NETWORK MODELLING FRAMEWORK

Background Documentation

Overview Document

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1. INTRODUCTION

1.1 The Network Modelling Framework (NMF) is a strategic modelling tool designed to support DfT, ORR and Transport Scotland (the Client Group) in testing schemes or options as part of defining the High Level Output Specification (HLOS and SHLOS).

1.2 The model covers the entirety of Great Britain, with a consistent zoning system throughout the country. The model comprises a number of modules, some which existed prior to the start of the study (predominantly the demand modules), and others which have been developed specifically for the project (the TOC operating cost module) or in parallel to the project (eg the performance, safety and ICM modules). The NMF integrates all the modules in a complementary manner and allows interaction between them.

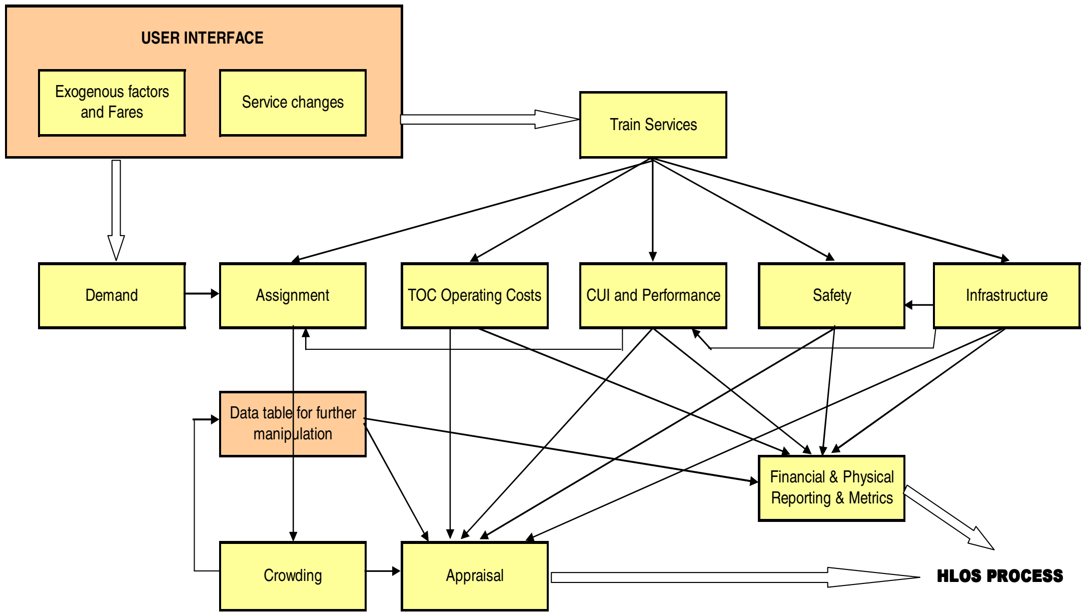
1.3 The Steer Davies Gleave and DeltaRail NMF teams were commissioned by the Client Group to develop the model and many of the constituent sub-modules, with the exception of the Safety Model (built by Risk Solutions on behalf of RSSB), the Infrastructure Cost Model – ICM (built by Network Rail), and the Performance Model (built by DeltaRail on behalf of Network Rail).

1.4 Since the NMF comprises a number of modules, some of which were not developed specifically for the NMF, the model was built using Oracle databases and Excel. The outputs are all provided in Excel format.

1.5 Figure 1.1 shows the NMF model structure. The User Interface allows the user to adjust the key drivers of demand (exogenous factors, fares and the timetable) and also allows the user to adjust some operating costs. The appraisal and financial and physical reporting is also called from this location.

1.6 The timetable specification drives changes in all modules, some of which are also inter-linked. For example, changes in performance impact upon demand and changes in infrastructure affect safety and performance. All modules feed the financial and physical, metrics and appraisal reporting.

FIGURE 1.1 NMF HIGH LEVEL MODEL STRUCTURE



1.7 Evolving during 2006/07, the NMF went through five stages of development after each of which a model was delivered to the DfT:

- NMF v0: a prototype model with little operable functionality (delivered March 2006)
- NMF v1.0: an operable model but which excluded the ICM, freight traffic and appraisal functionality (July 2006)
- NMF v1.01 (maintenance release): included appraisal functionality and more robust operating costs (August 2006)
- NMF v1.1: included the ICM, freight traffic, updated economic indicators and revised RIFF parameters (October 2006)
- NMF v1.2: provided improved station metrics, editing of the TOC Cost Data inputs and an improved Safety Model.
- NMF v1.3: includes consistent metric units, load factor reports based on total rolling stock capacities and additional functionality to employ the use of adjusted seating capacity (‘proxy’ seats) in the crowding algorithm.

Model Documentation

1.8 A User Guide is provided with NMF. This provides guidance on setting-up model tests including editing timetables, economic parameters and forecasts and some operating cost and appraisal indices. Supplementary guidance for timetable editing was also provided in an independent document (not developed for NMF).

1.9 Together with this Overview document, background documentation for the following modules was also provided:

- Demand (including crowding);
- Operating costs;
- Appraisal; and
- Financial and Physical reporting (including the baseline timetable and the ORR model).

1.10 This documentation provides detailed information on the methodologies underlying the NMF, the data used to populate the model and guidance on analysing model outputs.

1.11 Since the safety, performance and ICM were not developed by the SDG/DeltaRail team, detailed documentation for these modules is not included.

Summary Overview Document

1.12 This report provides an overview of the four aforementioned documents that comprise the background documentation, and should be sufficient for a user to gain an initial understanding of the model.

1.13 It is recommended that the user also reads the full background documentation, especially that which describes the demand modules, as although this overview provides a summary of the model (a more detailed summary is also included in the main volume), an understanding of the rationale behind the modules is important to fully understand and interpret the model. Furthermore, technical documentation setting out the overall software architecture and design is available.

Structure of Overview Document

1.14 This document comprises nine sections. Following this introductory section, the concept of the Baseline timetable is set out in Section 2.

1.15 Section 3 describes the demand module, including:

- the NMF network structure;
- how exogenous factors, fares and timetable changes impact on demand;
- the approach used to model crowding;
- the impact of performance on demand; and
- the calculation of passenger revenue.

1.16 Section 4 provides an introduction to the TOC operating cost module, including the assumed drivers of each type of operating cost, the source data used in the module (and how it was compiled) and guidance on interpreting the operating cost forecasts.

1.17 The NMF appraisal reporting is described in Section 5 and in Section 6 an introduction to the financial and physical reporting (the main outputs from the NMF) is provided.

1.18 Other, external, modules incorporated into the NMF are described in Section 7, whilst Section 8 provides an overview of traffic flows in the NMF.

1.19 Finally, Section 9 provides advice and guidance on the appropriate use of the NMF and sets out some key guidance for NMF users to ensure informed interpretation of results.

2. BASELINE TIMETABLE

Introduction

2.1 The Baseline Timetable is intended to be the starting point for all HLOS analysis and represents the timetable which will operate in 2009/10 as is currently committed.

2.2 This timetable is provided with each version of the NMF, in addition to the May 2004 timetable (which must be run in 2005 for all option tests) and the December 2005 timetable (which can be run in 2006 to validate the NMF operating costs and represents the starting point for the Baseline timetable). The Baseline timetable was agreed with DfT, ORR and Transport Scotland and represents the December 2005 timetable and amended as appropriate to reflect franchise commitments for 2009/10

2.3 The current Baseline assumptions were collated and agreed through a number of meetings during March and April 2007. The assumptions were discussed with a wide range of personnel at the DfT, plus key individuals from Transport Scotland and the SDG-DeltaRail project team.

2.4 It should be noted that the Baseline timetable is not the same as the “Basecase” timetable used in the Network Rail Initial Strategic Business Plan.

2.5 In order to be consistent with other studies undertaken on behalf of DfT, where possible the timetable information used in the Baseline was obtained from consultants working on these studies.

2.6 Detail on the changes from the December 2005 timetable incorporated into the Baseline timetable can be found in the Financial and Physicals documentation.

Changes Excluded from the Baseline Timetable

2.7 The following schemes are not included in the Baseline timetable specification.

- EM/WM/XC re-mapping;
- Draft, unpublished or un-contracted RPA/RUS recommendations;
- CTRL Domestic services;
- Crossrail, TL2K, ERTMS, IEP, ELL, Regional congestion charging, road schemes (except for the feed into average journey times);
- Olympics;
- New stations (Liverpool South Parkway, East Midlands Parkway, Chelsea Harbour, and White City and Ebbsfleet);
- Birmingham New Street enhancements;
- TfL initiatives and other PTE schemes;
- Airport expansion or Airtrack; and
- GARL, EARL, ‘Borders’, Edinburgh Tram.

2.8 Should the user wish to include these schemes in the NMF, the quickest way would be to include them as “overlays”, which the user can specify (in advance of any model run) using the NMF User interface. However, the quantification of the revenue and costs of these schemes must be available from other models, and in the NMF will only be recorded in the “Results” sheet, not in the other financials and physicals, metrics or appraisal results.

3. OVERVIEW OF DEMAND & ASSIGNMENT MODULE

Introduction

3.1 Demand forecasting is undertaken on an incremental basis, applying the forecasting methodology described in the Passenger Demand Forecasting Handbook (PDFH) 4.1, i.e. by starting with a known base year demand and applying a series of multiplicative factors to represent the incremental change in demand between the base year and each forecast future year. Each factor relates to the forecast impact of changes in one of the following:

- Exogenous factors (GDP per capita, employment, population etc)
- Private transport factors (car ownership, motoring costs, car journey times);
- Bus and underground fares and bus journey times and frequencies;
- Air fares, frequencies and air passenger growth;
- Rail frequencies, journey times, performance and crowding; and
- Rail Fares (based on PDFH 4.0 guidance).

3.2 In summary the process is as follows:

- The starting point is a Base Year matrix of flows between a set of origins (O) and destinations (D):
  - The base year is financial year 2004/5;
  - The Base Year O-D matrix is also segmented by ticket-type (Full, Reduced & Seasons) and contains both revenue and passenger journeys;
- Most demand drivers are applied directly to the O-D matrix to create a future year O-D matrix. This applies to:
  - exogenous factors (which impact differentially by geographical area);
  - fares (which are set between pairs of stations); and
  - timetable changes (which affect the opportunities to travel between each origin and destination).
  - The resulting future year O-D matrix is, however, incomplete as other demand drivers are applied at network level.
- O-D demand and revenue is assigned to a representation of the rail network, segmenting between sections of route, groupings of rail services, time periods, and combinations of these:
  - this has to be done for the base year as well as for future years;
  - the process for assigning demand is based on a simplified version of ORCATS, the model used to allocate ticket sales to services as part of the Rail Settlement Plan (RSP) process;
  - allocations are based on the May 2004 weekday timetable;
- Performance and crowding demand impacts are applied at network level because they affect particular groups of train services, particular sections of the network and/or particular time periods.

3.3 Demand that has been allocated to the network is described in this documentation as Network Usage to distinguish it from demand at an O-D level. Similarly, allocated revenue is referred to as Earnings.

3.4 The ultimate output of the forecasting process is Network Usage and Earnings. These can be aggregated to give results by TOC and Strategic Route Section (SRS), or sub-divisions of these, and also categorised by peak, shoulder-peak and off-peak periods (for most parts of the network).

3.5 However, segmentation by O-D flow and ticket-type is maintained at network level so that results can be aggregated on this basis for use in the Appraisal module.

3.6 The forecasting approach is only suitable for use where there is an existing base level of demand – it does not extend to forecasting the impact of new stations or lines. Where these are planned for future implementation, their effect can only be represented in the form of an overlay in the NMF.

3.7 The forecasting process can therefore be broken down into the following stages:

- Creation of base year O-D matrix (already setup within NMF);
- Creation of Base Year timetable (already set up within NMF) and Future Year timetables (editable by users);
- Allocation of demand to the network (using the MOIRA model);
- Forecasting the impact of Exogenous Factors and Fares (RIFF model with user-defined inputs for Future Years);
- Forecasting the impact of Timetable Changes (using the MOIRA model);
- Forecasting the impact of Performance (drawing on performance changes from the Performance module);
- Forecasting the impact of Crowding (drawing on seating capacity information held in the timetables); and
- Outputs are passed to the Appraisal Module and the Financial and Physical Reporting Module.

