www.pwc.co.uk

Schedule 8 Recalibration for CP6: Phase 1

Monitoring Point Weights (MPWs) and Cancellation Minutes (CMs)

Prepared for Rail Delivery Group (RDG)

November 2017

Contents

1 Introduction

1.1 Context

The Office of Rail and Road (ORR) is currently in the process of reviewing the access charges and related matters for Network Rail for Control Period 6 (CP6), which runs from 1st April 2019 to 31st March 2024. As part of this review, the Rail Delivery Group (RDG) is leading the recalibration of Schedule 8, the performance regime which compensates train operators for the impact of unplanned service disruption.

RDG commissioned PwC to undertake Phase 1 of the review, which focused on two key parameters used in the Schedule 8 performance regime[1]:

- **Monitoring Point Weights (MPWs)**
  A Monitoring Point is a point on the network (almost always a station) at which the lateness of trains in a Service Code within a Service Group in a given direction (forward/reverse) is measured. MPWs are calculated for each Monitoring Point. They reflect the proportion of a Service Group's passengers alighting and interchanging at that Monitoring Point and any preceding stations which are not captured by a Monitoring Point. Accurate MPWs ensure that Network Rail (and operators) are incentivised to manage delays in such a way that the fewest passengers are affected by incidents of unplanned disruption.

- **Cancellation Minutes (CMs)**
  Cancellation Minutes (CMs) are the number of minutes that are applied to a cancellation within Schedule 8 in order to "translate" it to lateness (as defined in Schedule 8 of the Track Access Agreement between Network Rail and operators), reflecting the estimated impact of the cancelled service on passengers. Accurate CMs ensure that industry parties are incentivised (for example) to make the right choice for passengers when considering trade-offs between cancelling stops and restoring order following incidents.

Phase 2 of the recalibration of Schedule 8 will take the results from this phase of the work to recalibrate other parameters, such as benchmarks and payment rates. The revised MPWs and CMs estimated as part of Phase 1 will need to be reflected in the parameters calculated in Phase 2. Phase 1 will undergo an independent audit during the initial stages of Phase 2, whilst Phase 3 is an independent audit of the work completed in Phase 2.

This report forms one part of the outputs for the Phase 1 Schedule 8 recalibration work.

The remainder of this report is structured as follows:

- Section 2 sets out the methodology and general principles for recalibrating MPWs and CMs. The detailed calculations for each parameter are also presented with worked examples.

- Section 3 explains the modelling process, including the data used and model review process.

- This is followed by an appendix which details Train Operating Company (TOC) specific assumptions used.

Alongside this report, other outputs provided to RDG from Phase 1 of the work include a list of MPWs and CMs results, TOC specific summary spreadsheets of results, a template model and a model guidance note.

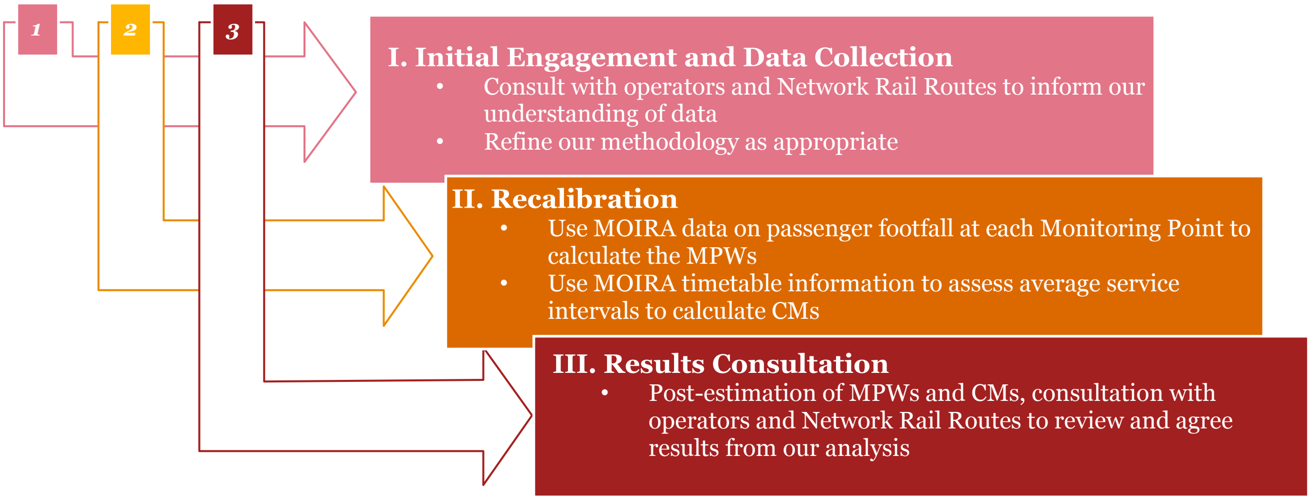
[1] Note that these parameters also feed through to the Schedule 4 possessions regime.

