Office of Rail and Road

Methodology Report

PR23 recalibration of the Network Rail passenger Schedule 8 regime

Reference: 292105-00

22 November 2023

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1. Introduction

This document has been written to accompany the 22 November 2023 release of parameters, which is the Final version for all parameters, following Draft and Near-final releases. This methodology report has been updated to reflect any changes between previous releases to this final position.

1.1 Context

The rail industry's train performance regime (Schedule 8 of the Track Access Agreements) compensates train operators for the financial impact of unplanned disruption to services caused by other train operators and Network Rail. The core objectives of the regime are:

- To provide incentives for both the infrastructure manager and operators are to minimise disruption and improve performance for the benefit of customers;
- To provide train operators with appropriate protection from losses arising from delays and cancellations outside their control; and,
- To provide information on the costs of delays to enable an efficient allocation of resources.

In addition to this, the Schedule 8 regime should:

- Avoid undue discrimination between different services;
- Avoid perverse incentives;
- Be simple, predictable and practicable;
- Be resilient to changing circumstances (such as developments in rail reform); and,
- Provide consistent performance incentives across the industry.

Schedule 8 payments are based on attributed delay, benchmarks and payment rates: if a party causes more performance minutes than its benchmarked amount, it pays an amount equal to the excess performance minutes multiplied by a payment rate. Benchmarks represent the average level of performance minutes and are expressed as performance minutes per train movements. The Benchmarks serve the purpose of minimising money flows within the regime. Payment rates represent the expected financial impact of a given unit of performance minutes and are based on the relationship between unplanned disruption and modelled revenue loss.

Schedule 8 benchmarks and payment rates are recalibrated at the start of each control period – this report provides the methodology for the national recalibration of Schedule 8 of the Track Access Agreement for Control Period 7 (CP7) for passenger operators, undertaken as part of the 2023 Periodic Review (PR23). It is important that parameters should be a reasonably accurate representation of expectations for the upcoming Control Period – that is, benchmarks are set so as for Schedule 8 to be 'financially neutral on expectation' and payment rates represent a reasonable estimate of the expected marginal revenue effects of performance changes.

For most parameters, we therefore use historical data as the best available representation of expectations for the upcoming Control Period. For Network Rail benchmarks, forward-looking regulatory performance trajectories are overlaid.

1.2 Overview

The objective of this report is to provide an overview of the modelling assumptions, calculations, and processes for the calculation of each of the Schedule 8 parameters, where these apply to all Train Operating Companies (TOCs). This report is part of a set of documents, models, and databases that comprise the output of the recalibration.

Throughout the process, multiple decisions and assumptions have been made to enable the calculation and we refer to these documents throughout this report. In particular, the CP7 recalibration of Schedule 8 has been undertaken in the context of:

- Significant volatility in passenger demand and revenue;
- Substantial changes in train service levels; and
- Numerous instances in which workforce issues, including industrial action, have impacted both revenue and train service levels, which has then impacted operational performance outcomes.

This represents an unprecedented level of change in the historical data as well as continued uncertainty in direction of future demand, revenue and train service structure. As a result:

- The methodology includes several adaptations made to account, in part, for the changing circumstances over the recalibration timeframe.
- Modifications to the previous (CP6) approach to enable the parameters to be more readily updateable should there be a need to make efficient variations during CP7 (as well as later Control Periods).

The Recalibration Timeframe (RT) for the CP7 Schedule 8 recalibration base year is thirteen periods between 2021/22 Period 8 and 2022/23 Period 7 (i.e., October 2021 to October 2022). This was directed by the Office of Rail and Road (ORR) after a programme of engagement with the TOCs and Network Rail Regions. The rationale for the selection of this timeframe is set out in the ORR note: '2023-02-09 – ORR note on recalibration timeframe' made available separately to the Recalibration Working Group (RWG).

1.3 Key points

The individual chapters of this report (notably chapters 3 to 7) provide detail on the methodology. Here we highlight key points from the calculation of each of the parameters:

Parameter	Key points
Network Rail Payment Rates	• Use of semi-elasticities as a means of calculating the relationship between performance and revenue impact. • Application of an uplift factor to account for COVID-related travel restrictions as well as other impacts within the recalibration timeframe.
Base Benchmarks	• Application of changes in Cancellation Minute Multipliers, Monitoring Point locations, and their weightings to rebase the TOC and Network Rail benchmarks accordingly. • Application of changes to Signal Berth Offsets and any agreed impact of removing advertised time.
Network Rail Annual Benchmarks	• Application (through a conversion model provided to the recalibration team) to convert regional On Time and Cancellations measures into TOC-level Network Rail delay per 100km, and Network Rail cancellations respectively. • Application of regression analysis to convert these trajectories into Average Minutes Lateness and Deemed Minutes Lateness at a Service Group Level.
TOC Payment Rates	• Calculation combining Responsibility Matrix with parameters above.
Sustained Poor Performance (SPP)	• Use of a 'taper' in 2024/25 that enables the SPP rate to progressively reflect the impact of the changes in Network Rail Payment Rates.

A comprehensive set of appendices provides a deep dive into the technical detail of the methodology.

2. Stakeholder engagement

The methodology has been developed and refined based on a comprehensive programme of engagement with:

- Passenger TOCs, Network Rail Routes and Regions who have provided expertise and insight to support the development of operator specific changes, as well as review of draft and near-final results.
- Technical experts and working group who have supported on overall methodology design.
- Policy leads who have provided direction on key decisions.

2.1 Recalibration Working Group

RWG meetings have been held on a 4-weekly cycle from September 2022 to November 2023 (with additional meetings prior to the appointment of the consulting project team).

2.2 Regional Workshops and bilateral engagement

The project team developed and delivered a series of Regional Workshops with the purpose of capturing any specific thoughts, concerns, issues and challenges that may have a geographic commonality that may have not been otherwise aired in the wider, national working group sessions. Five sessions were delivered, structured around Network Rail Regions, on the following dates:

- 07 Dec 2022: Regional Workshop **Southern**
- 07 Dec 2022: Regional Workshop **North West and Central**
- 08 Dec 2022: Regional Workshop **Scotland**
- 15 Dec 2022: Regional Workshop **Eastern**
- 15 Dec 2022: Regional Workshop **Wales and Western**

2.3 Engagement with individual TOCs and Network Rail

Individual meetings with eight TOCs were held in January and early February 2023. This was optional for all TOCs, and these one-to-one meetings provided the platform to discuss the recalibration process and the data provided for calculations. This was in addition to email communications with all TOCs throughout the programme, and emails specifically to do with Cancellation Minutes Multipliers (CMMs) and Monitoring Point (MP) data.

Throughout the project, there were also several meetings with Network Rail to discuss inputs, data requirements and the recalibration period itself.

2.4 Engagement with third party auditor

The ORR has engaged SYSTRA to act as a third-party auditor of the methodology undertaken by the project team, providing independent quality assurance and an iterative review process. The project team engaged with the audit team on a weekly basis beginning at the start of May 2023. A full audit report is provided as part of this final issue.

3. Network Rail Payment Rates

3.1 Overview

This section provides an overview of the methodology used to calculate the Network Rail Payment Rates for the CP7 / PR23 recalibration of Schedule 8.

3.2 Network Rail Payment Rates calculation

The Network Rail Payment Rate (NRPR) for a Service Group (SG) is calculated as follows:

$$NRPR = \frac{Price\ Base\ Factor\ \times \sum_{Segment}\left(-1\ \times Revenue_{Segment} \times Semi\text{-}elasticity_{Segment}\right)}{\sum_{Segment} Busyness\ Factors}$$

Where:

- The NRPR for each SG is equivalent to the modelled change in the Service Group's revenue for a one-minute change in Performance Minutes (PM) for a single day. PM are a combination of the effect of delays and cancellations on passenger journeys.
- SG is a subset of the TOC's services denoted by a four-character code (e.g., HF01). Some SGs are split into Peak and Off-Peak.
- Price Base Factor is a multiplier converting the MREs in outturn prices from the RT to the values for the start of CP7 (see Appendix 2).
- Revenue is the total value of the tickets sold for the RT as allocated in the LENNON Earnings data (with TOC specific adjustments). An adjustment was also applied to account for changes in revenue volume following relaxation of post-lockdown restrictions (see Appendix 1).
- Semi-Elasticity is a parameter reflecting how revenue is expected to vary with changes in PM. Note: semi-elasticities are applied to all flows; this is a change relative to CP6 (see Appendix 4).
- Revenue and Semi-Elasticities are defined at a Segment level, where a Segment is the combination of Sector and Ticket Category, as per Table 3-1.

Table 3-1: Semi-Elasticities (source: Disruption Semi-Elasticities Recommendations Note v3.0).

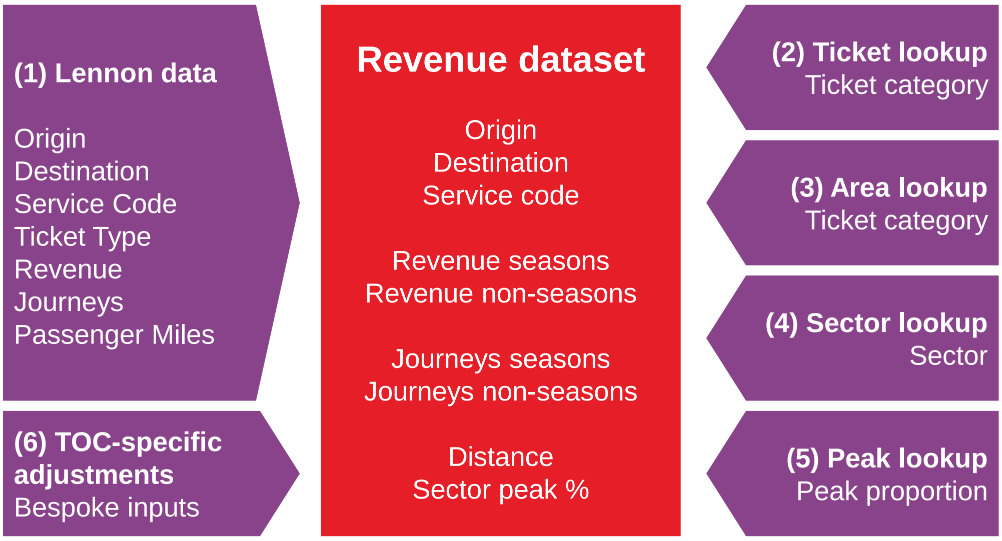
PDFH Sector	Non Season	Seasons
London Travelcard Area (TCA)	-0.022	-0.018
Airport	-0.012	-0.010
Long Distance flows to/from London	-0.009	-0.007
Rest of GB >20 miles	-0.008	-0.008
Rest of GB <=20 miles	-0.006	-0.002
SE to/from SE	-0.018	-0.018
SE to/from London	-0.013	-0.010

Busyness Factors measure the planned number of scheduled stops in the timetable for a Rail Period compared to the average number scheduled in the Bi-annual timetable. The sum of all the Busyness Factors across the RT is used to convert the NRPR into a daily rate (see Appendix 3).