Base Year O-D Matrix

3.8 The Base Year O-D matrix represents annual demand and revenue in the 2004/5 financial year (1st April 2004 to 31st March 2005). It is a fixed element of the NMF that does not change from run to run.

3.9 The origins and destinations in the matrix are groupings of stations into 566 Demand Zones.

3.10 The matrix is therefore a representation of trips on the rail network and does not identify the ultimate origin and destination of trips. As such it will not deal with opportunities for rail-heading to alternative stations. There are two exceptions to this:

- Central London (Travelcard zone 1) is divided (based on the 1991 LATS survey) into 18 zones representing the ultimate origin and destination of trips, and each of these are connected to London termini and certain other NR/LUL interchange stations by "walk links" (actually representing the journey time by all forms of access, typically tube);
- Some origins and destinations are ticketed as groups (e.g. Enfield Town and Enfield Chase) and in these cases the "group station" is linked to all the component stations by walk links

3.11 The matrix contains revenue and passenger journeys for the 566 x 566 O-D pairs, and is further sub-divided by ticket-type (Full, Reduced and Seasons). Intra-zonal demand and revenue is held in the matrix but does not currently flow through to network level as the assignment process excludes intra-zonal flows. This will cause a small under-statement in aggregate revenue (by 1.2%) and journeys (by 5%) in the final metrics. At a TOC level, the variation may be more or less than this, depending on the nature of the TOC (see the demand documentation for further details).

3.12 The matrix is derived from LENNON ticket sales data. However, as there are known omissions in this data in respect of TfL and PTE zonal tickets, and non-Rail Settlement Plan (RSP) tickets on some airport services, we have undertaken a matrix infilling exercise to estimate a complete 2004/5 O-D matrix. This is based on using LTS data for infilling within London and PTE specific data on rail ticket sales not included in the standard MOIRA matrix for infilling within the various PTE areas. Different methods for infilling for airport traffic were employed depending on the particular circumstances and data available for each airport. More detail on the in-filling process can be found in Chapter 3 of the Demand and Assignment Background Documentation.

Network and Timetables

3.13 The NMF Demand Zones represent a grouping of stations with one station assigned as the Primary station in that zone. The links between the NMF Demand Zones, as represented by the primary stations, are Demand Sections although there is a subtlety here as some Demand Zones contain interchange stations (this is mainly in cities such as Manchester, Birmingham, Liverpool and London but also in other towns where the are more than one station e.g. Dorking, Enfield, Hertford) which are also explicitly represented in the underlying network. So NMF Demand Zones and selected interchange stations are linked by Demand Sections forming a representation of the rail network. One of the criteria in defining Demand Zones was that the associated Demand Sections should be capable of being aggregated to approximate closely to Network Rail's Strategic Route Sections, so that results can be reported by Strategic Route Section.

3.14 A Base Year timetable (May 2004), and a Baseline timetable (December 2005 plus committed service changes) are already set up within NMF. Any of these may be edited using Timetable Editor to create alternative Future Year timetables. In NMF only weekday timetables can be modelled and these combined with demand profiles are used for assignment purposes.

3.15 Each train in each timetable has a common 4-digit code associated with each segment of its journey (i.e. between consecutive station stops). The structure of this code is that the first 3 digits are derived from the LENNON service codes used by RSP and TOCs to identify services for revenue allocation purposes, and the fourth digit is used by NMF to classify the service by time period to facilitate the production of capacity metrics, and the crowding calculations. This fourth digit is called the Peak Type.

3.16 To define the Peak Type, each Demand Section can be associated with a destination station, and demand and capacity on train services passing over that Demand Section can then be classified according to whether they arrive at or depart from the associated station in the AM or PM peak or shoulder-peak periods. Associated stations have already been set up in NMF for most Demand Sections (with those having no associated station being considered as not likely to experience any material crowding), but may be modified by the user. No crowding calculations or sub-division of capacity metrics by time period is undertaken for Demand Sections where no associated station has been set up.

3.17 The NMF uses the associated station information for each Demand Section to define the Peak Type for each train over each Demand Section prior to passing the timetable onto the assignment process. The resulting composite 4 digit code is referred to as a Service and Time Period code (or STP code) in this documentation. Where the term Service Code is used in the Demand Module it refers to the first 3 digits of the STP code.

3.18 Where a train segment traverses more than one Demand Section, the NMF assumes that the shortest route is taken so that every train service can be broken down into a series of consecutive Demand Sections, each with an associated STP code.

Assignment

3.19 The way that demand flows over the network and loads onto train services is determined by the timetable in operation, together with assumptions about when people making different types of journey would like to travel ("demand profiles").

3.20 Assignment of revenue and journeys to create Earnings and Network Usage by Demand Section, Service Code and Peak Type is undertaken using a special version of the MOIRA model based on the 566 NMF Demand Zones. Only the timetable processing part of MOIRA is used, which is not visible to the user – the user interface screens that MOIRA users will be familiar with are actually part of the Timetable Editor MOIRA module, which is replaced by Timetable Editor in NMF.

3.21 MOIRA is designed to produce allocations of demand for each O-D flow, by ticket type, to combinations of Demand Sections and LENNON service codes, so by incorporating the Peak Type classification in the STP code, MOIRA can assign demand by Demand Section and STP Code, and from this allocations by Demand Section, Service Code and Peak Type can be obtained.

3.22 MOIRA uses the ORCATS algorithm to allocate demand, as described in the following paragraphs. ORCATS is used by RSP to calculate allocations of revenue and journeys to individual service codes for the settlement process between TOCs, and so the assignment process in NMF is consistent with that used for most transactions in the RSP settlement process. However, there are some types of allocation that are handled in a simplified form by MOIRA or for which ORCATS allocations are not used by RSP, these include:

- Routed fares – effectively all allocations are based on "any reasonable route";
- Travelcard allocations are simplified; and
- TOC dedicated tickets, allocated 100% to one TOC in RSP systems, are not recognised by NMF and are allocated under ORCATS assumptions.

This has some implications for assignment results within the NMF, which the user should be aware of when interpreting results. Further information is provided in section 9.

3.23 For each timetable, MOIRA considers all the Opportunities to Travel (OTTs) between each origin and destination Demand Zone. These include both direct train services and those involving up to 4 interchanges, but with elimination of any overtaken services, unless these provide fewer interchanges. Walk links are also allowed when constructing OTTs.

3.24 MOIRA contains demand profiles for different types of O-D flow and ticket-type. These demand profiles break down demand by 15 minute intervals through the day, For each O-D flow and ticket-type, and for each 15 minute period MOIRA calculates the Generalised Journey Times (GJTs) for use of alternative OTTs as the sum of the overall journey time plus penalties for any interchanges and for travelling earlier or later than the desired departure time.

3.25 For each O-D flow, ticket-type and 15 minute interval MOIRA then applies the ORCATS model to allocate a proportion of demand to each OTT. The ORCATS model is a logit model aiming to forecast the choices that passengers wishing to travel at a particular departure time would make given the alternative OTTs available to them. Then, by aggregating over the whole day, total allocations can be derived for each OTT. Demand is then allocated within each OTT pro rata to distance to get revenue allocations by Demand Section and STP code

3.26 There is a distinction between the way that the allocations are applied to revenue (to create Earnings) and Journeys (to create Network Usage):

- Revenue allocations combine percentage splits between alternative OTTs with percentage splits by distance to the Demand Section/STP code combinations within each OTT and can therefore be aggregated to TOC or service group totals, Demand Section or Strategic Route Section totals, or any combination of these;
- Network Usage counts each journey once over each Demand Section traversed in order to measure the total annual loads over that section (which can be further segmented by STP code, and therefore also by Peak Type, Service Code or TOC). It will therefore multi-count the same journeys over different Demand Sections, and aggregation by TOC, for example, only makes sense for individual Demand Sections, to measure total TOC journeys over that section.
- Passenger-kilometres on the network are also computed by multiplying Network Usage for each Demand Section/STP code combination by the length of the Demand Section in kilometres. This calculation is based on distances between the representative stations (principal stations representing Demand Zones or interchange stations) and these may differ slightly from the "true" average distances to/from all stations within a Demand Zone.

3.27 The allocations for any timetable can be applied to any NMF Future Year O-D matrix to calculate Earnings and Network Usage if that timetable applied in the corresponding Future Year. However, the Base Year allocation must always use the Base Year timetable with the Base Year O-D matrix to ensure consistency between NMF policy tests.

Exogenous Factors and Fares

3.28 The impact of these demand drivers is forecast at a more aggregate geographical level than the 566 x 566 matrix using two specially created versions of the RIFF-Lite model. RIFF stands for "Rail Industry Forecasting Framework" and RIFF-Lite was designed to forecast "background growth" factors using the PDFH forecasting framework.

3.29 The reason for having two RIFF-Lite models is to allow more detailed geographical coverage of Scotland without losing granularity in England and Wales. The two models are used as follows:

- The Great Britain model consists of 69 zones and is used for O-D flows within England & Wales and also cross-border flows;
- The Scotland model consists of 61 zones and is used for internal flows within Scotland.

3.30 Each RIFF-Lite zone corresponds to a number of NMF zones, so that outputs from RIFF-Lite, in the form of growth factors by RIFF O-Ds and ticket-type can be expanded and applied to the full 566 x 566 matrix by ticket-type.

Timetable Changes

3.31 The impact of timetable changes is also forecast by using the MOIRA model, though a slightly different algorithm is used to ensure compatibility with the demand growth methodology recommended in PDFH. GJTs for each OTT are calculated as before, and the resulting profile of GJTs forms what is known as the "Rooftop Model". MOIRA calculates an average GJT value for each O-D flow by ticket-type as an average of the GJTs for each OTT, weighted by the demand allocated to the train.

3.32 This is done for the base timetable and each future timetable. Demand changes between the base timetable and the future year timetable are calculated by comparing the two GJTs for each O-D flow and ticket-type and applying a GJT elasticity.

3.33 This demand growth may be phased over a number of years using assumptions provided by the user about the percentage of demand growth that occurs in the year of timetable introduction and each successive year. These phasing assumptions apply across all O-D flows and ticket-types. The process for defining alternative demand build-up assumptions in the NMF is described in the User Guide.

3.34 The timetable growth phasing assumptions may also require additional forecast years to be included in the model run, e.g. if demand is phased over three years then each timetable introduction year and the following two years are automatically included as forecast years in the NMF run. The current default is that 100% of demand growth occurs in the year that the timetable is specified to commence (which could be the year following the actual commencement date, for example, to provide an approximation to phasing over two years from introduction).

Performance

3.35 The approach applies the methodology set out in the PDFH 4.1 (Chapter B4, Reliability). This translates average minutes lateness (AML) into equivalent minutes of generalised journey time (GJT) by applying a weighting factor (multiplier). The change in demand as a result of a change in AML is estimated by expressing the GJT equivalent of the change in AML as a proportion of a base GJT and applying a GJT elasticity. The multiplier is normally set to 3, as recommended by PDFH, but may be varied by the user. Also, an alternative set of multipliers varying by type of train service is recommended by PDFH and this set of parameters is also available as an alternative input. However, the model would normally be run with the multiplier set to 3 for all types of services.

3.36 AML are aggregated to Schedule 8 performance group, which the model translates to link level and then aggregates to O-D and ticket type.

Crowding

3.37 The demand and assignment processes (plus the performance calculations) determine semi-constrained network usage by Demand Section and STP code – semi-constrained meaning that it is a combination of base demand (which is constrained in places already) and unconstrained growth. The STP code also defines a classification by time period (peak type).

3.38 **It should be noted that, consistent with and implicit within the PDFH methodology, passengers who are crowded off a train are not assumed to transfer to other rail services, they are simply "lost" to the rail network.**

3.39 The NMF also calculates the total number of seats by Demand Section and STP code. This is used to calculate the seated load factor, which is the basis of the crowding penalties in PDFH 4.1. Functionality in v1.3 was extended so that the user can specify which set of seating capacities are used in the crowding: true seats or proxy seats. Proxy seats allow the user to reflect the impact of different seating:standing ratios from that implied in the PDFH. For example, high density stock, which has a lower number of seats for a given total capacity, is typically given a higher value for proxy seats than true seats so that at higher loadings, the crowding impact is lower than would be the case if the PDFH guidance is taken as face value.