2 Methodology

2.1 General approach

In this chapter, we set out our approach to recalibrating MPWs and CMs for CP6. The approach used to recalibrate the MPWs and CMs for CP6 involved three stages as shown below:

Figure 2.2.1 Stages for recalibration



By default, MPWs were estimated on the basis of passenger loadings during the recalibration period agreed by industry and confirmed by RDG (the default recalibration period being 2015/16 and 2016/17), and CMs reflected the May 2017 timetable.

Any changes expected to be made to services during CP6 were not included in our analysis. If MPWs and CMs were expected to change significantly between the recalibration period and the start of CP6, two options were available:

1. If TOCs/NR routes provided us with all the data required to estimate the new parameters we would use this data to form new estimates. The data must have been sent in an easy-to-use format, and agreed to be used by both the NR routes and TOC.

2. Alternatively, TOCs (with supporting reasoning and acceptance from the NR route) could directly provide us with the appropriate estimates for us to insert in our results.

Further changes not fitting into the above options were deemed out of scope of this work. However, RDG has advised that TOCs and/or routes may be pursued outside of the national recalibration process.

The details of any bespoke changes – or cases in which estimates have been provided directly to us – are outlined in Appendix 1 of this report.

2.2 Principles for recalibrating MPWs and CMs

This section sets out the core framework and principles that were used in recalibrating the MPWs and CMs for CP6. These were agreed with RDG early on in the project. Detailed methodologies for the calculation of MPWs and CMs are also provided in sections 2.3 and 2.4.

Table 2.1 Principles for recalibrating MPWs and CMs

	Guidance	Rationale
Recalibration period	The default approach was to calibrate MPWs based on loading data covering the periods 2015/16 and 2016/17. The data over these years were allocated to Service Codes based on the May 2017 timetable, using MOIRA. This recalibration period was agreed by industry and will be used as the default calibration period for all Schedule 8 parameters. The default approach was to calibrate CMs based on the May 2017 timetable on the basis of it being the latest version of MOIRA/timetable for which **all** TOCs and routes are covered.	This is in line with agreed calibration periods following the RDG Schedule 8 meeting on 3rd July 2017.
Service Groups	We considered the list of Service Groups provided by RDG at the outset of the project.	RDG provided instructions for operators and Network Rail routes to agree changes prior to the recalibration taking place.
Monitoring Points	We considered the list of MPWs provided by RDG, plus any changes communicated by TOCs in light of erroneous inclusion/exclusion of Monitoring Points during the initial consultation phase (as per Figure 2.1).	RDG provided instructions for operators and Network Rail routes to agree changes prior to the recalibration taking place.
MPWs Calculation	MPWs were calculated as the proportion of passengers alighting and interchanging at or before a Monitoring Point for each Service Group. MPWs are a weighted average across the weekdays and weekends. See detailed methodology below.	This calculation used the number of passengers that alight or interchange at each Monitoring Point. This would then reflect the usage of the train at each section of the Service Group. Aggregating across the entire 2 year period would effectively weight passenger use over weekdays and weekends. This is a standard approach to calculation of MPWs and follows instructions from RDG.
CMs Calculation	CMs were calculated as the estimated average service interval **using only that TOC's services** as experienced by passengers, multiplied by the service interval multiplier (currently this is 1.5). The overall approach to recalibrating this parameter was as follows: 1. We estimated CMs on the basis of our method (explained in section 2.4) to give an 'indication' of what the CMs could be. 2. These were then tested with TOCs and NR routes to see whether the figures are reasonable. As part of this assessment we also compared our estimates to the CP5 CMs (as for MPWs). 3. If they are, the CMs were adopted.	For computational ease and tractability and keeping in spirit of the intention of CMs (i.e. impact on passenger behavior with respect to an individual TOC), we focused our analysis on the Service Group timetables relating only to the individual TOC under consideration. In addition, the Schedule 8 regime is intended to reflect a TOC's long term lost (or gained) revenue as a result of Network Rail lateness being above (or below) a benchmark. Therefore the presence of alternative services from other operators would mean that a given cancellation would have a greater impact on that TOC's revenue (relative to a situation in which the competing service was not present), since passengers are able to