3.3 Processing LENNON Revenue data into Segment and Ticket Categories

This section provides the process for allocating revenue data from LENNON into the relevant Segment. There are six steps as per Figure 3-1.

Figure 3-1: Revenue data processing steps



Step 1: Processing LENNON data

The Rail Delivery Group (RDG) processed the LENNON Earnings data (i.e., revenue allocated to each TOC and Service Code) data for each TOC for the RT. Table 3-2 shows the fields extracted and their purpose.

Table 3-2: Fields used extraction of LENNON data

Field	Purpose of field
Origin	To enable Segment to be determined.
Destination	To enable Segment to be determined
Service Code	To enable the aggregation to SG. (4-digit Service Code equivalent to the 3rd, 4th, 5th and 6th digits of the 8-digit train service code)
Fares Group	To enable aggregation to Seasons, Non-Seasons and Other
Adjusted Earnings Sterling	Revenue input to NRPR calculation

For this recalibration, we made an adjustment to revenue. This adjustment methodology has previously been provided to the RWG and is included in Appendix 1 of this document.

Step 2: Aggregating into Ticket Category

We applied the mapping in Table 3-3 to assign each Fares Group into Seasons, Non-Seasons, and Unallocated. The Unallocated revenue is typically a very small proportion of the total revenue. We applied a pro-rata of this data into the Seasons and Non-Seasons so that this revenue is incorporated in the total.

Table 3-3: Ticket Category to Primary Product Group mapping

Ticket Category	Fares Product Group Description (Code)
Seasons	Seasons (FG05) Season Refunds* (SG28)
Non-Seasons	Anytime / Peak (FG01) Off-Peak (FG02) Super Off-Peak (FG03) Advance (FG04)

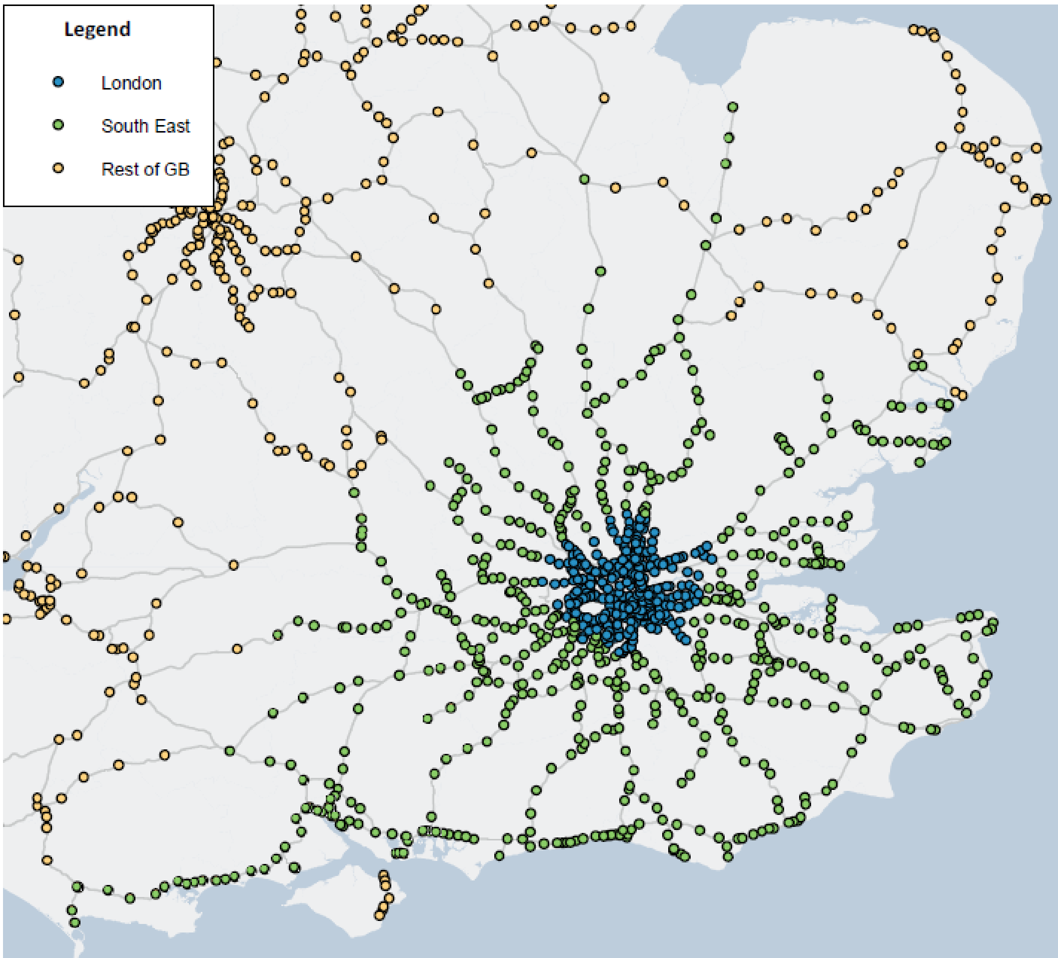
Ticket Category	Fares Product Group Description (Code)
	Ordinary Refunds* (SG27)
Unallocated	Other (FG06) N/A Fares Group entries

* Note: it is important that refunds are included as this avoids overestimating the total revenue in scope.

Step 3: Area mapping

Each (non-airport) station is mapped into one of three geographic areas: London, South East, and Rest of GB. For all locations, we add an Area field to the data, based on geographic Area definitions as shown in Figure 3-2. Areas not shown in the map are all Rest of GB.

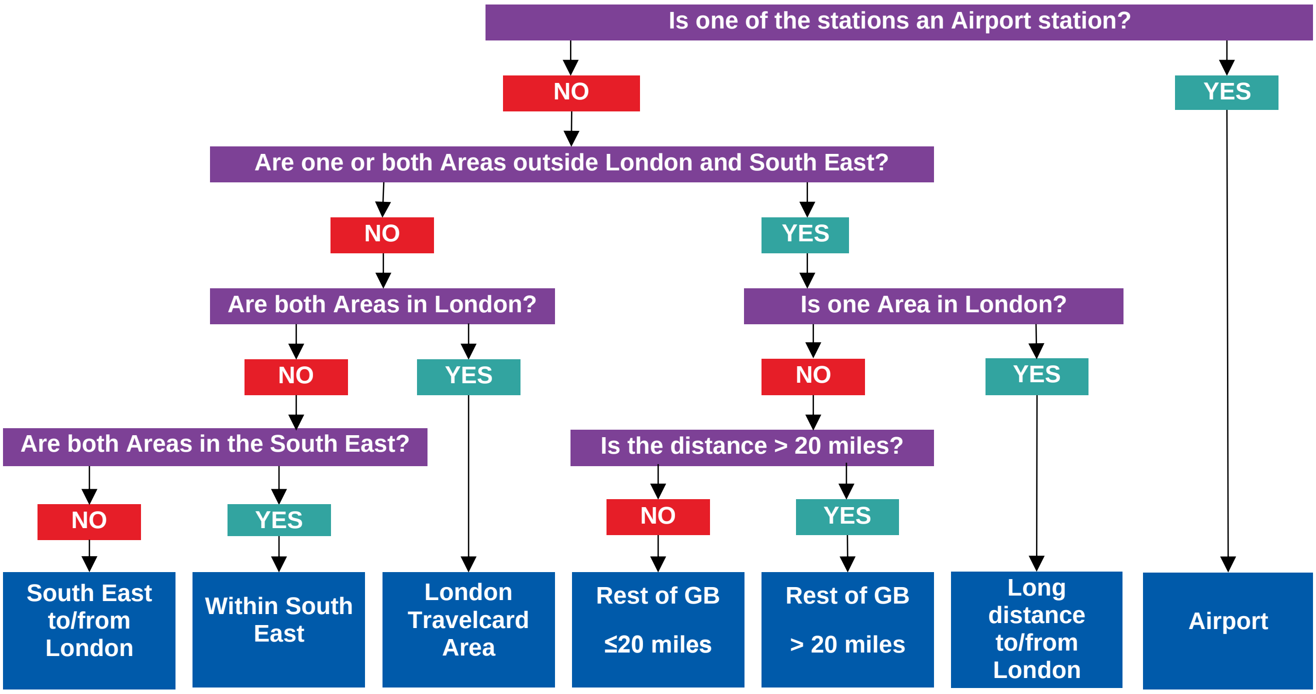
Figure 3-2: Map of areas



Step 4: PDFH Segment Mapping

The allocation in Figure 3-3 was used by RDG to map combinations of Origin Area and Destination Area into the Segments.

Figure 3-3: Sector mapping flowchart (Source: Steer interpretation of PDFH)



Step 5: Allocating revenue to a peak type

LENNON data does not provide any information on the actual time of travel. To convert the LENNON data into Peak and Off-Peak (for those SGs which have this distinction), we use the Fares Group splits in combination with the Peak Proportions for each Fares category. Further information on this allocation is provided in Appendix 5.

