time added between Kettering and Corby to increase the reoccupation time.
- During peak periods, it is unlikely that the specified freight paths could be accommodated. This is caused by a shifting of the Up and Down passenger timings relative to each other, principally affecting crossing moves at Kettering North Junction and equally affects freight in the counter-peak direction. As this shifting is caused by the GTR timetable, it will not be confirmed until the conflicts in the GTR peak timetable are resolved as part of the ongoing Thameslink timetable development by NR and GTR. Freight via Corby is not likely to be a problem in the peak.

3.2.2. Timetable Outputs

The Midland Main Line timetable developed by Atkins achieves the specified service levels and has been checked by Network Rail. A small number of known non-compliances exist for resolution in future development of this timetable. The most notable non-compliance results from an unresolved issue in the GTR timetable during the PM peak and GTR is currently working on a solution to this.

A summary of 2023 and 2019 off-peak public timings is included below, showing end-to-end journey time, turnaround time and the number of sets required for that diagram (excluding any strengthening):

Table 3-4 2023 Off-Peak Public Timings

Unit type		110mph EMU	125mph EMU	125mph EMU	110mph EMU	125mph EMU	125mph EMU
No. of sets required		3	4	5	3	4	5
Sheffield	d	-	-	11:23	-	-	11:56
Nottingham	d	-	11:48	-	-	12:17	-
Corby	d	12:02	-	-	12:32	-	-
St Pancras	a	13:08	13:21	13:24	13:38	13:51	13:54
Turnaround (mins)		25	30	22	25	30	22
St Pancras	d	13:33	13:51	13:46	14:03	14:21	14:16
Corby	a	14:39	-	-	15:09	-	-
Nottingham	a	-	15:25	-	-	15:54	-
Sheffield	a	-	-	15:49	-	-	16:14
Turnaround (mins)		23	23	34	23	23	42

Platforming at St Pancras would generally allow Corby, Sheffield and Nottingham units to keep to separate diagrams. However, during the PM peak, some inter-working between Sheffield and Nottingham units will be

required if units are strengthened (as opposed to running in fixed formation). Also, any units splitting down at St Pancras after the end of the am peak, will result in interworking and the situation where two consecutive services depart from the same platform within a few minutes of each other (for example the front unit forming xx:16 to Sheffield and the rear unit forming the xx:21 to Nottingham)

Compared to today, where two sets are required to be in the station at once, platforming at Nottingham is improved and Midland Main Line services could operate using only one platform.

At Sheffield, turnaround times are reduced compared to today and a maximum of two, rather than three, sets need to be in the station at once. However, in the current timetable, units frequently shunt at the country end to free up platforms for other services. Following electrification, this will not be possible as the shunt is unlikely to be wired and further timetabling work at Sheffield will need to be undertaken in order to determine whether the proposed timetable can be operated.

The principal change between the 2023 central case and the 2019 timetable is the continued use of HSTs on some Nottingham diagrams (and the Corby services running at 100mph). A summary is shown below.

Table 3-5 2019 Off-Peak Public Timings

Unit type		110mph EMU	Class 222	Class 222	110mph EMU	HST	Class 222
No. of sets required		3	4	5	3	5	5
Sheffield	d	-	-	11:22	-	-	11:55
Nottingham	d	-	11:47	-	-	12:10	-
Corby	d	12:01	-	-	12:31	-	-
St Pancras	a	13:09	13:21	13:24	13:39	13:52	13:55
Turnaround (mins)		24	30	22	24	29	22
St Pancras	d	13:33	13:51	13:46	14:03	14:21	14:16
Corby	a	14:40	-	-	15:10	-	-
Nottingham	a	-	15:26	-	-	16:03	-
Sheffield	a	-	-	15:50	-	-	16:15
Turnaround (mins)		21	21	32	21	67	40

The Class 222 and 110mph EMU diagrams are similar to the 2023 Central Case, with a slight increase in running times (generally no more than a minute). However, the use of HSTs on one Nottingham diagram increases running times to the extent that 5 HSTs are required to cover services that could operate using just 4 Class 222s or 125mph EMUs. Turnaround times at Nottingham are substantially increased and there will be occasions when two Midland Main Line services are in Nottingham station at the same time.

3.2.3. Timetable Outputs by Option

Table 3-6 shows the impact of the timetable change on projected journey times between St Pancras and the main terminus stations on the route:

Table 3-6 Journey Time Projections

Journey time from St Pancras to station	Baseline	Central Case	Option 1	Option 2	Option 3	Option 4
Corby	1:10	1:06	1:06	1:06	1:08	1:06
Nottingham	1:42/1:51	1:33/1:34	1:33/1:34	1:33/1:34	1:33/1:34	1:33/1:34
Sheffield	2:02/2:21	1:59/2:04	1:59/2:04	1:59/2:04	1:59/2:04	1:59/2:04

It can be seen from Table 3-6 that there is little difference in the journey time between the test options. Only Option 3 (Homogenous Fleet) adjusts the Central Case journey times where the time to Corby is extended with additional dwell times on 125mph EMUs. Overall, this adds 2 minutes to the St Pancras to Corby journey time from a ½ minute increase at four intermediate stops. Although the 125mph EMUs are slightly faster than the 110mph EMUs, owing to pathing restrictions at Harpenden with GTR services and the relatively frequent stops made, this only reduces the end to end journey time by ½ a minute, which is not sufficient to impact on the public timetable.

All options offer significant journey time savings to Nottingham and Sheffield this is a combination of:

- Faster journey times where fewer stops are made than in the baseline timetable;
- Linespeed improvements delivered as part of the Midland Mainline Upgrade Programme;
- SRT improvements delivered by 125mph EMUs over the Class 222s and more significantly HSTs.