3.40 The process of "crowding off" uses pre-calculated crowding curves that define the relationship between constrained and unconstrained load factors. These curves are used in two ways:

- To calculate "uplift factors" to compensate for the impact of crowding in the base year, which would otherwise be reflected in "unconstrained" forecasts of network usage in future years. In this case we observe the constrained load factor in the base year and look-up the corresponding unconstrained load factor;
- To calculate "suppression factors" in future years to allow constrained forecasts of network usage to be derived from the unconstrained forecasts of network usage resulting from the allocation of the future year O-D matrices (and application of the uplift factors). In this case we forecast the unconstrained load factor and look-up the corresponding constrained load factor.

3.41 These calculations are done for each demand section segmented by 4 digit STP code (incorporating peak type as the 4^{th} digit). The options exist for each demand section are as follows:

- Crowding calculations may be switched off to improve model performance on demand sections where crowding is unlikely and crowding metrics are not required as outputs (peak type 0);
- Crowding calculations are undertaken separately for the AM and PM weekday peak hours, and the AM and PM shoulder-peak hours – in this case a station must be defined to be associated with the demand section, and AM arrival/PM departure times at this station determine the peak type (1-4).
- Similarly, at other times of the day peak type 5 is designated (although this is not currently carried through to instigate crowding calculations within NMF).
- Where an all-day crowding calculation is required (typically inter-urban services) then peak type 6 is used.

3.42 The calculations are only undertaken for weekday network usage. MOIRA is used to estimate the proportion of demand on each O-D that is on a weekday (the de-annualisation process assumes 260 weekdays per annum), using the ORCATS demand profiles, and hence the proportion of network usage on a weekday for each Demand Section/STP code combination. The weekday component of annual unconstrained network usage is de-annualised for the purposes of the crowding calculations, the equivalent constrained network usage calculated, and then re-annualised and re-combined with the weekend element of network usage.

Outputs

3.43 At the end of the assignment process for each year, revenue, passenger-kilometres and network usage are held by O-D flow, Ticket-Type, Demand Section, and STP code, and this level of dis-aggregation is maintained throughout the performance and crowding calculations. Generalised journey times corresponding to the timetable in operation, and the corresponding demand indices are held at O-D-Flow and Ticket-Type level.

3.44 Revenue, passenger-kilometres, generalised journey times (split by service changes and performance changes (for which the performance index, average minutes lateness and AML multiplier are held) crowded and un-crowded demand by year are aggregated (where necessary) up to O-D flow and ticket-type level and passed to the Appraisal Module for calculation of benefits.

3.45 Revenue, Network Usage, passenger-kilometres, seat numbers and kilometres, and load factors are summarised by Demand Section and STP code (bearing in mind that Network Usage cannot be summed across demand sections) to produce various financial and physical reports and the HLOS capacity metrics.

Summary

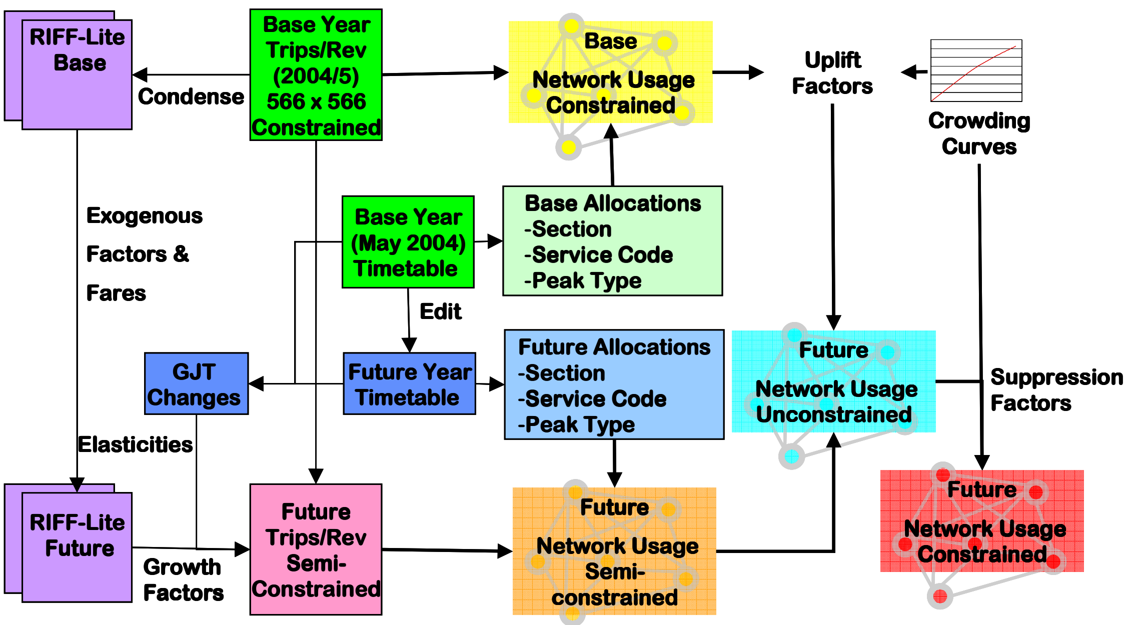
3.46 Figure 3.1 summarises the processes described in this chapter;

- A Base Year Matrix of trips and revenue by O-D flow and ticket type and a base year timetable have already been set up within NMF (green boxes);
- Base allocations to Demand Sections, Service Codes and Peak Type are derived from MOIRA (light green box) and used to quantify Base constrained Network Usage (yellow box with shading) and also Earnings (not shown);
- Two versions of RIFF-Lite (Great Britain and Scotland versions) are used to

forecast the impact of exogenous factors and fares at a more aggregate level than the full 566x566 matrix (purple boxes);

- Future Year timetables are created by the user (e.g. by editing the base timetable) and the GJT changes compared with the base timetable are used to forecast demand growth at the 566 x 566 matrix level, and combined with the RIFF-Lite growth factors (blue boxes);
- Future Year allocations to Demand Sections, Service Codes and Peak Type are derived from MOIRA (light blue box) and used to quantify Future Year semi-constrained Network Usage (orange box with shading) and also Earnings (not shown);
- Performance calculations are then undertaken at service code level (not shown on the diagram to simplify presentation);
- Base Year Network Usage, combined with the Crowding Curves are used to estimate the degree and location of suppressed demand in the Base Year, expressed as Uplift Factors – these are applied to Semi-Constrained Future Year Network Usage to get an estimate of true Unconstrained Future Year Demand (turquoise box with shading)
- The Crowding Curves are used again to get suppression factors to convert Future Year Unconstrained Network Usage to Constrained network Usage (red box with shading)
- Pro-rata adjustments are made to get constrained Earnings, and required outputs are passed to the Appraisal module by O-D flow and ticket-type and to the Metrics calculations by Demand Section, Service Code and Peak Type.

FIGURE 3.1 SUMMARY OF DEMAND ASSIGNMENTS AND ASSIGNMENT MODULE PROCESSES



Other Revenue

3.47 The NMF also includes "Other Revenue" to allow the complete representation of industry revenue and to provide an indication of the impact of a scheme on "Other Revenue". The definition of "Other revenue" is consistent with that in TOC management accounts, including such items as car park revenue, commissions and station maintenance.

3.48 The input data for Other Revenue was created by analysing historic (2004/05) data from the DfT's ORACLE database of rail industry costs and the forecasts contained within a number of Comparator Models.

3.49 The basic process is set out in the 4 stages below, although it does not cover data cleaning and re-mapping. Stages 1 to 3 generate the base 2004/05 data and the 4th stage generates the forecasting parameters.

- Compare ratios of other-to-passenger revenue by TOC in ORACLE. Focus on very high/low ratios.
- Analyse ORACLE other revenue. Focus on TOCs with limited or no dis-aggregation (e.g. MML) and who allocated a lot of revenue to 'other other'.
- Remove known one-offs, and performance and subsidy income. In-fill where necessary using Comparator Models.
- Determine the proportions of other revenue driven by passenger miles, train miles and flat by firstly grouping lines items and then comparing the assumed growth rates for similar line items in Comparator Models.

3.50 Group line items according to what the driver of changes in the revenue is assumed to be:

- Catering, Commissions, Sales (Passenger miles);
- Maintenance, Station (Train miles); and
- Other (Flat).

3.51 Changes in "Other Revenue" are forecast according to timetable and demand changes, and are reported as a separate line item in the results of each NMF test.

4. TOC OPERATING COSTS OVERVIEW

Introduction

4.1 The NMF TOC operating cost module (which forms part of the NMF Oracle database) provides estimates of the changes in operating costs for a TOC based on a user defined timetable and assumptions that can be varied by the user in the NMF front-end.

4.2 Operating cost forecasts are calculated for 23 line items (shown in Table 4.1) for each TOC and for every year for which the NMF is run. In NMF v1.1 and above, those items in italics are replaced with the Network Rail Net Revenue Requirement estimate, which is calculated by the ICM and ORR model, and reported as part of the operating costs reports in the financial and physicals standard reporting.

TABLE 4.1 OPERATING COST CATEGORIES MODELLED IN NMF

Staff	Rolling Stock	Network Rail costs	Station costs	Other
		Physicals		
Number of On-train staff (by stock type)	Train and Unit miles (by stock type)			
Number of Station staff	Train and Unit hours (by stock type)			
Number of "other" staff	Peak Unit hours (by stock type)			
	Seat Miles (by stock type)			
		Financials		
On-train staff salaries	Capital lease costs (by stock type)	*Variable track access costs (VTAC) (by stock type)*	*Station & Depot Long Term Charge (LTC) (Major Stations)*	Other Costs
Station Staff salaries	Non-capital lease costs (by stock type)	*Electric Current for Trains (EC4T) (by stock type)*	*Station & Depot LTC (SFO)*	Diesel (by stock type)
Other staff salaries	Maintenance costs (by stock type)	*Fixed track access costs (FTAC)*	*Station & Depot LTC (TOC)*	*Capacity charge*
Redundancy costs		*Supplementary Charge*	Station maintenance	Commission TOC
NI Pensions Overhead				Commission Other
				Performance DfT
				Performance NR

4.3 Whilst the TOC Operating Cost Module (TOCM) is an integral part of the NMF model, a second suite of models, the Operating Cost Input Spreadsheets (OCIS), are used to convert operating cost input data into a format that is input into the NMF to form the base data for the TOCM. Whilst these OCIS files are provided as part of the background documentation (although the data contained within them is extremely confidential and so the files may not be provided to users as a matter of course), they are not part of the NMF model, and the only reason for the user to refer to them is to interrogate the original source of the operating costs in detail.

Drivers of Changes in Operating Costs

4.4 The approach used by the NMF to estimate operating costs is to define a set of "drivers of change" for each line item based on evidence of how costs vary in practice (these are summarised in Table 4.2). The majority of costs are driven (at least to some extent) by the timetable (including train formations) which is operated, however some costs are assumed to be fixed.

4.5 Where appropriate (this is often where costs do not vary with train service), the user is able to define an efficiency factor to reflect some changes which might occur in reality but which cannot be modelled in an automated way. For example, the user station staff costs do not vary with train service but can be adjusted using an efficiency factor (to reflect a scenario where a TOC encourages a move to the use of self-service ticket machines instead of manned ticket windows, or the introduction of driver operation only). Other examples of these efficiency factors are those to reflect changes in oil or electricity prices (which will affect traction costs).