Step 6: TOC-Specific Adjustments

We have incorporated information provided by the operators to adjust the Flow data to account for places where the standard process (described in Steps 1 to 5) does not fully capture all the input information. These adjustments contain commercially sensitive information and are shown only in the TOC's Technical Report and not in this methodology document. TOC-Specific Adjustments can be classified as follows:

- Additional sources of revenue not captured in LENNON (i.e., tickets sold at airports);
- Information to disaggregate non-geographic records (e.g., Passenger Transport Executive tickets);
- Adjustments to the modelled peak/off-peak splits calculated in Step 5;
- Adjustments to the allocation of revenue to service codes;
- Information to ensure Refunds and Non-Issues are dealt with appropriately; and
- Identification of Non-Marginal Revenues (i.e., those that are not affected by performance) that have significant amounts of revenue on Full, Reduced or Seasons rather than Other.

4. Base Benchmarks

4.1 Overview

The Base Benchmarks we describe here reflect performance during the agreed RT, adjusted to account for changes to Monitoring Point Weightings (MPWs) and CMM that have happened or are expected prior to the start of CP7. We also incorporated the following impacts:

- Changes to Signal Berth Offsets (BO) where implemented prior to 20 August 2023
- Changes to advertised time or 'Public Differential' (PD), defined as difference between the public (GBTT) and working (WTT) timetables, where approach agreed by operator and Network Rail and data provided by Network Rail
- Removal of single dates on a case-by-case basis

The Network Rail and TOC Base Benchmarks comprise 'AML' (Actual Minutes Lateness, caused by delays) and 'DML' (Deemed Minutes Lateness, due to cancellations). For example, the Network Rail AML and DML for a (Victim) SG with new MPWs, new CMMs and with adjustments applied are calculated as follows:

$$NR\ AML = \sum_{MPs} NewMPW.\frac{\sum_{RT-Dates}[(Lateness + Adjustments).NRDelay\%_{SGT}]}{\sum_{RT-Dates} Trains}$$

$$NR\ DML = NewCMM.\sum_{MPs} NewMPW.\frac{\sum_{RT-Dates} NR\ Cancellations}{\sum_{RT-Dates} Trains}$$

Where:

- RT–Dates = Dates in RT minus any to be removed
- Adjustments = BOImpact/train. (Trains – Cancellations) + PDImpact
- NRDelay%$_{SGT}$ = Network Rail and TOC-on-TOC (TOT) share of responsibility for Delay Minutes on relevant Date for SG and Peak Type corresponding to MP, according to PEARS
- Trains = Trains planned to call at MP on the day

For the versions of these formulae with TOC responsibility, simply replace the Network Rail Delay % and Cancellations with TOC Delay % and TOC Cancellations.

During the agreed RT, or prior to the start of CP7, several TOCs, such as TransPennine Express and Northern, made significant changes to their routes and service patterns. Given the extent of these changes, in most cases the scope of the PR23 recalibration is limited to simple estimates of lateness and cancellations at any new MP locations, as well as changes to CMMs as provided by Network Rail and TOCs. Where data is available for existing MPs this has been used, no matter how small the sample.

One service change was incorporated into the recalibration where the straightforward movement of trains in two Capri codes from one SG to another made it relatively easy to implement.

The remainder of this section outlines the key inputs, calculations, checks carried out and outputs produced:

1. Data collection
2. Assumptions
3. Approach for new MPs
4. Apply adjustments
5. Service remapping

6. Benchmark comparisons
7. Dispute Reallocation
8. Checks

4.2 Data collection

This section describes the key input datasets to the Base Benchmark calculations.

4.2.1 MP + CMM repository

Under the guidance of the ORR, Network Rail and the TOCs submitted proposals for changes to MPs and MPWs for each operator, including any new MPs, as well as any changes to CMMs. We collated and consolidated these to generate inputs to benchmark calculations and to identify any new locations proposed for which there would be no historic PEARS data.

4.2.2 PEARS databases

The daily PEARS data only contains data at MPs that were valid during the RT. This is the main data source for lateness minutes and the number of cancellations at a MP level. Network Rail provided us with a download of the database for each of the TOCs in scope.

4.2.3 PSS On Time data for new MPs

For new MP locations at which data was not available in PEARS, where possible we used the PSS 'On Time' data provided by Network Rail, which included information on lateness and cancellations at each location, as well as Direction and Peak Type.

4.2.4 Cancelled trains

We used datasets of cancellations in 2021/22 and 2022/23 by train and incident category exported from Network Rail SharePoint to assign responsibility for the cancellations identified in the PSS On Time data.

4.2.5 Impact of changes to Signal Berth Offsets

Network Rail provided files showing the estimated impact per train of changes to Signal Berth Offsets (BO) on lateness at individual MPs, together with another file showing the date that the changes were implemented. Together these allowed us to identify (a) the impact of BO changes on lateness by MP and (b) to which periods of the RT – prior to their implementation – these impacts need to be retrospectively applied as outlined in section 5.4.2.

4.2.6 Impact of changes to Public Differential

Where an operator advised that the PD or advertised time – the difference between the public and working timetables – was to be removed at destination locations, Network Rail calculated the impact on total lateness of removing the PD by MP and Date, which we then incorporated into our total lateness calculations as an adjustment to the raw PEARS data.

4.3 Assumptions

Except where we have undertaken a full remapping exercise, Network Rail and TOC shares of responsibility for delays and cancellations are left unchanged irrespective of any changes to services and new MPs. For example, if responsibility for delays on a particular date and SG were in the ratio of 60:40 then this same ratio was used to divide responsibility for lateness at a new MP on that SG.

Where new MPs have been proposed we have assumed that services will call at them, and hence that they should be included in our calculations, even where no historical data exists.

The historical PSS data provided by Network Rail included Direction and Peak Type columns, which we assumed would be sufficiently accurate for the purposes of this exercise.

4.4 Approach for new MPs

We developed two approaches for estimating lateness at new MPs depending on whether historic data was available:

1. Where historical data was available, we used the PSS On Time data provided by Network Rail.
2. Where no historical data was available for the new MPs, we identified existing 'Proxy MPs' that we deemed to be appropriate approximations for the new ones and extracted the relevant PEARS data for these proxies.

For more information, see Appendix 6. A partial example is also shown for illustration in section 4.7

4.5 Adjustments

4.5.1 Signal Berth Offset Changes

Using files provided by Network Rail (see section 5.2), we first made sure that we could match each BO change to an existing MP and then aggregated the impacts (measured in minutes per train run) across MPs by Period. We merged these impacts – which only apply to periods prior to implementation – with the historical PEARS data to calculate revised lateness at each MP, see section 5.4.4 below.

4.5.2 Public Differential and Dates to Remove

We also applied adjustments to reflect the impact of changes to PD and removing agreed Dates.

4.5.3 Worked example

Table 4-1 below is a close approximation of how we apply these adjustments with an example for a hypothetical MP at which the following adjustments have been calculated / agreed:

- Impact of changes to Signal BO = +0.1 minutes per train run, which is only applied prior to its implementation in period 22_02
- Network Rail and Operator agree and provide increases to total lateness in each period caused by removal of Public Differential (PD) – see column (D)
- Removal of a single date in period 21_10 means pale blue '21_10 - Date' row replaces pale red row when calculating 'Adjusted' results in final row.

In this example, Total DML (based on CMM of 90 minutes) decreases from 0.57 to 0.33 due to removal of single Date while Total AML increases from 0.67 to 0.72 due to combination of three adjustments. Note that these values are 'unweighted' – they do not include the application of the MPW.

Table 4-1: Example calculation of adjusted AML and DML (unweighted)

Period	Trains (T)	Cancs (C)	Total DML	Trains Run (R) T C	Total Lateness Raw (A)	Total AML Raw A/T	BO Impact / Train Run (B)	PD Impact Lateness (D)	Lateness Adj. (E) A + (B x R) + D	Total AML Adj. E/T
21_08	1,000	5	0.45	995	500	0.50	0.1	10	610	0.61
21_09	1,000	2	0.18	998	1,000	1.00	0.1	9	1,109	1.11
21_10	1,000	40	3.60	960	2,000	2.00	0.1	11	2,107	2.11
21_11	1,000	0	0.00	1,000	500	0.50	0.1	8	608	0.61
21_12	1,000	5	0.45	995	500	0.50	0.1	12	612	0.61
21_13	1,000	2	0.18	998	200	0.20	0.1	10	310	0.31
22_01	1,000	10	0.90	990	300	0.30	0.1	12	411	0.41
22_02	1,000	0	0.00	1,000	200	0.20		10	210	0.21
22_03	1,000	5	0.45	995	500	0.50		9	509	0.51

Period	Trains (T)	Cancs (C)	Total DML	Trains Run (R) T C	Total Lateness Raw (A)	Total AML Raw A/T	BO Impact / Train Run (B)	PD Impact Lateness (D)	Lateness Adj. (E) A + (B x R) + D	Total AML Adj. E/T
22_04	1,000	2	0.18	998	1,000	1.00		11	1,011	1.01
22_05	1,000	10	0.90	990	500	0.50		8	508	0.51
22_06	1,000	0	0.00	1,000	500	0.50		12	512	0.51
22_07	1,000	1	0.09	999	1,000	1.00		10	1,010	1.01
21_10 - Date	950	5	0.47	945	1,800	1.89	0.1	10	1,905	2.00
Raw	**13,000**	**82**	**0.57**	**12,918**	**8,700**	**0.67**				
Adjusted	**12,950**	**47**	**0.33**					**131**	**9,328**	**0.72**

4.6 Service remapping

We generated separate results for SGs where it was possible to approximately reflect planned changes to the train service within the raw data without needing to make many subjective and impractical assumptions. To generate these results, we created a new input file, which took the original PEARS data and applied two adjustments:

1. **Daily MP lateness**: We remapped the victim service codes suffering lateness at each MP in the detailed daily PEARS data using the logic provided by the operator and assigned the corresponding new SG.
2. **Daily delay**: We adjusted the Network Rail and TOC shares of daily delay minutes in PEARS by applying the relative percentage change in the Network Rail share of the total, as calculated in the Responsibility Matrix (see section 7.3.5).