	4. If not, we continued to discuss with TOCs and NR routes whether the old figures are more appropriate and/or whether any other approach might be possible/useful. 5. In the event of disagreement, we provided our set of figures to RDG and recommended that TOCs agree with their NR route what they felt was more justified alongside any evidence to be submitted to ORR. For most passenger origin-destination pairs there is only one TOC running services between them. However, we know that there are instances where this is not true. Our default method focused only on timetables within the relevant TOC to determine service intervals (as oppose to examining whether there are alternative options via other TOCs). This approach was agreed with industry at a Schedule 8 recalibration working group.	substitute to the competing operators' services. Therefore, all else equal, the presence of the competing services should serve to increase the total compensation payment made to the operator. In principle, this would be reflected in the marginal revenue effect (MRE) calculation (i.e. the calculation of the NR payment rate) by means of a higher general journey time (GJT) elasticity - services for which there are more alternatives will (in principle) have a higher elasticity and therefore MRE. However, in reality the GJT elasticities that are used in the calibration of Schedule 8 are not sufficiently granular to pick up the fact that markets where there are multiple alternatives have higher elasticities (after all, following PDFH the calibration uses just a few different elasticities e.g. regional, long distance, LSE). Therefore, if we were to adjust CMs downwards to reflect the higher (effective) frequency associated with the presence of multiple operators, we would actually reduce the compensation payment - which is the opposite of how the regime is intended to work. Hence, in order to avoid a counter-intuitive situation in which the presence of alternative / competing services leads to lower compensation, we do not take account of the presence of these alternative services in the calculation of CMs.
Data Sources	MOIRA (version 1) passenger flow data (i.e. "train loading data") was used as the core data source to account for passengers alighting and interchanging at Monitoring Points over the recalibration periods 2015/16-2016/17 using the May 2017 timetable. Individual TOC data was used by exception to support the analysis of passenger flows such as in cases where Service Groups were not defined in CP5 and data was not available from MOIRA. MOIRA (version 1) was also the main source of timetable information for	MOIRA (version 1) was used as the main source of data for passenger flow and timetable data for the Service Groups, where available, reflecting instructions from RDG. This was to ensure consistency in the source of data. Our engagement with TOCs did not bring about any concerns with this data source.

	each Service Group, for the calculation of CMs.	
Forward and Reverse Direction	For each Service Group, the MPWs were calculated for both the forwards and reverse direction such that the sum of the MPWs on each Service Group was equal to one, after they have been rounded to four decimal places. We mapped train services to a direction using the set of rules provided by RDG – taken from PEARS – which outlined which calling orders are classified as "Forward" and "Reverse".	Forward and reverse MPW estimates were calculated in line with the previous methodology, as per instructions from RDG. Schedule 8 directionality is based on the PEARS system. Note that to improve accuracy, MPWs by direction do not necessarily have to sum to 0.5 as the weights are determined by passenger flows, which are not necessarily equal in both directions.
Peak and Off-Peak	Reflecting current practice, CMs and MPWs were established separately for Peak and Off-Peak Service Groups and Service Codes respectively (where they are currently separated) unless advised otherwise through our engagement with TOCs and NR routes. We used the latest set of timing rules provided by RDG, which are aligned with PEARS[2], to determine peak and off-peak services. Regarding weekends, we assumed that all services operating on Saturdays and Sundays were classified as "Off-Peak" unless the rules provided by RDG suggested that some services were Peak. In the latter case we classified these specific services as Peak.	Remaining consistent with PR13 approach, we saw no reason to change the current split of peak and off-peak estimates. This was agreed with RDG.
Modes of Transport	Other modes of transport, for example bus, were not considered in the calculation of CMs.	This followed precedent established as part of earlier recalibrations and was agreed with RDG.
Refranchising and line closures within the calibration period	Specific considerations for refranchising and line closures which took place within the recalibration period were considered on an individual basis as they emerged from the initial consultations with operators and routes. TOCs and/or NR routes were required to inform PwC of the specific considerations. The sample period used in the analysis was then adjusted to factor in these considerations. If data for periods, other than 2015/16 and 2016/17 were required, these were agreed with RDG.	If line closures or refranchising significantly impacted the recalibration period, the most representative years were chosen (or excluded) to recalibrate the parameters in CP6. This was agreed between the TOC, the NR Route and RDG.
Service Groups which change on route	Our objective for this work was to estimate MPWs and CMs for individual Service Groups. Where the Service Group changed on the route of a service, we adopted the new Service Group for the remainder of the route.	Given our estimates are defined per Service Group, we aligned to the Service Group at any particular section of a route rather than the Service Group in which the route started.