TABLE 4.2 SUMMARY OF DRIVERS OF TOC OPERATING COSTS

NMF Operating Cost Item	Primary Driver	Secondary Driver	Tertiary Driver
On-train staff salaries	Train hours by stock type		AEI
Station staff salaries	Efficiency assumption		AEI
Other staff salaries	30% fixed , 70% vary by on-train staff	Efficiency assumption	AEI
Redundancy	Change in staff numbers	Staff retention rate	% of annual salary paid as redundancy
Capital Lease costs	Change in peak unit hours by stock type		Fixed in nominal terms
Non-capital lease costs	Change in peak unit hours by stock type		RPI
Maintenance costs	Change in unit miles by stock type	Efficiency assumption	AEI
VTAC	*Change in unit miles by stock type*		*RPI*
EC4T	*Change in unit miles by stock type*	*Efficiency assumption (to reflect price of electricity)*	*Fixed in nominal terms*
FTAC	*ORR defined values for 2005/6 -2008/8, thereafter fixed in real terms*		
Supplementary Charge	*Fixed*		*RPI*
Station & Depot LTC (all categories) and qualifying expenditure	*Fixed*		*RPI*
Station maintenance (SFO stations)	Fixed	Efficiency assumption	RPI
Other costs	30% fixed, 40% vary with train hours, 30% vary with on-train and station staff	Efficiency assumption	RPI
Diesel	Change in unit miles by stock type	Efficiency assumption (to reflect oil prices)	Fixed in nominal terms
Capacity charge	*Fixed*		*RPI*
Commission	Fixed		RPI
Performance	Fixed		RPI

Calculation of Operating Costs in the NMF

4.6 For each year that the user specifies that NMF should be run, the timetable specified for that year (by the user) is interrogated automatically by the model to produce a set of dataseries which will be used to drive costs, for example, peak train hours / train hours and unit miles by stock type and TOC (after completion of the model run this information can be viewed in the "Results" sheet of the Financial and Physicals reporting if the user chooses).

4.7 The TOCM contains unit cost information, resource rates and timetable dataseries for the timetable that was operated in practice in 2005/6. The cost information was obtained from three main sources:

- TOC franchise models (usually comparator models)
- The Network Economics Model (incorporating ORR published cost rates)
- The DfT rolling stock database ("BRAIN")

4.8 The timetable information was obtained from the NMF Timetable Editor database, where it was assumed that the December 2005 timetable operated throughout 2005/6.

4.9 In the OCIS suite of models the cost information is converted into unit cost information using the source cost data and the timetable information. Resource rates (for example the number of on-train staff per train) was calculated from a combination of resource information provided in the source data and the timetable information. The output sheets of the two main OCIS files show the unit cost rates (and default efficiency factors) that are contained in the NMF database and used by the TOCM.

4.10 The NMF forecasts operating costs based on the timetable datasets produced for each timetable specified and a combination of unit cost rates, resource rates, efficiency factors and economic indicators (eg RPI and AEI).

Cost Escapability

4.11 In addition to the drivers of operating costs previously mentioned, costs are also affected by assumptions regarding the escapability of costs. Lease costs (both capital and non-capital) are assumed not to be escapable until the end of the lease. Therefore the user may make a change to a timetable which implicitly reduces the volume of fleet required, yet will not see a reduction in costs until a number of years after the timetable change. Model users should be aware that if a timetable change is implemented in the NMF, the effect of adding carriages to a train may involve new lease costs, while reducing the number of carriages may not involve an immediate cost saving.

4.12 Similarly, the model assumes that some staff will need to be made redundant as a result of reducing the number of carriages on a train, incurring redundancy costs; in practice this may not occur.

Validation of TOC Operating Costs

4.13 Within the OCIS three main categories of operating costs (staff costs, rolling stock costs and Network rail costs) are calculated based on the derived cost rates and the timetable information. These were compared to the totals from the source data to validate the model outputs. Other costs are then assumed to be the difference between the sum of these cost items and total TOC operating costs. In general the proportion of total costs accounted for by these other costs appeared credible.

4.14 For the user to assure themselves that the NMF reproduces the 2005/6 TOC operating costs, a timetable run of the December 2005 timetable in the NMF 2006 year should be undertaken.

Reporting and Analysis of Operating Costs

4.15 Operating cost forecasts are presented in the standard Financial and Physicals report which the user requests at the end of each run. The following sheets are most relevant:

- TOCRevOpex: Operating cost forecasts by TOC for each modelled year
- TOCOxex: Operating cost forecasts for each line item for any TOC selected for any modelled year
- Physicals: Timetable summary information (eg peak train hours) for any TOC specified
- Results (ensure that the report has not been specified as a "comparison" report): Operating cost and timetable information split (for many items) by stock type for any TOC specified
- KPIs: Average cost per train mile, implied staff salaries etc for any TOC and modelled year.

Guidance on Using the TOC Operating Cost Module

4.16 Firstly, to produce a full set of operating cost forecasts it is necessary for the user to run both the demand module (and therefore the performance module) and the operating cost module. This is because commission costs (an operating cost line item) vary according to passenger demand. In NMF v1.1 and above it will also be necessary for the ICM and ORR model to be run.

4.17 There are three constraints of the cost module that the user should consider when specifying and coding a timetable:

- Operating costs are only calculated for those stock types currently in use by that TOC
- A user is not able to introduce new rolling stock types into the model.
- It is not possible to adjust unit costs or resource rates

4.18 The user should also note that the NMF forecasts rolling stock requirements based on the proportional change in peak unit hours, a diagramming exercise is not undertaken. For this reason it was decided not to report the number of units of each stock type required as this would have implied a level of detail/robustness that does not exist.

4.19 Furthermore, the NMF assumes that each TOC has an unconstrained supply of staff and each type of rolling stock.

5. APPRAISAL MODULE OVERVIEW

Introduction

5.1 The appraisal module of the NMF is predominantly a reporting module based on the outputs of the other modules in the NMF (demand, operating costs, ICM, safety and performance). As such the appraisal is not undertaken as part of the main model run (although some preparatory calculations are undertaken as part of the run as this is the most efficient point to do so), but is requested by the user after a full model run.

5.2 The appraisal module in the NMF calculates the value for money of an option, compared with a user defined alternative. The appraisal methodology and parameters used are consistent with WebTAG and STAG.

5.3 The value for money assessment is presented in 2002 real prices (in £millions) and a discount year of 2002, with all inputs converted into market prices. The appraisal period starts in 2009/10 (the start of Control Period 4) and runs up to the year 2068/9. This appraisal period is fixed and cannot be altered by the user. However, appraisal data for off-line analysis can be extracted for years prior to 2009/10 through the use of model scripts; assistance with this should be requested from the NMF User Support helpdesk.

5.4 Since the NMF is only run for selected years, the appraisal interpolates between modelled years and extrapolates beyond the final modelled year. Costs are extrapolated based on the growth between the penultimate and final modelled year and demand is growthed by long-term forecast GDP growth from WebTAG (although this can be changed by the user).

Running an Appraisal in NMF

5.5 An appraisal is requested by the user as part of the NMF reporting package, after the NMF has been run. The user is required to select the appraisal option in the same way as the Financials and Physicals and Metrics options are selected. When undertaking an appraisal the user needs to specify a comparator test at the same time.

5.6 If the user requests an appraisal of the option, the appraisal results are saved in the Financial and Physical reporting output, in the five final sheets of the reporting pack.

Appraisal Outputs

5.7 The appraisal results comprises the three standard appraisal outputs formats:

- **TEE** – Transport Economic Efficiency table summarising the difference between time and cost impacts on passengers and transport operators for a pair of options.s The TEE sets out the impact of the tested option on all private sector parties: namely users, transport operators and developers.
- **PA** – Public Accounts table presenting the impact of an option on the public sector in terms of the requirement for capital funding, subsidy or changes in indirect taxation.
- **AMCB** – Analysis of Monetised Costs and Benefits. The AMCB summarises the outputs of the TEE and PA tables and includes non ‘economic efficiency’ impacts

including changes in accident costs or journey ambience (crowding in the NMF) benefits. The outputs of the AMCB are the Net Present Value (NPV) and Benefit:Cost Ratio (BCR) for the appraisal, which show whether the option tested represents public sector value for money.

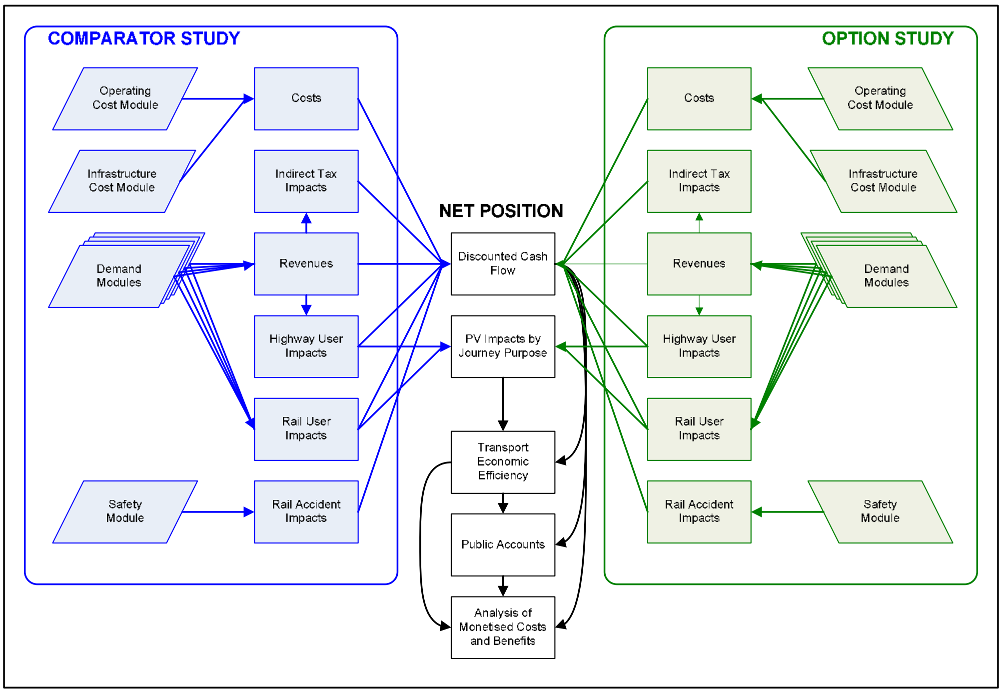
5.8 In addition, the NMF provides the user with information which gives clarity on the composition of the costs and benefits in terms of the demand flows which are affected by the option, and the benefits by journey purpose. These are found in the two sheets preceding the standard appraisal tables:

- **Discounted Cash Flow** – the direct output from the NMF appraisal showing the net difference between the two options in each impact category. This sheet provides a useful check of when changes occur and what impact they have.
- **Appraisal by Journey Purpose** – sets out the split of the user benefits into the journey purpose categories of Business, Commuter and Leisure. The latter two are combined in the appraisal as the 'Consumer' user impacts.

NMF Appraisal Methodology

5.9 Figure 5.1 summarises the components and series of calculations undertaken in the NMF appraisal module in NMF v1.1 (which includes the ICM).

FIGURE 5.1 APPRAISAL MODULE SCHEMATIC



5.10 As shown in the diagram there are six main components of the appraisal from which outputs feed the standard output tables. A brief summary of these components follows:

- **Costs:** information is drawn from the operating cost module and the ICM. No adjustment for risk or optimism bias is included in the appraisal.
- **Revenue:** information from the demand/crowding module is used and disaggregated by O-D pair and ticket type. Assumptions (consistent with those in

RIFF-Lite) are used to translate ticket type information into journey purpose splits. The NMF also calculates changes in bus passenger revenue.

- **Rail User Impacts:** the impact of fares, service pattern (frequency and journey time), reliability, crowding are calculated in terms of passenger benefits, applying the rule-of-a-half to passengers changing their travel behaviour. The GJT impacts for each demand driver are disaggregated by O-D flow and ticket type.
- **Rail accident impact:** forecasts of fatalities/casualties are supplied by the safety module and are then monetised using standard valuations from the Highways Economic Note No 1 (2001). Rail accident fatalities/casualties and incident costs are disaggregated by strategic route section.
- **Highway User impacts:** the impact of mode shift to/from rail is calculated based on the change in car km and monetised based on a unit rate of benefit per car-km change, derived from the National Traffic Model. Separate rates represent the impacts of mode shift on congestion and on highway accidents. The congestion impact is disaggregated using the standard highway journey purpose split into consumer and business users for presentation in the appraisal output tables.
- **Indirect Tax impacts:** comprise two elements: the impact of consumers transferring their spending between the taxed economy and untaxed public transport fares and the change in car travel (which affects fuel duty received by the Exchequer).

Guidance on using the NMF in Conjunction with the Appraisal Module

Selection of Modelled Years

5.11 As described previously, the model interpolates between forecast years and extrapolates (based on the preceding two years) after the final modelled year. It is therefore suggested that if it is known that an appraisal of the option is required, the user should undertake a model run for 2029/30 and try to ensure that there are no big gaps in modelled years.

5.12 Furthermore, the extrapolation relies on the change in the final year of the assessment being only a result of exogenous growth factors. Therefore care must be taken that the 2029/30 timetable used in the NMF assignment is identical to the previous timetable (which can be as late as 2028/29 with the user specified timetable option).