Having made these adjustments, the remapped PEARS data was used in the benchmark calculations in the same way as the PEARS data for other SGs.

4.7 Benchmark comparisons and worked example

In this stage of the methodology, we execute the core benchmark calculations:

1. Combine raw PEARS data, filtered for RT, with PSS and Proxy data for new MPs.
2. Calculate revised total lateness after applying adjustments for impacts of changes to Signal BO and PD + include Date filter.
3. Divide responsibility for lateness at new MPs using % share of responsibility for delay at existing ones by SG, Peak Type and Date.
4. Calculate versions of AML and DML to enable comparisons across steps in calculations:
    a. With current MPWs and CMMs (baseline)
    b. With current MPWs and new CMMs (to show impact of new CMMs)
    c. With new MPWs and new CMMs (to show impact of new MPs)
    d. As above with revised lateness after applying BO and PD adjustments + filtering out Dates (to show impact of adjustments)
    e. As above with remapped SGs (to show impact of remapping)

This process is repeated twice, with disputes set to operators and to Network Rail, which generates two sets of outputs to which we then apply dispute reallocation (see below).

Table 4-2 below illustrates comparisons 4a and 4d above, together with the approach used when adding new MPs (see section 4.4). Current MPWs and CMMs (4a) are highlighted purple; new ones (4d) are highlighted in blue.

Table 4-2: Example calculation of Benchmark (PM) comparisons

Measure	MP1 (current)	MP2 (current)	MP3 (new)	MP4 (new)	Total
Source	PEARS	PEARS	PSS	Proxy = MP2	
MPW-Current (wC)	0.5	0.5			
MPW-Current (wN)	0.35	0.45	0.15	0.05	
CMM-New (mC)	90	90	90	90	
CMM-New (mN)	80	80	80	80	
Trains (T)	12,950	12,950	1,000	No historical data	
Network Rail Lateness (A)	5,594	5,000	600		
TOC Lateness (B)	3,729	3,000	400		
Network Rail Cancellations (C)	19	20	5		
TOC Cancellations (D)	28	30	5		
Network Rail Average Lateness (E) = A/T	0.43	0.39	0.60	0.39	
TOC Average Lateness (F) = B/T	0.29	0.23	0.40	0.23	
Network Rail Cancellations % (G) = C/T	0.15%	0.15%	0.50%	0.15%	
TOC Cancellations % (H) = D/T	0.22%	0.23%	0.50%	0.23%	
Network Rail PM-Current = (E + mC x G) x wC	0.28	0.26	0.00	0.00	**0.54**
Network Rail PM-New = (E + mN x G) x wN	0.19	0.23	0.15	0.03	**0.60**
TOC PM-Current = (F + mC x H) x wC	0.24	0.22	0.00	0.00	**0.46**
TOC PM-New = (F + mN x H) x wN	0.16	0.19	0.12	0.02	**0.49**

4.8 Dispute reallocation

The final step is to reallocate the disputed minutes. Based on a methodology agreed by the RWG, any minutes in dispute at the time of extracting the data from PEARS, are allocated in line with the TOC/Network Rail share of undisputed minutes across the full RT. This is done separately for AML and DML. For example, on a SG:

- Network Rail undisputed AML is 3.0 mins (60% of the total undisputed AML)
- TOC undisputed AML is 2.0 mins (40% of the total undisputed AML)
- The level of disputed AML is 0.5 mins.
- Network Rail is assigned 0.3 (i.e., 0.5*60%) of disputed mins, giving a Network Rail AML of 3.3 mins.
- TOC is assigned 0.2 (i.e., 0.5*40%) of disputed mins, giving a TOC AML of 2.2 mins.

The same process was also carried out for DML.

4.9 Checks

We carried out checks on the benchmark calculations, the results of which are as follows:

1. Ensured that no MPs have null lateness
2. 8 MPs have 0 lateness, typically where sample available is small, hence probably means no lateness was suffered by few trains that called at these MPs during the RT
3. The only missing MPs are those with 0 weighting for CP7.

5. Annual Network Rail Benchmarks

5.1 Overview

The Network Rail Benchmarks consist of PM suffered by a (Victim) SG that is caused by delays and cancellations for which responsibility rests with either Network Rail or other passenger, freight and charter train operators. The Benchmark calculations incorporate the baseline trajectories from ORR's final determination showing the level of performance that Network Rail is funded to deliver and therefore typically vary by year. In this section we explain how each of the different categories of responsibility are combined to calculate the annual Network Rail Benchmarks.

5.2 Methodology

5.2.1 Shares of responsibility for Network Rail Benchmarks

We use the historical PSS data provided by Network Rail to calculate the passenger TOC-on-TOC (TOT), Freight-on-TOC (FOT), Charter-on-TOC (COT) and Network Rail (NR) shares of responsibility for the Network Rail benchmarks. The calculations are repeated using delay and cancellation minutes for the AML and DML parts of the benchmarks respectively. This is an output of the TOC Responsibility Matrix (see also section 6.2.1).

5.2.2 Passenger TOC-on-TOC

The passenger TOT contribution to the Network Rail Benchmark is kept constant throughout CP7. It is the average PM suffered by the Victim SG within the RT.

5.2.3 Apply Freight- and Charter-on-TOC Trajectories

The FOT and COT contributions to the Network Rail Benchmarks are not uplifted[1]. This is based on a direction provided to Steer/Arup by the ORR.

5.2.4 Apply Network Rail Trajectories

There are two definitions of the key inputs to the Network Rail Trajectory Process:

- Consistent Route Measure – Performance (CRM-P), see 5.2.4.1
- Network Rail Delay per 100km (NRDp100k), see 5.2.4.2

5.2.4.1 Definition: Consistent Route Measure – Performance (CRM-P)

The Network Rail Trajectories are developed by relating AML to an input metric called Consistent Route Measure – Performance (CRM-P). CRM-P is defined as follows: 'CRM-P is the Annual minutes of Network Rail attributed delay to passenger trains from incidents occurring within the route boundary normalised by the actual mileage travelled by passenger trains within that route.' (Source: Network Rail document 'Network Rail S8 Benchmarks trajectories v2'). CRM-P can be expressed as:

*CRM-P = Total attributed delay to the Network Rail Route ÷ 100 * Train kms in the route*

Where:

Total attributed delay to the Network Rail Route includes both primary and reactionary delay, and delay suffered in other routes from incidents occurring in the origin route. All attributed delay minutes are included to in-service passenger train services (i.e., Empty Coaching Stock moves are not counted, but delays to

[1] Note: In the CP6 recalibration, the FOT and COT contributions were increased by an uplift factor.

passenger operators such as the North Yorkshire Moors Railway, Tyne & Wear Metro and London Underground are included). The measure is assessed after all disputed minutes have been settled.

Train kms in the route is the distance as calculated by PSS for in-service passenger train movements within the route boundary. The distance is based on actual rather than planned train movements. Distance is measured in 100 train kilometres. The planned distance of a train that did not run is not part of the Train km part of the equation. Delay minutes and the distance operated by part cancelled trains are included in the measure.

5.2.4.2 *Definition: Network Rail Delay per 100km (NRDp100km)*

Network Rail Delay per 100km follows a similar definition to that of CRM-P. The difference is that itis calculated at a TOC-level and at a SG-level rather than a Route level.

5.2.4.3 *Phases of work*

There are five Phases for applying the Network Rail Trajectories shown in Table 5-1. Phases 1 to 3 have been determined by the industry (i.e., NR, TOCs and ORR) and are outside the scope of this report. Phases 4 and 5 have been developed by Steer/Arup.

Table 5-1: Phases in applying Network Rail Trajectories

Phase	Description	Organisation
Phase 1	ORR determines regional On Time and Cancellations trajectories	ORR
Phase 2	Network Rail creates Strategic Business Plan (SBP) assumptions for TOC level performance	Network Rail
Phase 3	Convert regional On Time and Cancellations trajectories to TOC-level Network Rail attributable trajectories for delay and cancellations, partly based on SBP assumptions	Network Rail model for ORR
Phase 4	Convert Network Rail Delay per 100 train kms (CRM-P) at a TOC-level to a SG-level	Steer/Arup
Phase 5	Converted annual Network Rail Delay per 100 train kms trajectory into a NR-caused AML trajectory for each SG	Steer/Arup

5.2.4.4 *Phase 4: Converting TOC-level Network Rail Trajectories to Service Group-level*

The Network Rail Delay per 100km (NRDp100k) trajectory inputs at a TOC-level are applied at a SG level through adjusting the TOC-level CRM-P by the following factor:

$$\text{SG-level NRDp100km}_{\text{Future}} = \text{TOC-level NRDp100km}_{\text{Future}} * \frac{\text{SG-level NRDp100km}_{\text{Actual}}}{\text{TOC-level NRDp100km}_{\text{Actual}}}$$

Where:

TOC-level $\text{NRDp100k}_{\text{Actual}}$ = The TOC NRDP100km in the RT.

SG-level $\text{NRDp100k}_{\text{Actual}}$ = The SG NRDP100km in the RT.

TOC-level $\text{NRDp100k}_{\text{Future}}$ = The change in NRDp100km at a TOC-level as provided to Steer/Arup by Network Rail for each year in CP7.

SG-level $\text{NRDp100k}_{\text{Future}}$ = The NRDp100km at a SG-level as calculated by Steer for each year in CP7.

5.2.4.5 *Phase 5: Converting Service Group-level Network Rail Delay per 100km Trajectories to AML*

The SG-level NRDp100km trajectory is then applied to the Network Rail proportion of the Network Rail Benchmark using the Network Rail part of the Base Benchmark as a start point and overlaying a regression between Total Actual Minutes Lateness, adjusted to reflect changes to measurement process (MP weights etc.) for PR23, and Total Delay per 100 km (TotalDp100km).