[2] The definitions from PEARS are assumed to be correct and in line with Schedule 5 of the track access contract.

	If the peak/off-peak status also changed during a train service due to a Service Group (or Service Code) change, then the estimates were aligned to that change.	
Interchanging passengers on same Service Group	Where passengers interchange between trains in the same Service Group, we identified any service differences through Service Codes. Where the interchanges are **within a Service Code**, we would have picked up "alighting" twice for a given passenger – first at their interchange and second where they disembark from their journey. This would have been captured in both the numerator and denominator in the MPW calculations and, therefore, we did not expect this to be material.	Our ability to treat individual passengers uniquely from a statistical perspective was limited by the amount of interchanging possible within a given service group code. We agreed this assumption with RDG during the early stages of the project.

2.3 MPWs

To set out the MPW calculations with precision, it is useful to make a number of definitions. For a given Service Group, services:

- Call at MPs $i = \{1, \ldots, I\}$;
- Have a forward and reverse direction $d = \{F, R\}$; and
- Are assigned to an arrival Service Code (or "CAPRI code") $s = \{1, \ldots, S\}$.

In addition, we define the following:

- $Passenger_{i,d,s}$ is the number of alighting and transferring passengers at that MP (i.e. MP i) and all stations between the previous MP and that MP (i.e. MP i) in direction d in Service Code s; and

The MPW at MP i, in the direction d, in Service Code s is calculated by the following equation:

$$MPW_{i,d,s} = \frac{Passenger_{i,d,s}}{\sum_{i,d,s} Passenger_{i,d,s}}$$

In words, for each Service Group, the MPW at MP i in direction d in Service Code s is given by:

- the sum of alighting and transferring passengers at that MP i, in that direction d, in that Service Code s; **divided by**
- the sum of alighting and transferring passengers across all stations, directions and Service Codes within that Service Group.

MPWs are be reported to four decimal places, consistent with how they are input into Track Access Contracts between Network Rail and Train Operators. Note that this approach means that the sum of the MPWs within a Service Group will be equal to one[3].

Example

A worked example is set out below to illustrate the approach:

---

[3] MPWs by direction will be determined by passenger flows and do not necessarily have to equal 0.5 as has been the case historically for some TOCs.

- Service group = XY Peak
- Direction = Forward
- Total number of passengers in Service Code 001 **in both directions over recalibration period** = 300
- Total number of passengers in Service Code 002 **in both directions over recalibration period** = 250

Figure 2.2 MPWs example

Arrival Service Code	Station in calling order	Monitoring Point check (i.e. whether a station is a monitoring point)	Numbers alighting or transferring off train over recalibration period
001	Station A	N	
001	Station B	Y	30
001	Station C	N	10
001	Station D	Y	60
001	Station E	Y	50
		Total passengers in forward direction	**150**
002	Station A	N	
002	Station D	Y	50
002	Station E	Y	70
		Total passengers in forward direction	**120**

This implies:

001 MPWs

Station B = 30/550 = 0.0545
Station D = (10+60)/550 = 0.1273
Station E = 50/550 = 0.0909

002 MPWs

Station D = 50/550 = 0.0909
Station E = 70/550 = 0.1273

2.4 CMs

In contrast to MPWs – for which a clear quantitative method of estimation is well-established – determining CMs involves a degree of judgement: it is more of an 'art'. We have been advised by RDG that the CP5 (and earlier) approach to CMs has not been documented. Indeed, it is our understanding (on the basis of conversations with industry) that, until the current recalibration, CMs have normally been determined on the basis of the judgement of practitioners with knowledge of the relevant timetable. As part of our work, we have sought to establish a more systematic quantitative approach to establishing CMs. While we consider that the approach we have developed represents a significant step forward for the accuracy and consistency of CMs, we recognise that there is no 'perfect' approach. For this reason, the method we have employed and results we have generated were intended to help guide the TOC/NR Route towards choosing an appropriate CM, rather than necessarily being the final estimate in all circumstances. Following RDG's guidance, our approach has been to offer flexibility and only continue with our set of results where it led to a materially better outcome (as viewed by from the TOCs and NR routes, and by RDG itself).