5.13 It is also recommended that where there is a timetable change **within** the appraisal period, then an additional forecast year is run immediately before this change to obtain the closest representation of the ‘step’ resulting from the new timetable. (Where this change occurs in the first appraisal year, then this is not required.)

Update of Parameters

5.14 Appraisal parameters that can be edited by the user in the user front end (via the annual index node) are:

- Post 2030 real demand growth factor (for example allowing no growth post 2030 sensitivity tests to be undertaken)
- Discount factor (and real growth adjustment factor)
- Indirect taxation factor (and Exchequer impact)

5.15 All other parameters (for example changes in values of time or disaggregation of road types) can be updated by running a script which will change the values in the database. Assistance with this should be requested from the NMF User Support helpdesk.

6. FINANCIAL AND PHYSICAL REPORTING OVERVIEW

Introduction

6.1 The results of any NMF test are called by the user in the NMF front end, they are not produced automatically at the end of each run. The user specifies which outputs are required:

- Financials and Physicals (revenue, costs, passenger kms and train/unit kms);
- HLOS metrics (crowding, demand, performance and safety metrics); and
- Appraisal results (in which case a comparator option must be selected).

6.2 The NMF produces the results file in a few (less than 5) minutes, with the user seeing the gradual completion of the calculations as ticks appear against each item in the financial and physicals front sheet (as shown in Figure 6.1).

6.3 A results spreadsheet is produced automatically, which should be named according to a pre-agreed naming convention.

FIGURE 6.1 FINANCIAL AND PHYSICAL REPORT: FRONT SHEET

NMF Reports

Report Details

Financials and Physicals

✓ TOC Revenue, Opex and Net
✓ TOC Opex by Cost Item
✓ TOC Revenue/Opex
✓ Sector Revenue/Opex
✓ TOC Revenue by Strategic Route Section
✓ KPIs
✓ Physicals
✓ Waterfall data showing how differences breakdown by Line Item
✓ Comparison by Line Item
✓ Custom Report with drill down

HLOS Metrics

✓ Safety Metric: FWIs by Region
✓ Safety Metric: FWIs by Strategic Route
✓ Safety Metric: FWIs by Strategic Route Section
✓ Reliability (Performance) Metric: PPM by TOC
✓ Reliability (Performance) Metric: PPM by Sector
✓ Capacity Metric: Passenger Kilometres by Strategic Route
✓ Capacity Metric: Load Factor by Strategic Route
✓ Capacity Metric: Load Factor by Strategic Route Section
✓ Capacity Metric: Load Factor including Standing Capacity by Strategic Route
✓ Capacity Metric: Load Factor including Standing Capacity by Strategic Route Section
✓ Station Footfall Metric: Passenger Moves by Station

Appraisal

✓ Discounted Cash Flow
✓ Appraisal by Journey Purpose
Demand by Flow
✓ TEE
✓ PA
✓ AMCB

Note: 2005 = Financial year 2004/05

Guidance on Selecting Financial & Physicals Reports

6.4 Unless the user has specified a comparator option the results will all represent the absolute values for the test in question, however two sheets will not work:

- Waterfall diagram showing differences by line item and
- Comparison by line item

6.5 If a comparator test has been specified the above two sheets will work, and the sheet "Custom Report with drill down" (the spreadsheet tab is actually called "Reports") will show the differences between the two tests.

6.6 It is recommended that if the user does require an appraisal for the option, a set of results without a comparator is also selected to assist in analysing the test results.

Using the Financials and Physicals Reporting Pack

Conventions Used

6.7 The financial and physical results will be produced for every year for which a model run was specified, however the metrics will only be produced for 2010 and 2014 (the start and end of CP4).

6.8 All financial results are expressed in nominal prices (RPI is 2.7% per annum as a default) and the years represent financial years, therefore 2005 represents the financial year ending 31st March 2005.

NMF Test Audit Trail

6.9 The first sheet in the reporting pack is "Report Details": this provides the user with an audit trail / summary of the inputs to the NMF model test. This can be used to confirm the timetables which were run in each model year, to ensure that the intended RIFF scenarios were used, and to ensure that the appropriate user editable datasets were used (for example GJT elasticities, indices and operating cost datasets).

6.10 If a user finds that the differences between two options do not appear credible it is sensible to compare the two "Reports data" sheets to ensure that any differences between the two were intended (if a comparator test is specified when outputting the results, the NMF produces a comparison automatically).

Analysis of Revenue and Operating Costs

6.11 There is no set approach to analysing the results of a model run using the financials and physicals reports, however a new user may find the following structured approach helpful to follow initially.

High Level Revenue and Cost Comparison

6.12 Using the sheet "TOCRevenue/Opex" compare passenger revenue and costs by TOC.

6.13 Select "revenue" or "operating costs" in the drop-down menu and copy (paste value) the results to a spreadsheet. Do the same for the comparator test.

6.14 Ensure that costs only change for those TOCs where the timetable specification has changed or a cost efficiency factor has been specified.

TOC Revenue Analysis

6.15 Using the sheet "TOC Revenue by Strategic Route Section", choose a TOC for which the revenue is of interest. The strategic route sections on which that TOC operates will automatically be displayed.

6.16 Output the results to an Excel spreadsheet and compare with those for the comparator, this will assist in understanding and explaining where on the network the TOC is experiencing changes in revenue.

6.17 For SRSs of particular interest, return to the "TOC Revenue by Strategic Route Section", select "All", then select only those SRSs in which the user is interested. Then drag the TOC drop down cell (Cell A1) to between the pivot table columns "Sum of Revenue £" and "Year".

6.18 This will produce, for each SRS, the revenue attributed to each TOC which operates on the SRS. This will show whether total revenue on the SRS is declining and whether revenue is being abstracted or generated by TOCs.

TOC Operating Cost Analysis

6.19 In the sheet "TOC Opex by Line Item" select the TOC of interest and output the results (where these will be the operating costs for c20 line items for that TOC in each modelled year) to Excel. Assess whether the changes are consistent with the timetable that has been specified and the operating cost drivers (described in Section 3 of this report).

6.20 To assist with this the user may choose to use results from the "Physicals" sheet: selecting the TOC of interest to allow the train/unit kms/hours (including peak unit hours) and various other indicators to be displayed.

6.21 Where unexpected changes in operating costs are found it is recommended that the user considers whether changes in the proportion of train kms/hours by each stock type (which themselves have different unit cost rates) may have affected the results. This is done using the "Custom Report with Drill Down" sheet. The user should select the TOC in question, and then drag the "Drill Down Value" to between the following columns in the pivot table "Organisation" and "Line Item Group". In the physicals selection this will allow the user to see the number of train kms/hours operated by each stock type.

Analysis of HLOS Metrics

6.22 The most useful sheets to consider in the metrics section of the reports are:

- Safety metric : FWIs by Strategic Route Section;
- Reliability (Performance) Metric: PPM by TOC;
- Capacity Metric: Passenger Kilometres by Strategic Route; and

- Capacity Metric: Load Factor by Strategic Route or Strategic Route Section

6.23 The majority of these are fairly self-explanatory, with two possible exceptions: "Reliability Metrics by TOC" and the Load Factors metrics.

Reliability (Performance) Metric: PPM by TOC

6.24 When comparing the results of "Reliability (Performance) Metric: PPM by TOC" the user should bear in mind that the PPM for each TOC are the weighted average results for each service group for that TOC, and this may result in unexpected results.

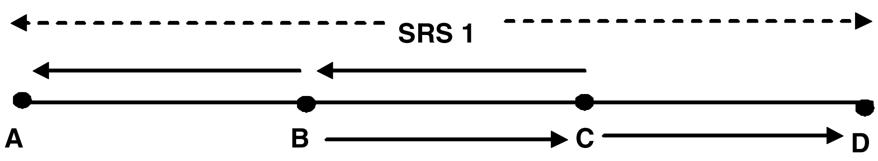
6.25 For example, a test was undertaken where the frequency of GNER services to Leeds was increased by 1tph. The user expected to see a reduction in PPM on GNER, however PPM actually increased. The reason for this was that of the four performance groups in GNER, the Leeds service is the most reliable. Therefore impact on GNER PPM of the increased proportion of GNER services accounted for by Leeds services outweighed the worsenment in the reliability on all GNER performance groups.

Capacity Metric: Passenger Kilometres by SRS

6.26 These load factors represent the weighted average of the load factors on all links within that Strategic Route Sections, for each peak type.

6.27 Thus SRS 1, shown in Figure 6.2, comprises 3 demand sections, AB, BC and CD. The AM Peak hour load factor is defined as the weighted average of the load factors (where load factor = passenger km/seat km) on each demand section where the weights are given by the length of each demand section.

FIGURE 6.2 CALCULATION OF LOAD FACTORS BY SRS



6.28 Since the peak type for each demand section (in the AM peak) is defined by the time at which trains arrive at their associated station, the associated stations determine the direction of the flows that are considered when calculating load factors. Therefore if:

- Demand Section AB is associated with station A;
- Demand section BC is associated with both stations A and D; and
- Demand section CD is associated with station D.

6.29 Then the directions of flows that are taken into account when determining the AM peak load factor on the SRS are shown by the arrows in the figure. A demand section with two associated stations is possibly less likely in the south east, but might be found on the route between Leeds and Manchester.

7. OTHER MODULES IN THE NMF

Performance Module

7.1 The Performance Module is owned and managed by Network Rail. This module was developed by AEA Technology Rail..

7.2 The model predicts changes to Average Minutes Lateness (AML) and the Public Performance Measure (PPM), based on the changes to the Capacity Utilisation Index (CUI). The CUI is a measure of traffic density by Strategic Route Section.

7.3 The model reports changes in AML by Service Group. The Service Groups are a key definition in the model, as call changes are relative to a base year's performance that is held as performance by Service Group.

Limitations/Caveats

7.4 The model is not designed to cope with changes to infrastructure e.g. doubling of track.

7.5 Care must be taken interpreting the results, and in particular the knock on effects to demand, where large changes in the CUI are reported (as warnings). Typically, this happens where the change is greater than 20%. In such cases, a significant deterioration in performance will typically be reported, making the services less attractive and therefore losing passengers. This is the effect that will probably be observed when attempting to model infrastructure changes indirectly (e.g. doubling the number of services over stretches of track). To best model such cases, you are advised to consult with the model owners.

7.6 Counter intuitive results may be obtained by adding additional services to service groups that have strong performance in the base timetable. An increase in services (and therefore CUI), could increase rather than decrease overall PPM for a TOC if it increases the proportion of high performing services relative to those overall.

7.7 Changes made to the fleet (e.g. stock lengthening, replacement with improved/refurbished stock) in the NMF are not reflected in the performance model – the inputs are based solely on number of trains. Assumptions on stock effectiveness can be made through the performance model itself. For advice and guidance, you should consult with the model's owners.

7.8 Service Group/TOC definitions are fixed in the current version of the performance model. Changes to TOC Franchise boundaries can not therefore be readily reflected in the performance model.

Safety Module

7.9 The Safety Module is owned and managed by the RSSB.

7.10 This module is based upon the Safety and Risk Model (SRM) which produces forecasts of fatalities and injuries on the railway based on the level of forecast rail traffic and passenger demand.

Limitations/Caveats

7.11 Due to the challenging timescales for developing the NMF, some of the input parameters needed by the NMF Safety Model could not be provided. These are:

- The number of empty coaching stock movements per hour in the peak, off-peak and night periods.
- The proportion of passenger trains that are of HST type (i.e. with a loco or driving van trailer at either end of the train) or conventionally loco-hauled.

7.12 In addition, there are a number of ways in which the NMF Safety Model could be developed to bring increased accuracy or functionality to the NMF, such as:

- Making the probability of train-train collisions a function of train frequency instead of using national averages from the SRM.
- Using train loading predictions from the NMF Demand Model, instead of loading estimates, to calculate passenger casualties.
- Calculating the cost of material damaged attributable to train accidents.

ICM

7.13 The ICM is owned and managed by Network Rail. It was designed to assist with the preparation of the Network Rail business case in 2006. Later in 2007 a new version (version 2) of the ICM will be released.

