Background

In recent years, there has been an increased recognition of the importance of a more holistic assessment of how best to evaluate the impacts of transport infrastructure, policy and demand management initiatives – all of which can have significant impacts on road travel. This focus arises out of the realisation that environmental externalities are as significant a by-product of transport demand as traffic congestion and road safety, which for many years have been the focus of transport appraisal.

The National Transport Model (NTpM) is the first all-Ireland strategic multi-modal transport model that can be used to assess and evaluate the impact of transport infrastructure, policy, demand management initiatives and strategic development plans.

The NTpM incorporates separate models for car traffic, freight, national rail and inter-urban bus, along with an innovative transport behaviour model which allows future transport and environmental impacts to be quantified. The NTpM was originally developed by the National Roads Authority in 2011 as an enhancement of the National Traffic Model (2008) and has recently been updated and enhanced using up to date data to a current base year of 2013.

The National Transport Model is maintained by the National Roads Authority Strategic Planning Unit. It is used as the basis for strategic planning, scheme appraisal and policy evaluation, and remains available for use by government bodies, local authorities and researchers.

All information on the development of the National Transport Model can be found at: www.nra.ie/policy-publications/national-transport-model
The functionality of NTpM was defined by the range of policies, measures and strategies that it would be required to assess and by the outputs that it would be required to generate. At the model scoping stage, it was recognised that the end product should:

- Be based on a flexible modular structure allowing modules to be added/enhanced at a later date;
- Make maximum use of the National Traffic Model, which has been developed to a high level of accuracy and has been employed successfully since its completion in 2008; and
- Avoid over complication in modelling to reduce the level of development risk.

NTpM Architecture

The NTpM is made up of several sub-models, each having its own unique inputs and structure. The total number of national origin and destination trips in the NTpM is generated by the Trip Attraction Generation Model (TAGM) which takes the outputs of the Demographic and Economic Models (e.g. population and jobs) and the Car Ownership Model and converts them to vehicle or passenger trips. The Freight Model is used to estimate freight demand at a national level.

A Trip Distribution Model then distributes the origin and destination trip end totals between the various zones in the model. The assignment models (Traffic, Rail & Bus) are used to assign the demand to the network, generating travel costs (time, distance, tolls, fares, etc) for each mode.

Finally, the Variable Demand Model is used to assess the impact of a change in the transport network or change in the cost of travel (e.g. fuel costs, fares) upon the demand for travel. This is calculated by comparing the zonal travel costs from the assignment models between a Do-Minimum (without change) scenario and a Do-Something scenario (with change).

The impacts captured by the VDM could include a switch in transport mode, a change in time of departure or a decision not to make a trip.

NTpM Zone Structure

A transport zone represents a geographical area in the NTpM into which transport demand data is aggregated. The National Transport Model is split into 1,077 transport zones.

To maintain compatibility with Census data, the 3,440 Electoral Divisions in the Republic of Ireland are aggregated into 927 NTpM zones. The 150 NTpM zones which represent Northern Ireland are based on an aggregation of the 582 Electoral Wards in Northern Ireland.
NTpM Demand Classification

As with any transport model, demand is classified into a number of individual segments to represent travel modes, trip purpose, car availability and travel period.

The NTpM does not assign walking and cycling demand – to do so would require an excessive level of detail which would make model runtimes unsustainably high. Instead walking and cycling assignments should continue to be addressed in models for urban areas. However the impact of increased walking and cycling on aggregate vehicular demand is reflected in the NTpM, through the estimation of demand responses.
THE NATIONAL TRAFFIC MODEL

Road Network

All motorways, national primary, secondary and regional roads in the Republic of Ireland and all motorways, A roads and B roads in Northern Ireland are included in the National Traffic Model (NTM) network.

The network information for the first NTM (2008) was obtained from information held by providers of satellite navigation systems. This proprietary network data provided detailed information on all existing roads throughout the country at all levels of complexity, with information on road type, speed and distances.

This information also provided geographical data for all roads which allowed the data to be input directly to the NTM. All roads are classed by road type, by speed flow curve, link capacity and speed limits. The NTM network has evolved as new road schemes have opened since it was first developed. The current network represents the road network as of December 2013.

Private Car Travel

A representation of the demand for travel by car was constructed based on data from:

- POWSCAR – Place of Work, School or College Census of Anonymised Records (2011) – CSO;
- 267 NRA Traffic Monitoring Units;
- Surveys and information from the previous version of the NTM; and
- Various traffic survey data collected by the NRA in 2013.

NRA Traffic Monitoring Units (TMU)

The NRA has recently invested in their traffic counters system. Up to date traffic data is now available across the national road network at 267 sites, double the previous coverage.

The NTM also operates as a standalone traffic assignment model. Its application in scheme appraisal is integrated into the NRA Project Appraisal Guidelines (PAG) where it is used to inform strategic decision making in the planning of future infrastructure and policies where demand responses are not considered to be relevant.

At a local level, the NTM is used as a donor model for more detailed Local Area Models (LAM) which can be used to appraise the impact of road or traffic management projects.
Reflecting Rail Demand

Rail passenger demand was constructed using a combination of datasets:

- POWSCAR Census Data – Commuting and Education Trips;
- 2012 Heavy Rail Census; and
- Existing Business and Other Rail Trip Purpose Matrices.

The NTpM uses the railway network and Irish Rail commuter and intercity timetable services as they existed in December 2013. Fares were coded based on the average fares for a range of ticket types.

Light rail services are not included in the model due to the shorter distance nature of these trips. These are better represented in models of urban areas. The rail model is a weekday model, which represents a time period of 07:00-22:00. This ensures that all significant commuter and intercity rail trips are captured within the model period.