Following feedback from colleagues in the industry, we considered *direct services offered by a given TOC regardless of Service Group (or Service Code)* in estimating the service interval between an origin and destination station. Put differently, we considered intervals between services taking into account *only* the services of that TOC (ignoring the services of other TOCs) but looking across all services in that TOC (rather than, for example, only considering services within a particular Service Group). This approach helps address a common query discussed in the early stages of the project i.e. how to take into account stations which are served by multiple Service Groups. The method we adopted allows for this possibility by focusing on stations identified as monitoring points, regardless of Service Group/Code.

In order to estimate the CMs, we undertook the following steps:

1. Calculate the average frequency between each MP pair served by each TOC. For each pair, this is calculated as: operating hours per day (i.e. the time elapsed between the first and last train in the timetable between that pair); divided by the number of direct trains per day between that pair minus one (the denominator)[4]. This calculation is done across all services, regardless of Service Group or Service Code, and is done separately for Weekdays, Saturdays and Sundays and in both directions.

2. Where services between a pair of stations are very infrequent (>120 minutes), following discussion with RDG, we excluded these pairs from the sample used to calculate CMs. Often, where there are very infrequent direct services between a pair stations, there are alternative routes (for example using another TOC or interchanging via another station) from a passenger's perspective that they could take rather than waiting for the next direct train service.

3. Determine which Service Group(s) the MP is relevant for, by identifying whether trains in each Service Group serve the MP pairs.

4. Proxy the importance of the relevant pairs in that Service Group by multiplying the MPWs of the two stations together. This is calculated in order to provide a 'weight' (used in the next step) for each station pair served by each Service Group so that the CM reflects the average journey in the Service Group. The approach is described in Box 1, and was agreed with RDG.

Box 1: Approach to weighting

The possible combination of pairs are formed by matching all forward MPs to all possible reverse MPs within a Service Code, and vice versa, e.g. MP station 1 forward is matched to MP station 2 reverse for a station pair which travels from station 1 to station 2 in the reverse direction. This then allows the respective MPWs to be used for weighting the pair.

The theory behind this approach is that we would like to capture the importance of the pair that passengers travel between, but we do not have the exact number of passengers between station pairs to weight the importance of the pair. Hence we look to use the MPWs. In the example mentioned above, which is a reverse direction pair, the MPW for station 2 captures those alighting at that station but we do not know how many get on at station 1. Therefore we proxy for this by using the forward MPW for station 1 (i.e. people getting off station 1 approximates those getting on). We acknowledge that this approach is a proxy but we believe this approach does best approximate the importance of a pair given the data limitations.

For pairs which have a possible pairing e.g. MP station 1 reverse to MP station 2 forward, it may not have relevant trains to weight because the trains that are accounted for in the denominator are in the reverse direction rather than forward.

[4] For example, the first train between a station pair departs at 07:00 and the last train between the same station pair departs at 19:00, which means the operational hours are 12 hours. There are 13 trains during this operational period. The average frequency is therefore calculated as 12 hours / (13 – 1) = 1 hour. If the operational hours are for a Peak Service Group, it will follow the PEARS defined peak hours, for example 3 hours. For Off-Peak Service Groups, the operational hours are calculated as the time elapsed between the first and last train between that pair minus the operational hours of the associated Peak Service Group.

The possible pairings are also based on direct train services i.e. we do not account for pairings which involve switching onto other trains to reach the destination.

In summary, the way in which the pairs are weighted within a service code:

- for a forward direction pair: station 1 reverse MPW * station 2 forward MPW
- for a reverse direction pair: station 1 forward MPW * station 2 reverse MPW

(Please see example for how pairs are weighted using their MPWs)

5. Use these weights to calculate a weighted average service interval for the Service Group as a whole (i.e. combining steps 1 and 3). Additional adjustments were made for some TOCs at this stage, for example adjustment for repeated station pairs[5]. These are detailed in Appendix 1, which lists out specific TOC adjustments.