Regression analysis was undertaken to evaluate the relationship between Total AML and TotalDp100km at a SG-level:

- Independent variable (also known as X variable): TotalDp100km at a SG level.
- Dependent variable (also known as Y variable): NR AML + TOC AML = Total AML, adjusted for impact of changes to MP weights and Signal Berth Offsets etc.

Note: Total delay and AML measures are used because the relationship between delay and AML is not thought to vary importantly, whether delays are caused by Network Rail or operators. This approach also simplifies calculations. The regression relationship is determined by Ordinary Least Squares estimation at a SG level. The following model was estimated for each SG.

$$Total\ Actual\ Minutes\ Lateness\ (NR\ + TOC)_{i,t} = \alpha_0 + \alpha_1 TotalDp100k_{i,t} + \varepsilon_{i,t}$$

Where:

'i' represented SGs and 't' represented time (Period);

$Total\ Average\ Minutes\ Lateness\ (NR\ + TOC)_{i,t}$ adjusted NR AML + TOC AML for SG 'i' at time 't'.

$TotalDp100km_{i,t}$ measures Total Delay per 100 train km for SG 'i' at time 't'; and

α_1 is the coefficient of the independent variable.

In the first stage of the estimation process, we estimated the coefficient of correlation. We found high positive correlation between the two variables for most SGs. The model was then estimated using Ordinary Least Square approach for each SG. The coefficients for TotalDp100km were generally as we expected i.e., positive and statistically significant at 5 percent level of significance, meaning that the delay in a service would increase average minutes lateness.

Where the regression did not provide a good fit, we did not apply this to the trajectory calculation. The regression was regarded as inappropriate if the R-squared value was below 50%.

We then calculate the Network Rail portion of AML at SG level in each year as follows:

$$\mathrm{AML}_{\mathrm{NR\ only,Year\ x}} = \mathrm{AML}_{\mathrm{NR\ only,Base}} + \alpha_1 (NRDp100km_{Year\ x} - NRDp100km_{Base})$$

The Network Rail portion of Deemed Minutes Lateness (DML) is assumed to have the same trajectory as the TOC-level Network Rail cancellations trajectory – we first calculate the Network Rail share of the Base Benchmark for each SG before then applying the trajectory:

Base: $\mathrm{DML}_{\text{Network Rail only}} = \mathrm{DML}_{\text{NR+TOT+FOT+COT}} * \mathrm{Cancellations}_{\text{NR}} \div \mathrm{Cancellations}_{\text{NR+TOT+FOT+COT}}$

Annual: $\mathrm{DML}_{\text{NR only, Year x}} = \mathrm{DML}_{\text{NR only, Base}} * \mathrm{Cancellations}_{\text{NR only, Year x}} \div \mathrm{Cancellations}_{\text{NR only, Base}}$

5.2.4.6 Note on use of Delay trajectories at a TOC-level for Schedule 8

The input trajectory for the Network Rail BM profile across CP7 is Network Rail Delay per 100km at a TOC level. If we assume that Network Rail meets its Network Rail Delay per 100km target exactly, this does not necessarily mean that the Schedule 8 payments from the Network Rail part of the regime between Network Rail and a TOC will be zero. The use of this trajectory may lead to three types of divergence:

- **TOC Delay to SG Delay**: If the rate of change at a SG level diverges from the TOC-level Network Rail trajectory and SGs with a lower Network Rail Payment Rate improve at a greater rate than SGs with a higher Network Rail Payment Rate, this would lead to a net pay-out by Network Rail.
- **SG Delay to SG AML**: If the ratio between AML and Delay per 100km changes such that there is a higher rate of AML per NRDp100km it would lead to a net pay-out by Network Rail.

In each of the three situations above, if the reverse case is true (e.g., DML increases at a lower rate than AML), then this would lead to a net pay-out from the TOC to Network Rail.

5.2.5 Phase 5: Combining Components

The Network Rail Benchmarks (Network Rail BM) for each SG in each year are calculated as follows:

$$NRBM_{Year\,x} = NRAML_{Year\,x} + NRDML_{Year\,x}$$

$$NRAML_{Year\,x} = TOTAML_{Base} + NRonlyAML_{Year\,x} + [1.000] * FOTAML_{Base} + [1.000] * COTAML_{Base}$$

$$NRDML_{Year\,x} = TOTDML_{Base} + NRonlyDML_{Year\,x} + [1.000] * FOTDML_{Base} + [1.000] * COTDML_{Base}$$

Where:

$TOTAML_{Base}$ = TOT AML suffered by the Victim SG during the RT

$NRonlyAML_{Year\,x}$ = Network Rail-on-TOC AML suffered by the Victim SG during the RT, varied annually according to the application of the NRDp100km trajectory for that SG.

$FOTAML_{Base}$ = Freight-on-TOC AML suffered by the Victim SG during the RT

$COTAML_{Base}$ = Charter-on-TOC AML suffered by the Victim SG during the RT

Equivalent definitions apply to $TOTDML_{Base}$, NRonlyDMLYear $_{x}$, $FOTDML_{Base}$ and $COTDML_{Base}$

6. TOC Payment Rates

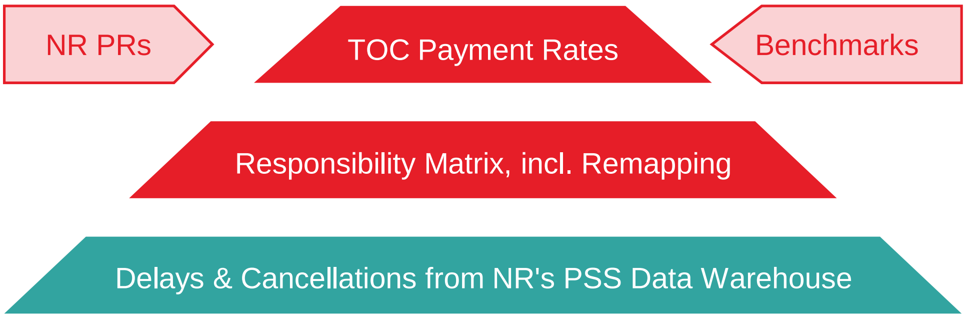
6.1 Overview

This section describes the process of calculating the Schedule 8 TOC Payment Rates for each SG. The TOC Payment Rate (TOC PR) is the amount an operator pays to/receives from Network Rail in respect of disruption caused by a Perpetrating SG (PSG) (i.e., the SG which causes the performance incident) and experienced by the Victim SGs (VSGs) (i.e., the SGs which suffer delays and/or cancellations from the performance incident).

The TOC PRs are intended to (on average) hold Network Rail financially neutral to TOT delays through the application of the VSG's NRPR to the proportion of the total Network Rail and TOT delays for the VSG that is caused by each Perpetrating SG.

We begin this section by describing how we calculate the SG TOC PRs and then work back to show how we derive the information from the input data sources, along with the process for applying TOC-specific adjustments. Figure 6-1 provides an illustration of how we have structured these calculations.

Figure 6-1: Organisation of the TOC Payment Rate methodology



6.2 Methodology

The TOC PR for a (Perpetrating) SG is calculated as follows:

$$TOC\ PR = \frac{\sum_{VSG=1}^{n}(PRC\ Delay_{VSG:PSG} + PRC\ Cancellations_{VSG:PSG})}{TOC\ BM}$$

Where:

$$PRC\ Delay_{VSG:PSG} = \frac{Delay\ Minutes_{VSG:PSG}}{NR\ \&\ TOT\ Delay\ Minutes_{VSG}} \times NR\ AML_{VSG} \times NRPR_{VSG}$$

$$PRC\ Cancellations_{VSG:PSG} = \frac{Cancellations_{VSG:PSG}}{NR\ \&\ TOT\ Cancellations_{VSG}} \times NR\ DML_{VSG} \times NRPR_{VSG}$$

- The Payment Rate Cost (PRC) between a VSG and PSG pair (denoted VSG: PSG) is the amount of money Network Rail is assumed to pay to a VSG as a result of Delays and Cancellations caused by a PSG.
  - PRC Delay $_{\text{VSG: PSG}}$ is the contribution to PRC $_{\text{VSG: PSG}}$ from the PSG's Delay Minutes.
  - PRC Cancellations $_{\text{VSG: PSG}}$ is the contribution to PRC $_{\text{VSG: PSG}}$ from the PSG's Cancellations.
- The TOC BM is the TOC Benchmark for the PSG (calculated as per Section 411). This is used as a divisor to convert the PRC which is an absolute value into the TOC PR which is a per-minute value.

Delay and Cancellation Minutes are calculated in the TOC Responsibility Matrix (see section below).

- Delay Minutes are the above-threshold PfPI performance minutes from PSS Delay Data.

- Delay Minutes $_{VSG: PSG}$ is the Delay Minutes caused by the PSG on the VSG, with adjustments to (a) 'Spread' minutes for which no valid PSG was provided and (b) reallocate disputes.
- NR&TOT Delay Minutes $_{VSG}$ is the total Delay Minutes caused by Network Rail and TOT on the VSG, adjusted to better match PEARS.
- Cancellations Minutes are the PfPI minutes as output by PSS for cancellations, which attempts to replicate the PEARS treatment of cancellations using a multiplier (CMM).
- Cancellations $_{VSG: PSG}$ is the Cancellation Minutes caused by the PSG on the VSG, again with adjustments (a) and (b) as above for delay.
- NR&TOT Cancellations $_{VSG}$ is the total Cancellation Minutes caused by Network Rail and TOT on the VSG.

6.2.1 Assumptions

We use the 'PfPI Minutes – AT' column in the PSS data provided, which includes only 'above threshold' (AT) minutes – excluding sub-threshold delays. This is assumed to sufficiently approximate similar calculations in PEARS.