7.14 The ICM takes forecast traffic from the NMF, in the form of weights and equivalent weights travelling on each Constant Traffic Section (CTS). It uses this to forecast the costs of maintaining the network. Figures are produced for each year of Control Periods 3, 4 and 5, but only aggregate numbers for each Control Period are produced thereafter.

Limitations/Caveats of ICM Version 1

7.15 The ICM does not allow for "new build" infrastructure projects. It will only model maintenance and renewal programmes on the existing infrastructure.

7.16 Electricity usage is a fixed value regardless of traffic volumes.

7.17 ICM does not include an income element for Network Rail's revenues. Therefore the costs to the TOCs are not directly modelled nor included in the ICM. .

7.18 Annual values for each cost category are produced in the ICM for Control Periods 3, 4 and 5. For the remaining years of the NMF study, an aggregate total for the Control Period is produced, which is then averaged over each year of the relevant Period to produce an annual figure.

ORR Model to convert Network Rail's operating, maintenance and renewals expenditure (OMR) to Revenue Requirement

7.19 The ORR model is integrated in the NMF in version 1.1 et al, where the Infrastructure Cost Model (ICM) is also integrated. When the ICM is called as part of an NMF run, the ORR model converts the Network Rail costs (estimated by the ICM) into an estimate of its revenue requirement. The results are then reported in an output spreadsheet.

7.20 The model was used by ORR in December 2005 to estimate NR's funding requirements under different levels of OMR expenditure and was used to generate the figures and charts included in their report "Initial assessment of NR's CP4 revenue requirement and consultation on the financial framework".

8. OVERVIEW OF TRAFFIC IN THE NMF

General overview

8.1 Overall rail traffic is the key input for the Network Modelling Framework. Variation to the level or characteristics (rolling stock assignments, or unit type) of passenger services by route, franchise operator etc is the way NMF represents schemes or policy proposals that could be tested.

8.2 Traffic is entered and managed in the form of a weekday timetable. (Weekends are not explicitly modelled in NMF; there are a set of static assumptions within the model that translate average weekday data to equivalent annual data.). A timetable editor is provided for this purpose. This facilitates both the bulk editing of trains (e.g. changing the frequency or journey times by route) and the detailed editing of specific train paths (e.g. stopping patterns, preserving connections).

8.3 The NMF distinguishes between passenger and non-passenger traffic. The timetables managed through the timetable editor do not allow changes to be implemented to the freight and other non-passenger trains.

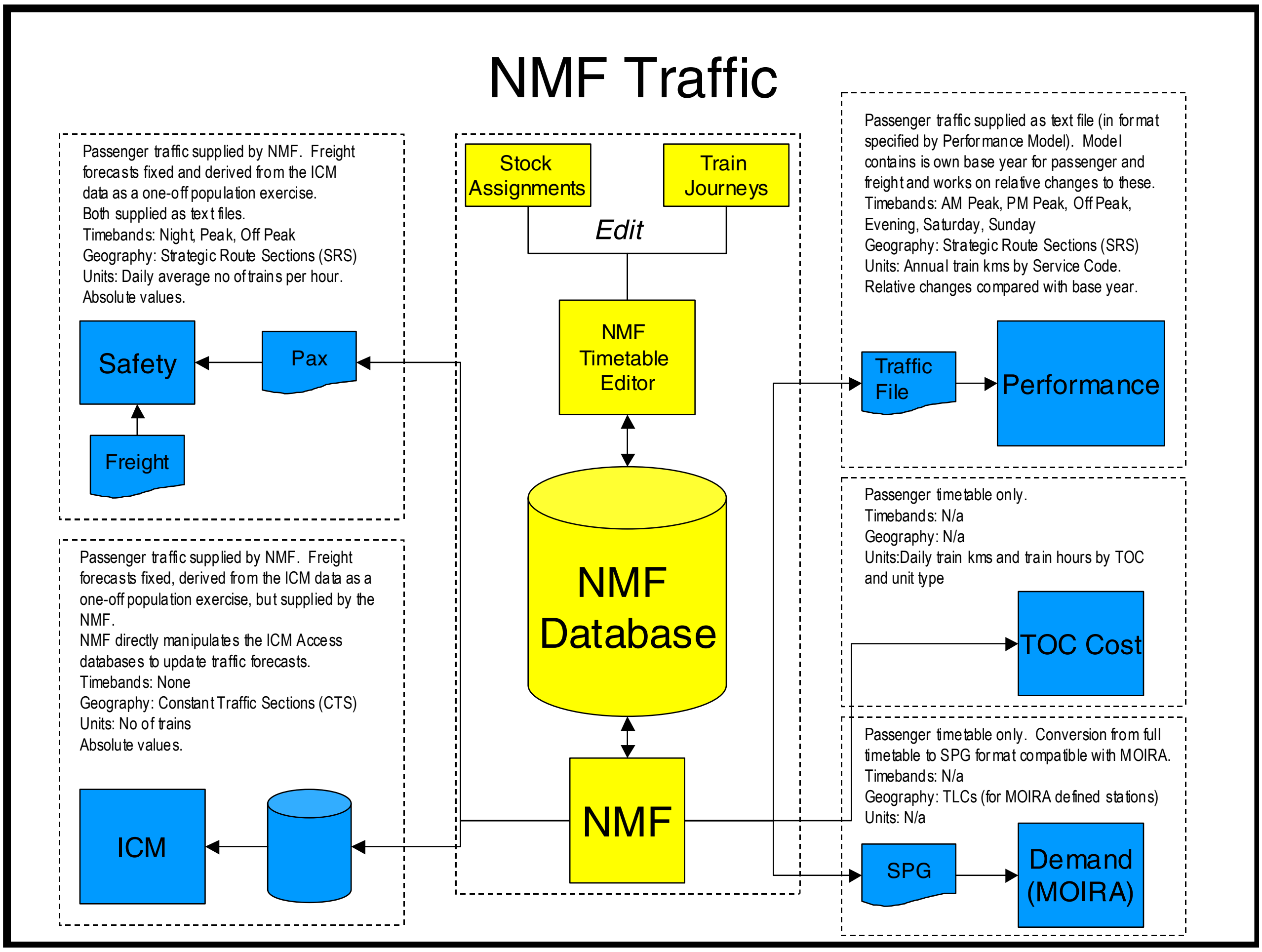
8.4 The Safety, Performance and Infrastructure Cost Models require freight and non-passenger traffic. Each model has a representation provided of the agreed freight forecast as part of its input data.

8.5 While a consistent view of the passenger timetable is presented to each of the models for Demand, TOC Costs, Performance, Safety and the ICM, the format, representation and means of communication is different for each model. This is summarised in Figure 8.1. This has been necessary since the each model was commissioned separately, some existing before the NMF was built. As a result the NMF manages the interfaces and all conversions required to present the data in the format required. The key differences relate to the geographic breakdown of the network, the timebands and/or annualisation required, the units (for example train miles/kms, number of trains, average number of trains per hour).

8.6 For the Safety Model, the passenger timetable is presented in terms of average number of trains per hour during the timebands “peak, off peak and night” for each Strategic Route Section. The freight timetable is stored as a separate, fixed input file which is picked up by the Safety Model when it runs.

8.7 The Performance Model has a baseline timetable of its own, which is stored as part of the input data. The NMF describes the timetable for later years as percentage changes on the number of train miles for each Service Code. This is broken down further by Strategic Route Sections and Timebands, of which there are six: AM Peak, PM Peak, Off Peak, Evening, Saturday, Sunday).

FIGURE 8.1 OVERVIEW OF NMF TRAFFIC FLOWS



8.8 The ICM receives annual totals for the number of trains running on each Constant Traffic Section (a subset of Strategic Route Sections). The numbers presented to the ICM are a combination of passenger and non-passenger traffic, where the non-passenger elements have been derived from values originally provided by the ICM team.

8.9 The Demand Module (MOIRA) receives a timetable file, known as an SPG file, for the passenger timetable. This is a simple format describing for each train the times at stations along its route, the service code and stock type.

8.10 The TOC Costs receives its traffic data in terms of the "physicals" derived from the timetable e.g. number of train hours and train miles by combinations of TOC and Stock Type.

Other Data Flows Between Modules

ICM to Performance Module

8.11 From an ICM run, the NMF takes values for the following categories and passes them to the Performance Model for each SRS and year:

- Track TSRs
- Track ESRs & defects (including broken rails)
- Track circuit failures
- Traction power supply (OLE/3rd Rail faults)
- Possessions
- Structures defects/failures/loss of service (including weather impact)
- Points failures
- Other signalling (including telecoms & level crossings)
- Other infrastructure-related

ICM to Safety Module

8.12 For each Strategic Route Section, the following values are extracted from the ICM and passed to the Safety Model:

- Broken Rails
- Track Defects
- L2 Excedences

Performance Module to Demand

8.13 The AML by Service Group are extracted from the Performance Model and applied to the Demand Module. A Performance Index is generated for each service group, based on the Generalised Journey Times, Elasticity Factor and AML. This is then used to modify the number of passengers per flow.

Demand to Safety Module

8.14 Weekday Passenger Kilometres are passed to the Safety Model. This is the passenger kilometres by SRS. This is the only passenger data passed to the Safety Model.

Demand to TOC Costs

8.15 Other revenue is calculated as part of the TOC Costs Module. For this, the percentage change in passenger kilometres (as compared with the base year) is passed to the TOCM.

Freight

Overview

8.16 The input to the safety model consists of the daily average number of trains per hour for each Strategic Route Section (SRS) for an average weekday for years 2005 to 2069[1]. This is calculated in four stages:

- Obtaining an estimate of annual freight train kilometres per year on each SRS

[1] The NMF uses e.g. 2005 to represent e.g. 2004/05 in the files it creates for the Safety Model

using data from the ICM;

- Calibrating this number against an external source and reweighting accordingly;
- Dividing the annual freight train kilometres by the total number of track kilometres within each SRS[2] to give a number of trains per year;
- De-annualising and splitting between the time of day.

8.17 The four stages are described below. Figure 8.2 is a flowchart providing an overview of the process.

Calculation Process

Stage 1

8.18 The ICM provides input data in the form of, for each financial year from 2004/05 to 2014/15, the number of annual freight train kilometres by Constant Traffic Section (CTS) and direction.

8.19 The number of annual freight train kilometres per year on each SRS is produced by summing over all constant traffic sections and both directions within a SRS.

Stage 2

8.20 The actual number of freight train kilometres on the whole rail network in 2004/05 was estimated from the National Rail Review 2005/06 Q1 (Office of Rail Regulation, 2006). This figure was compared against the equivalent figure as estimated from the ICM data and an adjustment factor derived. This was applied to the disaggregate annual freight train kilometres derived from the ICM data to produce a weighted annual freight train kilometres by SRS for each year.