6. Multiplying by the Interval Multiplier (determined by RDG to be 1.5).

Example

A worked example is set out below to illustrate the approach:

- Service group = XY Peak

Figure 2.3 CMs example

Arrival Service Code	Monitoring Point Location	Direction	Monitoring Point Weight (MPW)
003	Station A	Forward	0.2000
003	Station B	Forward	0.3000
003	Station C	Reverse	0.5000

- List of possible station pairs

Figure 2.4 CMs example

Service Group	Service Code	Station 1	Station 2	Direction	Station 1 MPW	Station 2 MPW	MPW1* MPW2	% Weight of Service Group	Average Frequency (mins)
XY Peak	003	Station A	Station C	Reverse	0.2000	0.5000	0.1000	20%	30
XY Peak	003	Station B	Station C	Reverse	0.3000	0.5000	0.1500	30%	10
XY Peak	003	Station C	Station A	Forward	0.5000	0.2000	0.1000	20%	20
XY Peak	003	Station C	Station B	Forward	0.5000	0.3000	0.1500	30%	10
						Total	0.5000		

Service Group XY Peak average frequency	= (20% * 30 mins) + (30% * 10 mins) + (20% * 20 mins) + (30% * 10 mins)
	= 16 mins
Service Group XY Peak CM	= 16 mins * 1.5 (*the service interval multiplier)*
	= 24 mins (rounded to the nearest minute)

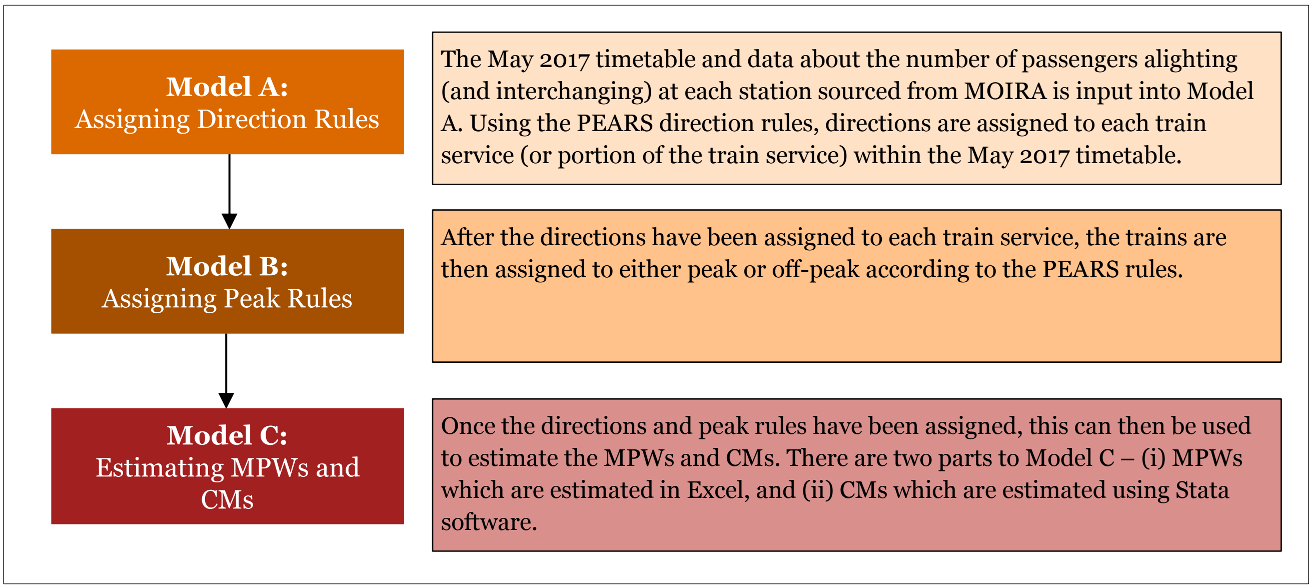
[5] During the computation of CMs, station pairs may be listed twice as trains may be classified as either forward or reverse in the timetable and so calculated separately. The number of trains, which is used in the denominator, should include both forward and reverse trains. Hence an adjustment is made to the average frequency between the station pair. The adjustment is for the average frequency to be divided by two as we have made an assumption that only half the number of trains were counted in the denominator rather than the total amount which included both forward and reverse direction.