6.2.2 TOC Responsibility Matrix

The purpose of the Responsibility Matrix is, for each VSG, to calculate the proportion of Network Rail and TOT delay and cancellation minutes caused by each PSG. This calculation also applies any service remapping to both the victim and responsible service codes. By comparing pre- and post-remapped data, we calculate the impact of remapping on the TOC/Network Rail share of delays, which in turn is an input to the Base Benchmarks calculations (see section 4.6).

The key calculation steps are:

1. Apply adjustment to Network Rail and TOT delays to reflect PEARS treatment of unexplained and uninvestigated 'Z-coded' incidents – responsibility is shared between Network Rail and the TOC affected; this adjustment reduces NR+TOT total slightly, and hence leads to a small increase in each perpetrating TOC's share.
2. 'Spread' minutes across any gaps in the raw data where PSG is 'invalid' (e.g., because not populated or inconsistent with Responsible Organisation) using distribution of minutes across valid data
3. Replicate the treatment of disputed minutes that is applied in the benchmark calculations (see section 5.4.5); disputed minutes in PSS are shown as TOC-on-Self responsibility with Attribution Status = 'Attribution Disputed'.
4. Apply the remapping to victim and perpetrator Service Codes
5. Aggregate minutes across the RT

6.2.3 Network Rail VSG Parameters

For all VSGs, we need the AML and DML parts of the Network Rail benchmark, as well as the corresponding Network Rail payment rate. The sources of these inputs are different for passenger TOCs than for freight and charter operators.

Passenger TOCs

The AML and DML parts of the Network Rail PM are outputs of the Base Benchmarks calculations, see section 5.

- The Network Rail AML $_{VSG}$ are the portion of the NR+TOT PM for the VSG due to NR+TOT Actual Minutes Lateness.
- The Network Rail DML $_{VSG}$ are the portion of the NR+TOT PM for the VSG due to NR+TOT Deemed Minutes Lateness.

The Network Rail Payment Rates for the VSGs (NRPR $_{VSG}$) are as output by the relevant model in 2023/24 price base, see section 4.

Freight and Charter

The freight and charter benchmarks are as output by the corresponding recalibration exercise for PR23. These benchmarks do not have AML and DML parts in the same way as those for the passenger SGs do:

- AML: This is the corresponding Freight or Charter benchmark, specified in terms of delay minutes per 100 train miles.
- DML: We have not incorporated the Freight and Charter cancellations benchmark in our calculations, see section 6.2.4.2 on Payment Rate Cost calculations.

For Freight and Charter as Victim, the NRPR are those provided by the ORR.

6.2.4 Freight and Charter as Victim

The Freight as Victim and Charter as Victim calculations differ from the TOC as Victim calculations for:

- Payment Rate Cost Delay
- Payment Rate Cost Cancellations

6.2.4.1 Freight and Charter: Payment Rate Cost Delay

The Freight and Charter Payment Rates for Delays are calculated as follows:

- Freight PR $_{Delay}$ = Freight delay values * Freight mileage ÷ (100 * annualisation factor)
- Charter PR $_{Delay}$ = Charter delay values * Charter mileage ÷ (100 * annualisation factor)

The Payment Rate Cost Delay calculations are then carried out in the same way for Freight and Charter as Victim as they are for TOC as Victim.

6.2.4.2 Freight and Charter: Payment Rate Cost Cancellations

In relation to Cancellations in the Freight and Charter performance regimes, those caused by passenger operators would strictly generate a cost to Network Rail. However, we agreed with ORR to follow the approach used for PR18, not to include Freight and Charter cancellations in the passenger TOC Payment Rate calculations, noting also that their contribution to payment rates would be small.

6.3 Worked example

A simplified illustration of TOC Payment Rates calculations is shown below. The contribution to PRC from the PSG’s delay minutes is calculated as follows:

$$PRC\ Delay_{VSG:PSG} = \frac{Delay\ Minutes_{VSG:PSG}}{NR\ \&\ TOT\ Delay\ Minutes_{VSG}} \times NR\ AML_{VSG} \times NRPR_{VSG}$$

				Delay Minutes Suffered by VSG						
TOC	VSG	PRC Delay VSG: AA01		Caused by AA01		Caused by Network Rail & TOT		Network Rail AML		NRPR
BB	BB01	£475	= (	5,000	÷	20,000	) x	1.9	x	£1,000
BB	BB02	£40		250		10,000		0.8		£2,000
BB	BB03	£643		2,000		14,000		1.5		£3,000
CC	CC01	£0		0		25,000		2.2		£5,000
CC	CC02	£1,448		3,000		58,000		2.8		£10,000

$$PRC\ Delay_{VSG:PSG} = £475 + £40 + £643 + £0 + £1{,}448$$

$$\boldsymbol{PRC\ Delay_{VSG:PSG}} = \mathbf{£2{,}606}$$

The contribution to PRC from the PSG’s cancellations is calculated as follows:

$$PRC\ Cancellations_{VSG:PSG} = \frac{Cancellations_{VSG:PSG}}{NR\ \&\ TOT\ Cancellations_{VSG}} \times NR\ DML_{VSG} \times NRPR_{VSG}$$

				Cancellation Minutes Suffered by VSG						
TOC	VSG	PRC Canc VSG: AA01		Caused by AA01		Caused by Network Rail & TOT		Network Rail DML		NRPR
BB	BB01	£175	= (	35	÷	240	) x	1.2	x	£1,000
BB	BB02	£75		5		120		0.9		£2,000
BB	BB03	£315		15		100		0.7		£3,000
CC	CC01	£0		0		400		0.3		£5,000
CC	CC02	£292		35		600		0.5		£10,000

$$PRC\ Cancellations_{VSG:PSG} = £175 + £75 + £315 + £0 + £292$$

$$\boldsymbol{PRC\ Cancellations_{VSG:PSG}} = \mathbf{£857}$$

With a TOC Benchmark of 1.5 for this dummy calculation the TOC Payment Rate is then calculated as:

$$TOC\ PR = \frac{\sum_{VSG=1}^{n}(PRC\ Delay_{VSG:PSG} + PRC\ Cancellations_{VSG:PSG})}{TOC\ BM}$$

$$TOC\ PR = \frac{£2{,}606 + £857}{1.5}$$

$$\boldsymbol{TOC\ PR} = \mathbf{£2{,}309}$$

7. Sustained Poor Performance

7.1 Overview

The ORR states that[2]: ‘The Sustained Poor Performance regime is intended to provide additional compensation to a TOC when lateness and cancellations attributable to Network Rail reach a specified threshold, beyond which it is considered the liquidated sums nature of Schedule 8 could start significantly to undercompensate the TOC. That additional compensation is measured in relation to the benchmark level of Network Rail’s performance.’

There are three steps of calculation:

1. SG Period SPP
2. TOC Period SPP
3. Annual Periodic Liability TOC

The difference between ‘Annual Value’ and ‘Annual Periodic Liability’ is explained in Step 3. We provide the formulas for each step following by a worked example at the end of this section.

7.2 Methodology

Step 1: Service Group Period SPP

The SG Period SPP is calculated as follows:

$$SPP_{SG,\ Period} = Network\ Rail\ BM_{SG} * NRPR_{SG} * Busyness\ Factor * Threshold_{SPP}$$

Where:

Network Rail BM $_{SG}$ = Network Rail Benchmark for the SG in a year

NRPR $_{SG}$ = Network Rail Payment Rate for the SG in a year

Busyness Factor = A parameter to convert daily Network Rail Payment Rates to a periodic figure. This is a constant value of 28.

Threshold $_{SPP}$ = The constant parameter that defines at what deviation from the Benchmarks should the Sustained Poor Performance regime be triggered. For Control Period 7, this value has been set at an absolute deviation of 20% above the benchmark.

Step 2: TOC Period SPP

The TOC Period SPP is calculated as follows:

$$SPP_{TOC,\ Period} = \sum SPP_{SG,\ Period}$$

The Period data is summed across the SGs by year to give the annual cost of being 20% above the Trajectory Benchmark across the entire TOC.

Step 3: Annual Periodic Liability Tapering

Annual Periodic Liability (APL) is provided for the third, sixth, tenth and thirteenth reporting period and gives a moving annual cost of being 20% above the Trajectory Benchmark based on the number of the 13

[2] Source of definition: http://orr.gov.uk/__data/assets/pdf_file/0004/16429/sustained-poor-performance-2014-11-14.pdf

periods that fell in the previous year (multiplied by that year's rate) and the number in the current year (multiplied by that year's rate). This Tapering is done as follows:

$$APL_{\,Year\,X,\,Period\,3} = 10 * SPP_{\,Year\,X\text{-}1} \quad + 3 * SPP_{\,Year\,X}$$

$$APL_{\,Year\,X,\,Period\,6} = 7 * SPP_{\,Year\,X\text{-}1} \quad + 6 * SPP_{\,Year\,X}$$

$$APL_{\,Year\,X,\,Period\,10} = 3 * SPP_{\,Year\,X\text{-}1} \quad + 10 * SPP_{\,Year\,X}$$

$$APL_{\,Year\,X,\,Period\,13} = 0 * SPP_{\,Year\,X\text{-}1} \quad + 13 * SPP_{\,Year\,X}$$

Special Case: 2024/25

As a result of the more significant changes in NRPR, it has been specified by ORR (following discussion with operators and NR) that the Tapering approach will also apply to Year 1 i.e., 2024/25 (Note: In Control Period 6, there was no Tapering in Year 1).

In 2024/25, the 'Year X-1' would use the NRPR and Network Rail BM, values from the last year of Control Period 6 (i.e., 2023/24), and the Network Rail BM from 2024/25. Therefore, the SG Period SPP for Year X-1, where X = 2024/25 is calculated as follows:

$$SPP_{\,SG,\,Period,\,2023/24} = Network\ Rail\ BM_{\,SG,\,2024/25} * NRPR_{\,SG,\,2023/24} * Busyness\ Factor * Threshold_{\,SPP}$$

7.3 Worked example

The example below uses three SGs to demonstrate the calculations to expand to a TOC-level. We show the SG Period calculations for Year X-1 (Table 7-1), Year X (Table 7-2), and then the Annual Periodic Liability in Year X (Table 7-3).