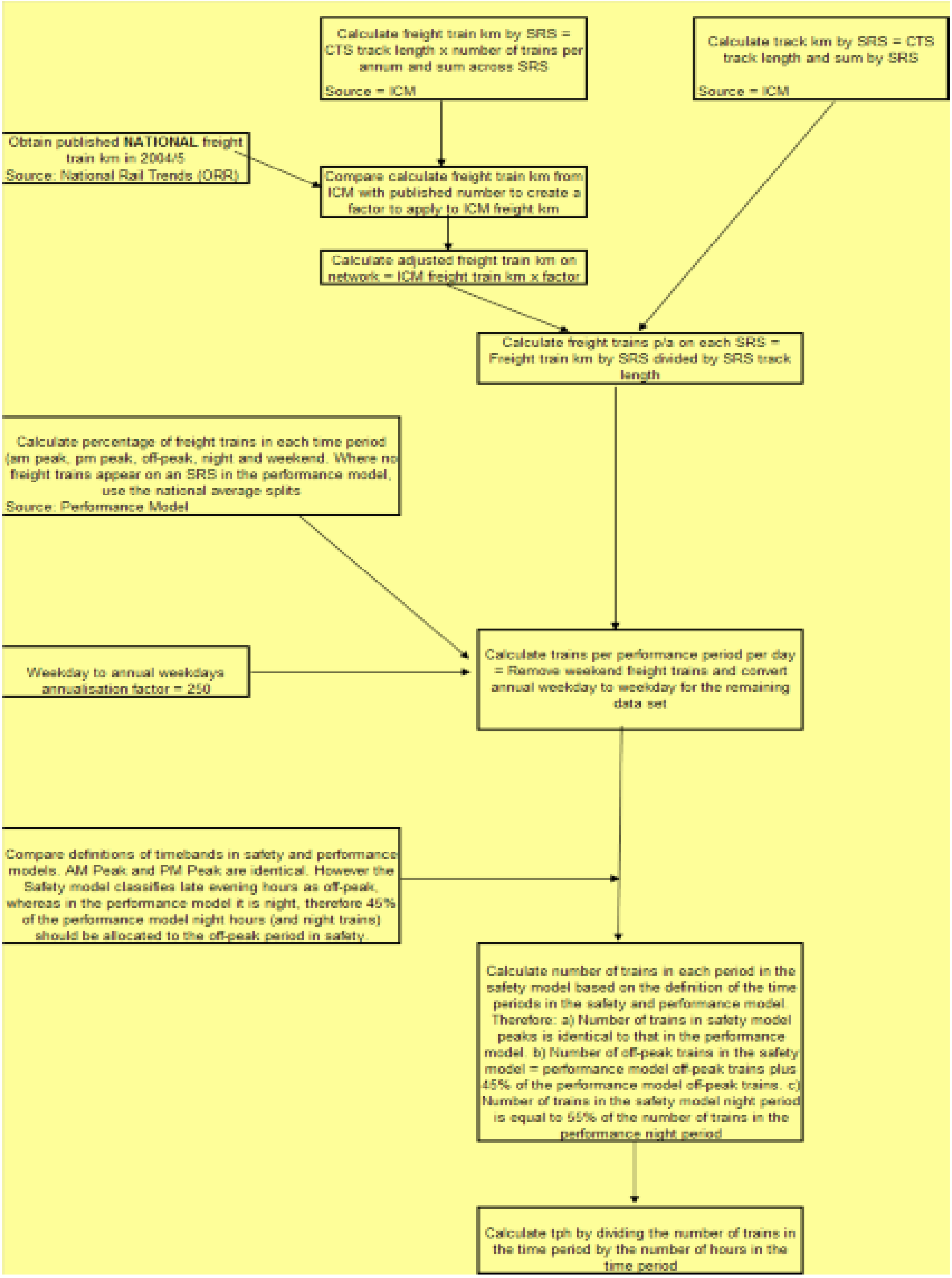
Stage 3

8.21 The ICM provided input data for this stage as the number of track kilometres by CTS and direction. The total track kilometres over a SRS was derived by summing over all CTSs and both directions within each SRS. Note that, as both directions were summated over, one kilometre of bi-directional or doubled track will count as two kilometres of track, and so this is calculated on a consistent basis to the annual freight train kilometres per year per SRS (stage 1).

8.22 The weighted annual freight train kilometres was divided by the track kilometres in order to derive, for each SRS and each year, an estimated annual average number of trains travelling over any single kilometre of track within a SRS in each year. This is equivalent to an annual average number of trains per year travelling over each CTS within a SRS weighed by the track length in each CTS. Note that the figure derived considers each direction as separate and therefore the expected number of trains per year travelling over a single kilometre of doubled track will be twice this figure.

[2] Where one kilometre of doubled or bi-directional track equals two kilometres of track length

FIGURE 8.2 FLOWCHART OF SAFETY MODEL FREIGHT TRAIN FREQUENCIES CALCULATIONS



Stage 4

8.23 The annual average number of trains has to be apportioned to that attributable to weekdays and weekends and, within weekdays, to that attributable to different time periods. To achieve this, the percentage of freight train kilometres occurring in each time period was derived from Performance Model data in the following manner:

- Input data was provided from the Performance Model detailing annual freight train kilometres by SRS, Performance Model timeband, traffic type (Passenger, Freight, other[3]), and annual and core (excluding 'other' traffic types) train kilometres.
- The percentage of annual freight train kilometres within each SRS that occurred in each time period was calculated, taking the average percentage split where no freight train kilometres were reported or where there was missing data.

8.24 The annual average number of trains in each weekday time period was then converted to a daily average number of trains by dividing by an annualisation factor of 250. At this stage weekends are no longer considered, as the Safety Model required input concerns weekdays only.

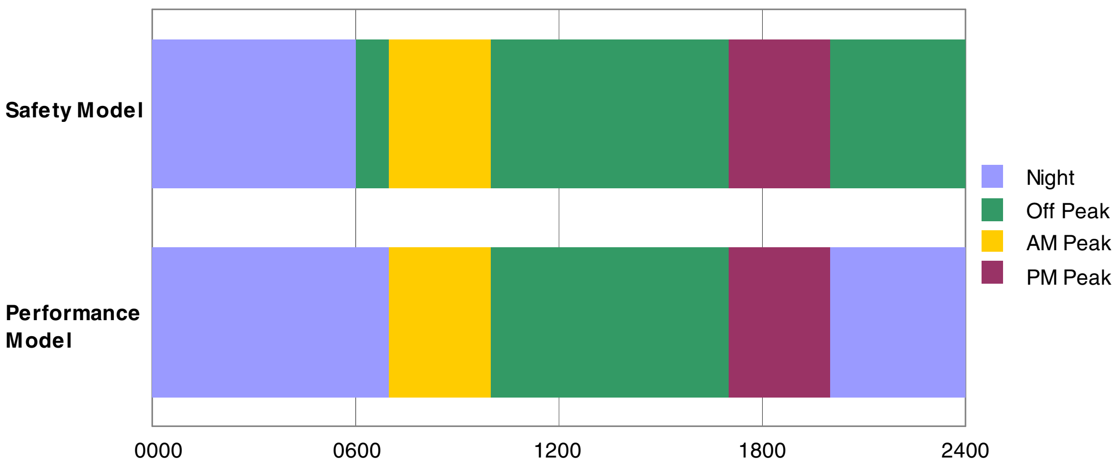
8.25 After apportioning the estimated daily average number of trains per year per SRS to Performance Model timebands, it was necessary to rescale the data to account for the differing period lengths between the Performance Model and Safety Model. These differing period lengths are depicted in Table 8.1 and Figure 8.3.

TABLE 8.1 PERFORMANCE MODEL AND SAFETY MODEL TIME PERIODS

Period	Performance Model	Safety Model
Morning Peak	0700-0959	0700-0959
Afternoon Peak	1700-1959	1700-1959
Off Peak	1000-1659	0600-0659; 1000-1659; 2000-2359
Night	2000-0659	0000-0559

[3] 'Other' includes trains that are not passenger trains or commercial freight trains e.g. ballast trains, ecs passenger trains, sandite, maintenance trains.

FIGURE 8.3 PERFORMANCE MODEL AND SAFETY MODEL TIME PERIODS



8.26 As can be seen the safety model off peak time period consists of the performance model off peak time period plus five of the 11 hours that the performance model assigns to the night time period. Accordingly the apportioned daily average number of trains was reassigned to safety model time periods as follows:

- Morning peakSafety = 100% x Morning peakPerformance
- Afternoon peakSafety = 100% x Afternoon PeakPerformance
- Off peakSafety = 100% x Off peakPerformance + 45% x NightPerformance
- NightSafety = 55% x NightPerformance

8.27 Finally, the daily average number of trains per hour in each time period was calculated for each SRS and each year by dividing the number of trains by the safety model period length.

8.28 As ICM data was only available from 2004/05 to 2014/15, safety model input years from 2016 to 2069 were assumed to be equal to the inputs for 2014/15.

9. USE AND INTERPRETATION OF THE NMF

Introduction

9.1 The NMF is designed to provide a national, multi-year evaluation of the impact of changes to passenger train services on rail demand, revenue, crowding, performance, safety, train and network costs. It is the first model of its kind in the UK to bring together this range of forecasting disciplines for the national rail passenger network. In designing a model of this scale, while meeting the non-functional requirements of short run times, ease of use and relatively straightforward data maintenance, simplifications and assumptions are inevitable. Understanding these assumptions is important for deciding how to use the model and interpret the results.

9.2 They include a number of industry-agreed assumptions and approximations and some of our understanding of behavioural drivers of demand and of factors influencing capital and operating costs in the rail industry, all of which is based on data subject to variation and sampling errors. There are some areas where the approximations used to create this representation are more evident, either because the process is difficult to model, or has a limited body of evidence supporting it, or does not correspond to a key output of the model and has not been a main focus of the modelling.

9.3 Given these limitations, models require an intelligent user who is able to understand and recognise the strengths and weaknesses of the model and who uses the model and its outputs with due recognition of this. To facilitate this understanding, any user of the NMF should familiarise themselves with the range of methodologies and assumptions employed in the model; these are set out in this and the other Background and User Guide documentation.

9.4 The rest of the Chapter focuses on providing some general guidance in two areas:

- The sorts of policies and schemes that the NMF can and cannot be used for;
- The key considerations in the use and application of the NMF

Use and application of NMF

9.5 The NMF model is a strategic railway industry model covering the **existing**[4] passenger rail network within Great Britain in its entirety. It includes both the demand/revenue and cost elements comprehensively, as well as providing metrics on the safety and performance of the network. It provides a common platform for the development and appraisal of passenger rail policy and schemes across Great Britain to enable decision makers to prioritise investment.

9.6 In general, NMF should be seen as a **gateway** tool, which assesses the relative performance of a wide range of policies and schemes, before a preferred sub-set are considered in more depth using more locally focused and detailed tools.

9.7 Given the nature of the NMF, it is best employed for appraising strategic level policies

[4] The passenger network which was operational at the introduction of the May 2005 timetable

and schemes that have material impacts at a city, regional or national level. The impacts of policies and schemes that are more local in nature, or have low level impacts across a wide area may not be properly reflected in NMF. In general, the following indicate the sort of policy or scheme that NMF is designed to model:

- General changes in fares levels on an RPI+x basis, with some differentiation by flow (constrained by the RIFF-Lite zoning system);
- Material changes to frequency and service patterns;
- Comprehensive train lengthening across a route/corridor;
- Schemes to improve performance;
- Changes to journey times;
- Comprehensive changes in the use of different stock types;
- Overall background growth rate, and implications for crowding if capacity not enhanced; and
- Sensitivity to variations in economic growth.

9.8 Schemes where the NMF will be potentially less robust are essentially smaller scale versions of the above interventions, such as:

- Local or targeted fare changes (such as local route specific fares, specialty fare products or fare structure changes);
- Minor changes to timing, routes and/or connecting services (such as additional stops at minor stations or minor re-timing of services);
- Ad-hoc changes to train lengths and/or stock types arising from stock re-diagramming.

9.9 Note also that NMF is built around representing the existing passenger rail network. It cannot directly model the demand and cost impacts of new passenger lines (such as CTRL domestics and line re-openings).

9.10 In the wider sense, the deployment of NMF will always be a pragmatic choice dependent on a number of issues, including time available, alternative methods and/or models, the level of quality and detail required and the skilled resources available.

Key considerations in the use and application of NMF

9.11 The following sets out key guidance for NMF users to ensure informed interpretation of the results.

Demand response to additional capacity

9.12 The crowding curves used in the NMF represent an estimate of the relationship between constrained and unconstrained load factors, given an estimate of the variation of the loadings over the relevant time period and the proportion of commuters travelling. These curves have been derived using crowding penalties for commuters and other travellers detailed in PDFH. These penalties have only been researched, and are therefore only specified, up to load factors of 140% and 160%, beyond which we have extrapolated linearly – broadly extending the relationship present between 100% and 160%.

9.13 The crowding curves provide an estimate of the level of suppressed demand (the difference between unconstrained and constrained load factors) at all levels of the constrained load factor and hence indicate how demand levels would change in response to a change in capacity. The relative level of suppressed demand increases with higher constrained load factors to a maximum level, beyond which it falls slightly, although, as this is driven by the load factor, the absolute level of suppressed demand continues to rise.

9.14 The crowding curves are applied to demand and supply within discrete time periods, notably the peak and shoulder peak hours. However, peak spreading is not explicitly modelled within NMF. Where this occurs in practice, passengers can reduce their crowding disbenefits by switching to less crowded trains, typically moving from a train in the peak to one in the shoulder peak. Where a capacity enhancement scheme would reduce peak crowding disbenefits, then passengers can return to their desired travel time, but the net benefit to them is less than the full change in crowding in that peak. Hence, the crowding benefits for capacity enhancement schemes forecast by NMF may be overstated.