The development of the rail model of the NTpM was prepared as a standalone assignment model and is known as the National Rail Model (NRM), due to its value as a standalone too.

Modelling Inter-Urban Bus Passenger Demand

The Inter-Urban bus model includes all Expressway and Regional bus services provided by Bus Éireann and a number of private inter-urban bus operators.

Given the sensitivities in collating observed bus data, the development of the Inter-Urban bus model focused on the construction of a partially ‘synthetic’ representation of bus demand. This reflects a typical level of demand on currently available services and supports the functioning of the VDM module. The procedure was undertaken by:

- Estimating the average weekday bus demand based on aggregate travel data for all operators;
- Identifying the contribution of commuting and education demand from POWSCAR; and
- Synthesising a matrix of the ‘other’ (non-commuting and non-business) demand based on the non-commuting travel patterns established in the traffic model.

The final bus demand matrix was checked through the estimation of load factors on key corridors (comparing the total bus capacity against daily passenger flow). More accurate bus demand information could be substituted at a later date following the development of a protocol for access to and use of commercially sensitive information on bus demand.

Average fares were calculated to reflect a range of ticket types. This fare has been applied across all operators. The model is a weekday model, which uses a time period of 07:00-22:00.
The Variable Demand Model (VDM) works as a ‘Do-Minimum Pivoting’ Model. Pivot point models take travel costs from a ‘Do-Minimum’ scenario as the starting point and then forecasts the changes in demand (mode share, trip distribution, etc) as a function of the changes in travel costs between the ‘Do-Something’ scenario.

This approach enables some of the complex behavioural decisions which inform the base demand to be carried through to alternative scenarios.

Measures which invoke responses in the VDM include:
- Change in fuel cost;
- New or increased tolls or other user charges;
- New infrastructure;
- Improved / reduced public transport services;
- Traffic congestion;
- Traffic Management; and
- Public Transport Priority.

The effects modelled by the VDM are:
- The frequency of trip making (increased travel costs can reduce the number of trips made);
- Mode Choice, including car, bus, rail and walking/cycling;
- The destination of a trip (trip lengths will tend to reduce with increased travel costs); and
- Time of day (trips may shift to other times as the cost of peak period travel increases).
MODEL ENHANCEMENTS

A number of enhancements have been incorporated into the NTpM since it was first developed in 2011.

Northern Ireland

A more detailed representation of Northern Ireland including estimated inter urban rail and bus travel demand has been included in the NTpM. This ensures that cross border trips are accurately represented to allow cross border road schemes to be appraised in a manner consistent with other schemes.

Heavy Goods Vehicles

The representation of HGVs in the NTM has been greatly enhanced as a result of the incorporation of the ‘National Survey of Transport of Goods by Road’ undertaken by the CSO in 2012. Data on the movement of freight by road was provided by the CSO at a county level and disaggregated to NTpM zone level based on employment type data from the CSO.

Education Trips

As part of the 2011 Census, data on journeys to school and college was collated alongside data on commuting. This was the first time that this dataset was collected and it provides another level of detail within the NTpM and was used to inform the development of the ‘other’ trip purposes matrices.

NRA Asset Management System - GIS Link

The NRA Asset Management System is a GIS based tool that the NRA employs to store and present data on the National Roads Network (e.g. NRA Pavement Management System). As part of the NTpM update, a new interface tool was developed to allow data to be readily transferred between the NTpM and the NRA Asset Management System.
The National Transport Model is constructed to represent a base year of 2013. Future year models have been prepared for 2030 and 2050. These forecast years were selected to reflect the projected delivery of the EU TEN-T core and comprehensive networks. The forecasting procedure uses the following:

- Population and jobs forecasts;
- Car ownership forecasts;
- Travel demand forecasts; and
- Goods vehicle forecasts.

A ‘Central Growth’ scenario has been developed alongside low and high growth scenarios that can be used for sensitivity analysis in project appraisal.

**Car Ownership Model**

Detailed car ownership forecasts were developed using statistical models based on current trends and an analysis of saturation levels across Europe. Car ownership was forecast at county level then aggregated to national projections. NTpM zone car ownership projections were based on disaggregated county level forecasts.

**Population & Jobs Forecasts**

The population and jobs models generate forecasts of future growth in population and jobs at ED level, which is subsequently aggregated to NTpM zone level. The central forecast is based on the ESRI Recovery Scenario from their Medium Term Review (2013). The low and high growth scenarios are based on the CSO M2 and M3 scenarios respectively, which assume different levels of migration.
A suite of documents which support the National Transport Model have been produced and include detailed information on the process employed in the construction of the NTpM. These documents are as follows:

• NTpM Volume 1 – Model Development Report;
• NTpM Volume 2 – Data Collection Report;
• NTpM Volume 3 – Demographic and Economic Forecasting Report; and
• NTpM Volume 4 – Variable Demand Modelling Report.

All information on the development of the National Transport Model including these documents can be found at www.nra.ie/policy-publications/national-transport-model

**FUTURE YEAR FORECASTING**

**Goods Vehicle Forecasting**
The forecast increase in Heavy Goods Vehicles (HGV) is based on the predicted increase in the size and structure of the national goods vehicle fleet. This relates the total carrying capacity of the fleet to GDP forecasts and results in a uniform growth rate in HGV traffic across all zones.

**Travel Demand Forecasting**
In order to convert future socio-economic forecasts (population, jobs, car ownership etc) into car vehicle trips and public transport passenger trips, a range of trip rate equations were required for each trip purpose and transport mode. These trip rate equations were developed based on the relationship between on the number of trips in the base year and a range of socio-economic variables for the same base year.
For further information on the National Transport Model, contact

Strategic Planning Unit
National Roads Authority
St Martins House
Waterloo Road, Dublin 4
(01)660-2511
www.nra.ie