3 Modelling

3.1 Process

This chapter explains how we put the methodology described in the previous chapter into practice by means of our modelling. The modelling process can be broken down into three main stages. Each TOC has a separate model which follows these three stages:

Figure 3.1 Model Process Diagram



3.2 Data sources and data cleansing

Industry engagement

Through the initial TOC and NR Route engagement process, information was gathered to gain a better understanding of whether the standard approach for estimating MPWs and CMs was appropriate. The TOCs and NR Routes confirmed the list of Monitoring Points and Service Groups to use in the analysis during this engagement process. Additional information, such as whether the recalibration period was appropriate, were also discussed and documented, and subsequently used if appropriate. TOC-specific assumptions which are deviations from the standard methodology are listed in Appendix 1.

MOIRA

The main source of input into our model was MOIRA (version 1) passenger flow data. For a typical weekday, Saturday and Sunday May 2017 timetable, the estimated number of passengers alighting from each station on each train service was extracted from MOIRA, along with three digit Service Code for each train service. The number of passengers alighting was based on 2015/16 and 2061/17 data and mapped to the May 2017 timetable, as per RDG's instructions.

PEARS

Rules for direction and peak/off-peak trains were provided by RDG from PEARS.

By default, all train services are assumed to be forward. The reverse direction is assigned to train services which follow a rule listed in PEARS. The rules are a list of station pairs which state the ordering of two stations by service code, for example station A followed by station B in Service Code 001. If a train service in the timetable calls firstly at station A and then station B within Service Code 001 then the train is classified as a reverse direction train service.

By default, all trains are off-peak except for trains which follow a rule listed in PEARS. If a train arrives at, or departs from, a station within the peak hours as listed in PEARS then the train is a peak train.

TOC specific data

Where data was not available in MOIRA, the TOC provided additional data to estimate MPWs and CMs. The details of specific additional data used is listed in Appendix 1.

3.3 Modelling MPWs

This section provides a high-level approach of how the MPWs are estimated. For detailed information please refer to the model user guidance document.

The MPWs are estimated using an Excel based model. The data required for this calculation is imported from Model A and B, which allocated a direction and peak/off-peak status to every station in the timetable. Model C then draws upon a list of Monitoring Points, as provided by the TOC, to count the number of passengers alighting at and before each Monitoring Point (and after the last Monitoring Point).

The timetable data is provided on a daily basis so the count of passengers alighting are multiplied by the number of days in each of the recalibration periods to estimate an annual total. TOCs provided information about which day of the week their Bank Holidays timetables could be proxied by, so that the number of weekdays, Saturdays and Sundays could be adjusted for Bank Holidays.

The MPWs are estimated using both 2015/16 and 2016/17 data separately. The final MPWs are a weighted average of the two years of the recalibration periods, weighted by total number of alighting passengers in each period. If the TOC and NR Route specified a bespoke recalibration period, for example using only 2016/17 data, this is noted in the model. Other adjustments, for example when data is not available in MOIRA, are also noted in the model and outlined in Appendix 1.

3.4 Modelling CMs

This section provides a high level approach of how the CMs are estimated, for detailed information please refer to the model user guidance document.

The CMs are estimated using a Stata[6] software based model.

1) Firstly, the Stata model imports the list of MPWs from the Excel-based Model C to generate every possible station pairing within each Service Code, listing the associated Service Group for each pair.

2) Next, the timetable data is imported into Stata which then lists out every possible origin-destination (OD) pair in the TOC's May 2017 timetable for each train service. The model then counts how many times each pair occurs during each weekday, Saturday and Sunday timetable respectively.

3) First train and last train departure times are used to determine the operational hours for each pair. The operational hours are then divided by the number of trains minus one to determine the average frequency of the pair.

4) The average frequencies for each pair are then weighted by passengers alighting per weekday, Saturday and Sundays to reach a weighted average frequency for the week.

5) Service Groups are assigned to each pair and MPWs are multiplied to generate the weighting for each pair. The proportionate weight of each pair in each Service Group is estimated by dividing the pair's weighting by the sum of the Service Group's weightings (see above).

6) The Service Group CM is the sum product of each pair and the weighting within the Service Group multiplied by the service interval multiplier (1.5).