9.15 Conversely where such high levels of crowding exist, a key benefit of capacity enhancement that the model does not properly reflect is the ability to board earlier trains than would otherwise be the case. (For example, SWT commuter passengers waiting for inbound services at Clapham Junction in the morning peak often have to wait for two or more trains before being able to board. Major train capacity enhancements would allow boarding sooner.) On that basis, NMF may underestimate the benefits of capacity enhancement where crowding levels are severe.

Impact of zoning system on demand and crowding relief

9.16 When assigning demand and estimating crowding levels, the NMF is necessarily an aggregate representation of the actual situation. NMF uses an aggregate zone system, whereby most zones represent a set of stations which often do not have common train services. (For example, the Bedford zone includes Bedford, Luton and three stations that are not served by MML - Flitwick, Harlington and Leagrave). In these circumstances, demand from the zone will typically be biased to services from the station with the highest level of service (for the three aforementioned stations, demand may be incorrectly assigned to the MML services which stop at Bedford).

9.17 However, the exact impact will be dependent on the relative service levels (for example, there are few MML Bedford services in the peak) and the split of actual demand from the stations within the zone (Bedford and Luton having around two thirds of the demand from that zone). In many cases therefore, whilst it may not correctly forecast crowding, it may not always be material.

Impact of service groups on crowding relief

9.18 A related issue is the fact that the crowding relief calculations are undertaken at the service group level. This may include a mix of fast and stopping trains and hence the impact of capacity enhancements on a sub-set of services within the group may either dilute or exaggerate the impact, depending on the relative share of demand and exact scope of the capacity enhancement scheme.

Issues related to the use of MOIRA

9.19 There are a number of issues which need to be considered with the use of MOIRA at the heart of the NMF. These are largely known issues that MOIRA does not explicitly address, or are a function of the assumptions underpinning its methodology, such as the zoning system. The most fundamental is that it is used to model the impact of timetable changes based on PDFH elasticity-based methodologies which are most relevant for relatively small incremental changes to the current timetable.

MOIRA does not model dedicated fares

9.20 MOIRA assigns demand to trains purely on the attractiveness of the timetable; fares are not considered in the process. For many journeys, this is not an issue, for example with season tickets, or where the ticket is unrestricted.

9.21 However, some journeys will have ticketing restrictions which will limit the ability to travel on any route or train. Such dedicated fares are only an issue in certain areas of the country where either premia or discounts are applied to particular services. The most common example is for flows where there is an alternative which involves travelling into and then out of London, such as Reading to Leicester, where the 'not via London' route will attract a discount. Similarly, some operators have introduced dedicated fares at a discount to the 'any permitted' fares, to compensate potential customers for a slower and/or less frequent service. Examples include Silverlink services between London and Birmingham and FCC services between Peterborough and London.

9.22 Where such dedicated fares are common, the level of demand will be mis-assigned within the MOIRA routing algorithm.

MOIRA does not model crowding

9.23 Whilst crowding is modelled within NMF to suppress future year growth and to evaluate the crowding impact of timetable changes, this is done at a route section / time period level. The allocation of demand between train operators / individual train services does not take account of crowding (ie. passengers do not choose between trains based upon the relative levels of crowding), and, if anything, this favours the longer distance operators relative to London and SE and local operations.

MOIRA and Central London demand

9.24 To enable the modelling of competing services into alternative Central London termini MOIRA divides Central London demand into 18 zones. The demand split between these zones and the access/egress times from the zones to the London termini are based on the 1991 LATS survey. Hence this is a rather crude methodology which uses rather old data. The crudeness of the methodology is unlikely to lead to any systematic bias in results, but could lead to larger swings than expected. So, for example, the withdrawal of a number of peak FCC services into London Bridge from South leads to a larger than expected increase in demand for Gatwick Express services into Victoria. The age of the data is more of an issue particularly as the vast majority of the Docklands development, and associated transport infrastructure, did not exist in 1991.

Intra-zonal demand in MOIRA

9.25 Another impact of the MOIRA zoning system is that demand and revenue between stations assigned to the same principal station (intra-zonal demand) is not assigned to a timetable. Therefore demand and revenue for certain short-distance trips will not be reported. This intra-zonal demand represents 5% of journeys and only 1.2% of revenue, and is likely to impact more on more local operators.

Cost implications for rolling stock

9.26 The specification of the timetable can involve a number of places where rolling stock has been transferred between TOCs, and/or where new rolling stock may be required. Firstly, it is important that any new combination of TOC and rolling stock type is included in the unit cost database as otherwise the attributed costs will be zero. However, even if the costs are correctly specified there are a number of issues to look out for:

- The current TOC Cost data in the model may get quickly dated.
- If the unit costs for the new operator have been newly specified there may be a change in aggregate cost, despite little change in the service, due purely to the individuals TOC's unit costs.
- Some costs are inescapable..
- New rolling stock for an operator may mean that the user has to copy the cost of similar stocks used by other TOCs, and these may not be representative of the actual lease cost incurred by the procuring TOC.

APPENDIX A

GLOSSARY OF TERMS

A1. GLOSSARY OF TERMS

Term	Description
AMCB (Analysis of Monetised Costs and Benefits)	This summarises the outputs of the TEE and PA tables and includes non 'economic efficiency' impacts including changes in accident costs or journey ambience (crowding in the NMF) benefits. The outputs of the AMCB are the Net Present Value (NPV) and Benefit:Cost Ratio (BCR) for the appraisal, which show whether the option tested represents public sector value for money
AML (Average Minutes Lateness)	Average minutes lateness experienced by passengers, according to estimates of the number of passengers affected by delays at specified monitoring points.
Associated station	The timing point at which it is defined what peak type a train falls in.
Cost Escapability	Lease costs (both capital and non-capital) are assumed not to be escapable until the end of the lease.
Crowding Curves	Define the relationship between constrained and unconstrained load factors. Used to calculate "uplift factors" or "suppression factors" to adjust base year constrained demand or future year unconstrained demand.
CTS (Constant Traffic Section)	A sub-section of a Strategic Route Section where the traffic over that section is essentially constant across the section.
CUI (Capacity Utilisation Index)	CUI is a measure of the extent to which capacity of a given route section is used up by train services running (or proposed to be run). Statistical relationships have been established between CUI and congestion related reactionary delay.
Demand Sections	Demand Sections form Strategic Route Sections (SRS's), these aggregate to form Strategic Routes(SR's). Demand Sections should not cross SRS's There are approx 880 Demand sections.
Demand Segment	The part of the network between 2 consecutive station stops.
Demand Zones	Groups of stations where the zones have been defined specifically for the NMF. There are 566 zones. Demand zones are linked by Demand Sections. Every demand zone has a Primary station
EC4T (Electric Current for Trains)	The cost of power supply for electric trains (relating to the cost of the electricity consumed only, NOT the cost of the associated equipment required to supply it ie sub-stations, cabling etc)
FTAC (Fixed Track Access Charges)	The charge to franchised operators for providing the infrastructure required to operate train services.
GJT (Generalised Journey Time)	The GJT is the total time of a rail journey comprising three elements: station to station journey time, service frequency and interchange.
ICM (Infrastructure Cost Model)	The Network Rail model to forecast the cost of operating, maintaining and renewing the rail infrastructure.
I-codes and Private Settlements data	The 'I-codes and Private Settlements' file provides sales information on some, but not all PTEs. The file contains information on ticket sales at RSP outlets which are not included in the standard MOIRA matrix (eg. PTE ticket sales at national rail stations), by originating (but not terminating) station. The destination field is the ticket type purchased rather than a particular station.

Term	Description
Interchange station	Interchange stations are specified where appropriate There are 98 interchange stations in the NMF.
LENNON (Latest Earning Networked Nationally Overnight)	LENNON is the rail industry's standard ticket sales database, through which the vast majority of rail ticket data is processed. It records the date and location of purchase, origin station, destination station, ticket type, revenue allocated by TOC, journeys and passenger miles for each ticket sold.
LTC (Long Term Charge)	The charge to TOCs for the use of stations and depots
LTS (London Transportation Studies)	A multi-modal model covering London and the South East used by TfL for strategic policy and scheme testing.
Network Rail Net Revenue Requirement	The revenue required by NR from the franchised passenger train operators (or network grant that may be paid by government in lieu of such access charges) after all other sources of revenue have been deducted from the efficient level of expenditure to deliver the required network outputs and the return it is permitted to earn on its regulatory asset base.
NLC	National Location Code A pre-defined unique 3-letter code for every station. Used throughout the rail industry (not just the NMF).
NMF Demand Matrix	A representation of trips on the rail network. It does not identify the ultimate origin and destination of trips.
NMF MOIRA	A special version of MOIRA, comprising 566 zones. In the NMF only the timetable processing part of MOIRA is used, which is not visible to the user. However a stand-alone version of NMF MOIRA can be provided
OCIS (Operating Cost Input Spreadsheets)	Spreadsheets used to convert operating cost input data into a format that is input into the NMF to form the base data for the TOCM.
ORCATS	MOIRA uses the ORCATS algorithm to allocate demand and revenue to individual service codes for the settlement process between TOCs. The NMF uses this algorithm to do the same task.
Other Revenue	Non rail ticket related items of TOC revenue, such as car park revenue, commissions and station maintenance
OTT's (Opportunities to Travel)	Direct trains or combinations of trains that allow travel between each origin Demand Zone and each Destination Demand Zone. The basic building blocks for which allocations are derived.
PA (Public Accounts)	Table presenting the impact of an option on the public sector in terms of the requirement for capital funding, subsidy or changes in indirect taxation.
PDFH	Passenger Demand Forecasting Handbook (PDFH) 4.1
Peak Type	Used in the crowding calculations. Defined according to the pre-defined demand section and the time at which trains crossing over that Demand Section arrive at an associated station
PPM (Public Performance Measure)	PPM is the percentage of franchised passenger trains arriving at their destination and within a specified lateness margin (typically five or ten minutes). This measure captures all delay causes (Network Rail, train operators (TOCs) and others.
Primary station	A single Primary station is identified for every demand zone. There are 566 in total.

Term	Description
Proxy seats	The defined seating capacity of rolling stock (differing from the true seating capacity) to reflect the revised crowding curve arising from rolling stock with differing seats to total capacity ratios from that implicit in the PDFH crowding curves.
R23	London travelcard zones 2 and 3 (only)
RIFF-Lite	A sub-module within NMF that is used to forecast the impact of exogenous drivers (and fares) on demand
RSP (Rail Settlement Plan)	The RSP provides central retail support services to the UK Train Operating Companies (TOCs). This includes the distribution of fares and timetable data, the provision of other retail information to all National Rail retailers and, most critically, the allocation and settlement of rail revenue to operators.
Semi-constrained demand	A combination of base (2004/5) demand (which is constrained in places by crowding) and unconstrained growth (where this growth is driven by exogenous factors, fares and the timetable changes)
Service Group	Defined groups of services for the purposes of allocation of costs and revenues.
SFO (Station Facility Owner)	The nominated station owner for the purposes of station operation and maintenance. The SFO is usually a franchised TOC, with the exception of 17 key stations where Network Rail is the SFO.
SRS (Strategic Route Section)	Key section of route as defined by Network Rail in their 26 route plans (see www.networkrail.co.uk/aspx/3085.aspx).
STAG (Scottish Transport Appraisal Guidance)	Transport Scotland's appraisal guidance for transport schemes in Scotland
STP Code (a Service and Time Period code) 4-digit code	Each train in each timetable has a 4-digit code associated with each segment of its journey (i.e. between consecutive station stops). The first 3 digits are derived from the LENNON service codes used by RSP and TOCs to identify services for revenue allocation purposes. The fourth digit is used by NMF to classify the service by time period to facilitate the production of capacity metrics, and the crowding calculations. This fourth digit is called the Peak Type.
TEE (Transport Economic Efficiency)	Table summarising the difference between time and cost impacts on passengers and transport operators for a pair of options.s The TEE sets out the impact of the tested option on all private sector parties: namely users, transport operators and developers.
TOCM (TOC Operating Cost Module)	Module integral to NMF which forecasts TOC operating costs.
VTAC (Variable Track Access Charges)	The charge to train operators to cover the cost of maintenance and renewals arising from actual train operation.
WebTAG (Web based Transport Appraisal Guidance)	Web site maintained by the DfT which provides guidance and advice on the development and appraisal of transport schemes

CONTROL SHEET

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