Table 7-1: Example Inputs – Year X-1

Phase	Network Rail BM	NRPR	Busyness Factor	SPP Threshold	SPP_{Period}
SG_A	1.0	£15,000	28	20%	£84,000
SG_B	3.0	£10,000	28	20%	£168,000
SG_C	2.0	£5,000	28	20%	£56,000
TOC					£308,000

Table 7-2: Example Inputs – Year X

Phase	Network Rail BM	NRPR	Busyness Factor	SPP Threshold	SPP_{Period}
SG_A	0.8	£15,000	28	20%	£67,200
SG_B	3.2	£10,000	28	20%	£179,200
SG_C	2.0	£5,000	28	20%	£56,000
TOC					£302,400

Table 7-3: Example Inputs – Annual Periodic Liability in Year X

Phase	Period 3	Period 6	Period 9	Period 13
Year X-1	10*£308,000	7*£308,000	4*£308,000	0*£308,000
Year X	3*£302,400	6*£302,400	9*£302,400	13*£302,400
Total	£3,987,200	£3,970,400	£3,953,600	£3,931,200

Appendix 1: Recalibration Timeframe Revenue Adjustment

Recalibration Timeframe Revenue Adjustment

The timeframe for the CP7 Schedule 8 recalibration base year is 2021/22 Period 8 to 2022/23 Period 7 (i.e., October 2021 to October 2022). This timeframe includes:

- A significant ramp-up in the demand recovery after the 2nd National lockdown and restrictions were slowly eased.
- Omicron related restrictions in 2021/22 Period 10.
- Recent periods of industrial strike action that affected a substantial number of services.

Direction was sought from the RWG on whether to adjust the Base Revenue (where Base Revenue is the revenue in the 2021/22 Period 8 to 2022/23 Period 7), and the most appropriate approach to make the adjustment. The recalibration project team calculated post-COVID revenue recovery by comparing revenue in current periods to equivalent period in the pre-COVID year 2019/20. Revenue recovery figures were provided by GBRTT and based on LENNON earnings data using the GBRTT / RDG definition of passenger revenue. The RWG was provided sight of this revenue recovery data at a RWG meeting and accompanying paper on this topic.

Revenue has gradually been recovering since the end of the second National Lockdown in 2020/21 Period 13. Since the start of 2023 Rail Year, revenue recovery (as a % of pre-pandemic levels) was relatively stable at c.80 – 85% of pre-COVID levels, and industry revenue recovery appears to have plateaued. Revenue in recent periods has been impacted by significant periods of local industrial action and National Rail Strikes. Revenue in strike periods (Period 3, Period 5, Period 7) has been around 75% of pre-pandemic levels.

Methodology for calculating uplift factor

Data from the recalibration period as a whole is uplifted to reflect revenue in the latter half of the same period. To uplift revenue in the recalibration timeframe, we are using recent periods of data to calculate a revenue recovery figure by TOC and / or SG (as applicable) for the recent more stable periods which is likely to be more reflective of revenue in CP7. We would assume that revenue throughout the RT would have reached this level of revenue recovery and uplift the data in the RT accordingly. The periods of recent data used to calculate an assumed revenue recovery for the recent periods are that 2022/23 Periods 1, 2, 4 and 6.

Worked example to calculate uplift factor for given TOC Z and service group and ticket type (as applicable)

- **TOC Z Recent Period Recovery Rate = 77% (of pre-COVID level)**
- **TOC Z Base Revenue Recovery Rate = 72% (of pre-COVID level)**
  - Periods used to calculate are 2022/23 Periods 1, 2, 4 and 6.
- Uplift factor for TOC Z = $\frac{\text{TOC Z Recent Periods Recovery Rate } \mathbf{77\%}}{\text{TOC Z Base Revenue Recovery Rate } \mathbf{72\%}} = 1.07$
- Adjusted RT revenues = RT revenues × uplift factor (1.07)
- A single uplift factor is applied to the whole recalibration base revenue rather than on a period-by-period basis as this is more robust means to handle the Marginal unallocated revenue (e.g., the bulk inputs to LENNON & contractual payments) that are settled in LENNON at different points across the year.
- We assume that that 2022/23 Periods 1, 2, 4 and 6 are likely to be most representative of the Recent Recovery Rate as these periods are not significantly affected by the strike action in 2022/23 Periods 3, 5 and 7. We identify whole periods (rather than days) to strip out, because the effect of strikes on 'LENNON settled' revenues is likely to affect revenues on the days around the strikes.

Multiple periods of non-strike data are used to calculate a revenue recovery (so is likely to reduce bias / variability between TOCs compared with using an individual period.) The uplift calculated from 2022/23 Periods 1, 2, 4 and 6 has been applied to the base revenue from the whole recalibration timeframe.

Appendix 2: Price Base Factor

Overview

The Price Base Factor adjusts for inflationary changes up to the NRPR Price Base. It does not adjust for any other impact (i.e., revenue growth).

ORR is using 2023-24 prices[3] in PR23. This is resulting in changes to the contractual terms of Schedule 8 as the initial charges and payment rates that will apply in 2024-25 need to be uplifted for one year of inflation (rather than two). This means that the 'initial indexation factor' is removed from Schedule 8. NRPRs (and resultantly TOC Payment Rates and Sustained Poor Performance thresholds) need to be uplifted for a further year of inflation to bring them to 2023-24 prices, and for that indexation methodology to be consistent with regulated access charges: ORR has advised that this will be the Consumer Price Index (CPI).

The recalibration year was not a financial year and therefore a technique was used to uplift each period accordingly to enable conversion to a full year.

Calculation steps for uplift factor

1. Calculate the CPI index base value for the recalibration period.
   - Weighted average of CPI index values from Oct 2021 to Oct 2022 (with the first and last months weighted as 0.5 and all months between weighted as 1).
2. Calculate the uplift factor between the CPI index base value for the recalibration period and the CPI index value for rail year 2022/23.
   - The average of the CPI index values from April 2022 to March 2023 (inclusive).
3. Apply the Network Rail Passenger Schedule 8 Regime inflationary uplift from 2022/23 to 2023/24 prices to the uplift factor calculated in Step 2
   - November 2022 CPI index value divided by November 2021 CPI index value, with the result rounded to 3 decimal places.

[3] If we were to follow the methodology in previous recalibration, PR23 would have expressed financial figures in 2022-23 prices.

Appendix 3: Busyness Factors to convert MREs to NRPRs

Overview

Busyness Factors measure the planned number of scheduled stops (as defined by the Schedule 8 Monitoring Points and their weightings) in the timetable for a Rail Period compared to the average number scheduled in the Bi-annual timetable. The sum of all the Busyness Factors across the RT is used to convert the Payment Rate into a daily rate (see Appendix 3).

Methodology

We use the sum of Busyness Factors (∑BF) across the RT as the divisor in the NRPR equation. We use ∑BF rather than number of days as ∑BF is better aligned with the formula for the calculation of performance payments.

By way of example, taking a given year in CP7 and assuming that Network Rail Performance Minutes for a SG exceed the Network Rail benchmark for the year by one minute:

- (a) The amount of revenue lost would be the MRE for that SG.
- (b) The total amount paid out will be SG NRPRs x ∑BF for that SG.
- If (a) equals (b), then MRE = NRPRs x ∑BF
- Rearranging this equation gives NRPRs = MRE ÷ ∑BF

If the Busyness Factor is increased in CP7 compared to CP6 for any reason (e.g., there are fewer engineering possessions), then it would be reasonable to assume that revenue would increase in the same proportion to the Busyness Factors. Therefore, there should be a higher amount paid out per minute over the Benchmarks (i.e., while NRPRs is constant the ∑BF increases).

Appendix 4: Semi-elasticity recommendations

For the initial draft of the NRPR, the following assumptions applied:

- The ORR approved the recommendations of the Revenue Sub-Group of the RWG that the CP7 Schedule 8 recalibration should use semi-elasticities for all flows. The rationale was described in the document: 'PR23 NRPR Proposal 20221201' (this has been made available separately to the Recalibration Working Group).
- A range of studies had been undertaken to determine the semi-elasticities, and the document 'Disruption Semi-Elasticities Recommendations Note v3.0' detailed how the recommended values had been derived (again, this had been made available separately to the Recalibration Working Group).

Subsequent to this, the ORR engaged with operators and Network Rail and approved a revised approach (as shown in document '2023-08-10 – Slides for S4&S8 PRWG'). This approach involved 'a single transitional adjustment to moderate the size of the change in Network Rail payment rates in CP7. This adjustment will apply 50% of the implied change in semi-elasticity between the PR18 and PR23 recalibrations.'

The text below describes how this revised approach was applied.