[6] Stata is a general purpose command-line software package

3.5 Model Review

The model and results were reviewed internally as part of Phase 1 as listed in C. The review process helped ensure the process used to estimate the parameters were calculated accurately and allowed for improvements in the calculations. The model used to estimate MPWs and CMs will also be externally reviewed in Phase 2 of the Schedule 8 recalibration.

Table 3.1 Review process for the MPWs and CMs model

Review Type	Description
Model WebEx walkthrough	• A WebEx[7] session was set up for TOCs and NR Routes. This session went through a draft version of the model online and allowed attendees to comment on the approach and modelling. As a result of this session, improvements to the CM estimation approach were incorporated in later versions of the model.
Internal consistency	• Inclusion of built in checks within the model allowed comparison of key elements of the results e.g. distribution between forward and reverse and deviations from CP5 results. This allowed any unexpected deviations to be flagged and investigated further.
Internal model review	• OAK[8] review of the Excel based model by PwC colleague independent from the project team. • Model review of Stata code by PwC colleague independent from the project team.
Rail industry expert sense-check review	• Our rail industry expert advisor, reviewed the results to comment on the reasonableness of MPWs and CMs results for each TOC.
Results consultation	• Draft results were sent to each TOC and relevant NR Route for review. Comments and issues arising from the results consultation were addressed as necessary or the feedback was passed onto RDG for comment.
External review	• The modelling of MPWs and CMs will undergo an external review in Phase 2 of the Schedule 8 recalibration for CP6 by a team external to the project team for Phase 1.

[7] WebEx is an application for online meetings and presentations.
[8] OAK is an Excel add-on tool which helps review Excel model formulae and structure.

Appendix 1

Table A1. TOC specific assumptions

Train Operating Company (TOC)	TOC specific adjustments (MPWs)	TOC specific adjustments (CMs)
Arriva Rail London	N/A	N/A
Arriva Train Wales	N/A	• Adjustment for repeated pairs
c2c	• 2016/17 recalibration period used to reflect new services which were introduced in 2016/17.	• Adjustment for repeated pairs
Chiltern Railways	• 2016/17 recalibration period used to reflect new timetable introduced in December 2015.	N/A
CrossCountry	N/A	N/A
Crossrail	• Data for Crossrail was not available in MOIRA hence Crossrail performed their own estimations of MPWs.	• Data for Crossrail was not available in MOIRA hence Crossrail performed their own estimations of CMs.
East Coast	N/A	• Station pairs with frequencies above 180 mins excluded
East Midlands	N/A	• Adjustment for repeated pairs
Grand Central	N/A	• Station pairs with frequencies above 120 mins included
Great Western Railway	N/A	• Adjustment for repeated pairs
Greater Anglia	• Cambridge North data not available. Based on data provided by Greater Anglia, an assumption that 15% of customers from Cambridge station migrate to Cambridge North was made to estimate the MPWs.	N/A
Hull Trains	N/A	• Station pairs with frequencies above 120 mins included
London Midland	• Coventry-Leamington Spa (Service Code 255) MPWs proxied by Coventry-Nuneaton (Service Code 328) MPWs. The Coventry (Service Code 328) and Nuneaton (Service Code 328) MPWs were divided by two to attribute half the weighting to Coventry and Leamington Spa. • Bromsgrove MPW estimated using passenger alighting data provided by London Midland as Bromsgrove is a new Monitoring Point. The split between peak and off-peak passengers were proxied on the 2016/17 Longbridge and Redditch peak and off-peak split.	• Adjustment for repeated pairs
Merseyrail	N/A	• Additional station pair added to the list of stations pairs used to calculate CM for HE02 (Chester to Liverpool Central and Liverpool Central to Chester)

Scotrail	• Services currently running under Service Code 579 will change to 577 from CP6 so has been adjusted in the May 2017 timetable.	• Adjustment for repeated pairs
South West Trains	N/A	• Used station pairs provided by SWT • Prefer not to use the (n-1) approach as default in the denominator for the average frequency calculation, and would prefer to use the (n) approach.
Transpennine Express	N/A	• Prefer not to use the (n-1) approach as default in the denominator for the average frequency calculation, and would prefer to use the (n) approach.
Virgin West Coast	• Requested the removal of Milton Keynes Central reverse 104 and adding the weight to Crewe reverse 104. Submitted as a separate set of results.	N/A