Step 1: Derive a PR18 Semi Elasticity

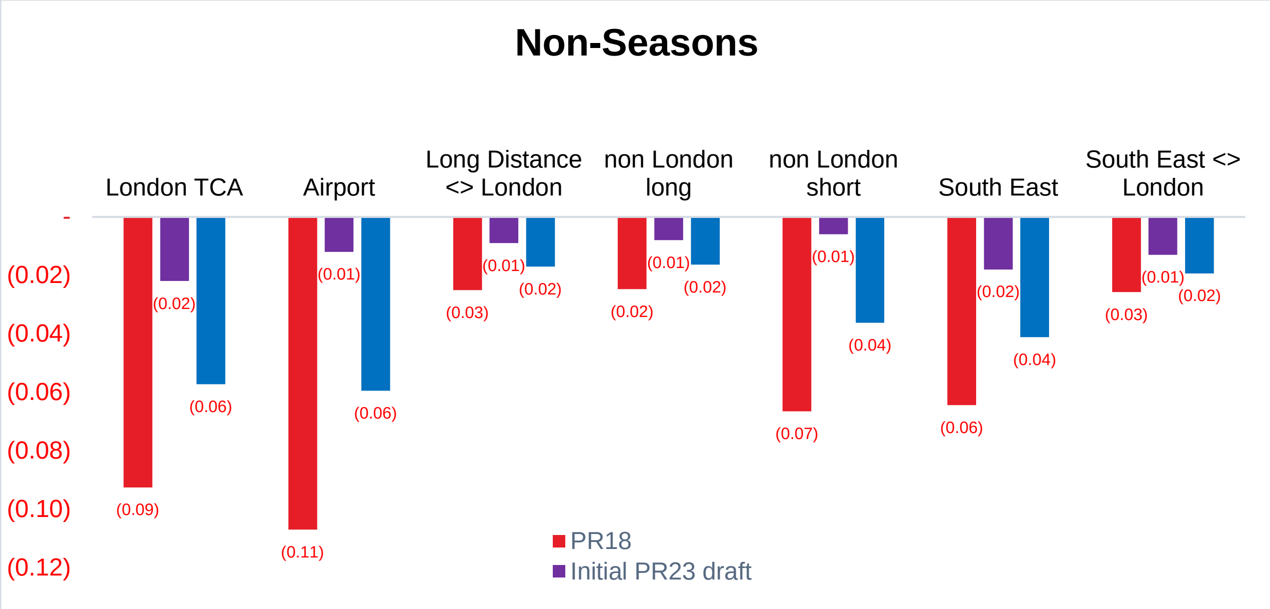
- Assign each RUDD data flow to one of the 7 PDFH segments, and hence to a Schedule 8 segment.
- Calculate the average Generalised Journey Time (GJT) for each Schedule 8 segment for Seasons and non-Seasons, weighted by revenue, across all RUDD data flows.
- By segment, convert the GJT into semi elasticities using the following formula:

$$Semi\ Elasticity = \left(1 + AML\ Change\ * \frac{PDFH\ Delay\ Multiplier}{Average\ GJT}\right)^{GJT\ Elasticity}$$

Step 2: Combine the PR18 Semi Elasticities with Steer-recommended PR23 Semi Elasticities

- Use existing PR18 semi elasticities for London TCA and South East to/from London, semi elasticities derived above for remaining segments.
- Combine the resulting PR18 semi elasticities and the previously recommended PR23 semi elasticities in an equal ratio:
- To calculate '50% of the implied change in semi-elasticity between the PR18 and PR23 recalibrations' for Segments which used Semi-Elasticities in PR18, a simple addition:
- *Hybrid Semi-Elasticity = 50%*PR18 Semi-Elasticity + 50%* Semi-Elasticity as per the 'Disruption Semi-Elasticities Recommendations Note v3.0'*

The figures below show the impact of this (noting that 'Initial PR23 draft' in the charts represents the previously recommended values and that 'PR23 Hybrid' represents the values used in the NRPR release for Near Final, the y-axis is the elasticity value.)


Non-Seasons
London TCA
Airport
Long Distance <> London
non London long
non London short
South East
South East <> London
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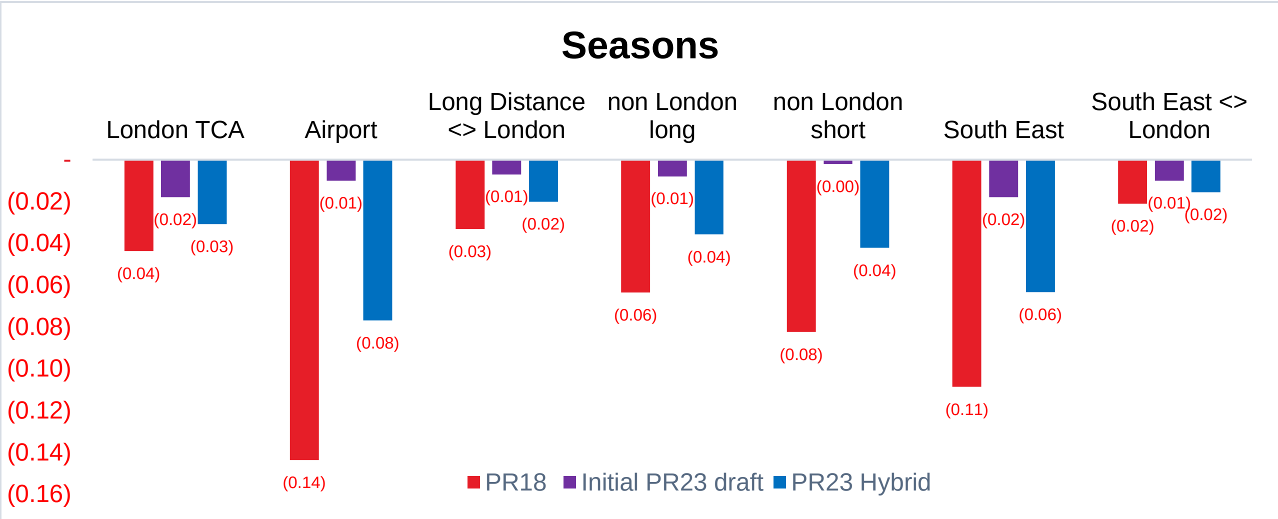
PR18
Initial PR23 draft


Seasons
London TCA
Airport
Long Distance <> London
non London long
non London short
South East
South East <> London
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PR18
Initial PR23 draft
PR23 Hybrid

Appendix 5: Peak Proportions

LENNON data does not provide any information on the actual time of travel. To allocate Revenue to PEARS Peak and Off-Peak categories, we applied modelling assumptions on the proportion of Seasons and Non-Seasons journeys that are made on services at Peak times of the day based on the methodology used in PR18. We considered both the PEARS Peak hour definitions as well as the variation in daily distribution of travel demand for London, ‘Core Cities’ and Other Stations (note that other stations is not applied in the modelling). Peak flows are defined in specific directions i.e., to Manchester in the am peak and from Manchester in the pm peak. Contra-peak flows are considered as off-peak. Table A5 shows the SG, City and City Type.

Table A5: Cities, City Type, Peak Hours of Operation and Service Groups

City	AM Peak	PM Peak	Service Groups
London	07:00 – 09:59	16:00 – 18:59	EB02, EB03, EB04, EB06, EB07 EF05 EJ05 EK01, EK02, EK03, EK04 ET01, ET02, ET03, ET04, ET05, ET08, ET09, ET10, ET12, ET13 ET11 timings to be confirmed. EX01, EX02 HO01, HO02, HO03, HO04 HT01 HY01, HY03, HY04, HY05, HY06, HY06, HY07, HY08
Manchester	06:00 – 09:30	16:00 – 18:30	ED08, ED10
Birmingham	07:30 – 09:00	16:30 – 18:00	EJ01, EJ03
Cardiff	06:31 – 09:00	16:01 – 18:00	HL05. HL05 also has a Saturday Peak, which includes departures and arrivals from Cardiff (i.e., Cardiff Central, Cardiff Queen Street or Cardiff Bay) from 09:01 to 17:00.

We note that the demand recovery has varied significantly between Seasons and Non-Seasons ticket categories. We have assumed that within Seasons the proportion between Peak and Off-Peak is similar to CP6. Similarly, we have similarly assumed that within non-Seasons that the proportion between Peak and Off-Peak is similar to CP6. The CP6 proportions were based on the ‘Calibrated Demand Profiles’ and ‘Calibrated Day of Week Splits’ from MOIRA2.2 (which were based on more recent information than that used in MOIRA 1). The Calibrated Demand Profiles table defines peak profiles in terms of the percentage of the total number of passengers that are travelling in 15 minutes time bands throughout the day. This is segmented by journey purpose, flow type and journey length. The Calibrated Day of Week Splits’, apportioned demand into Weekday, Saturday, and Sunday by Ticket Type.

Appendix 6: Calculating Lateness at New MPs

We developed two approaches for estimating lateness at new MPs.

Approach 1

Where data is available for new MPs during the RT a script was written in R to extract the data relating to those MPs from PSS. The key steps of this program are:

4. Import 2 years of train-level cancellations covering RT downloaded from Network Rail SharePoint
5. Process PSS data for new Monitoring Points (MPs) as provided by Network Rail from the On Time universe.
6. Merge with data for new MPs with cancellations, to assign responsibility for missed stops, and aggregate by Date and MP
7. Prepare outputs for export to Excel file I_PSS
8. Generate list of new MPs not found in On Time data for identification of Proxy MPs

The code outputs a spreadsheet called I_PSS with one row for every MP and date that trains ran showing the number of trains, total lateness and Network Rail / TOC cancellations.

Approach 2

Where no data is available, due to the MP not currently existing or no services calling there during the RT, an appropriate proxy MP has been identified. In these cases, the average lateness and cancellations from the corresponding Proxy MP selected are extracted and it has been assumed that services will call at these new MPs during CP7.

Identifying MPs with no data and selecting proxy locations

By comparing the full list of new MPs with those for which there was historical data in PSS, we identified 'missing' MPs with no historical data available. We then reviewed these one by one to determine appropriate Proxy MPs.

In some cases, selecting a proxy was straightforward: Kirkby is the obvious proxy for Headbolt Lane as it is less than 1km further down the line. In other cases, it was less easy, either because no service called at a similar station, or no similar service called at the same station, or both. These were address on a case-by-case basis.

Processing PEARS data for Proxy MPs

We then extract data from PEARS for these Proxy MPs and feed it back into our calculations to ensure we have lateness estimates for all proposed MPs. To do this, an R script was developed, and the steps of this process are outlined below:

- Loop through the PEARS input files for each Operator, extracting the tbl_H_MP_Headers table in the .mdb file provided.
- Filter PEARS data for the selected Proxy MP IDs by matching both the MP id and Peak Type
- Combine into a single dataset for all TOCs across the relevant RT.
- Map structure to the PSS format by extracting the relevant columns only (average lateness and cancellation percentages) and reordering/renaming as per the PSS data.

Finally, this data is appended to the I_PSS.xlsx file produced by the code described in Approach 1.