Traffic Modelling Guidelines
TfL Traffic Manager and Network Performance Best Practice

Version 3.0
# Contents

**Foreword** 3  
**Acknowledgements** 4  
**Introduction** 12  

**PART A – MODELLING CONSIDERATIONS** 15  
1 **Introduction** 17  
2 **Background to Traffic Signal Scheme Modelling in London** 19  
2.1 Introduction 19  
2.2 Legislative Responsibilities 20  
2.2.1 Applying the NMD in TfL 20  
2.2.2 Modelling Journey Time Reliability 21  
2.3 Transport Modelling Hierarchy 22  
2.3.1 Strategic 23  
2.3.2 Cordon Area 23  
2.3.3 Micro-simulation 23  
2.3.4 Local Area 24  
2.3.5 Operational 24  
2.3.6 Model Integration 24  
2.4 Modelling Standards 25  
2.5 Fit for Purpose Modelling 25  
2.6 Modelling Expertise 26  
2.7 Site Visit and Data Collection 26  
2.8 Assessing Future Scenarios 26  
2.9 Modelling Boundary 27  
2.10 Presentation of Modelling Results 27  
2.11 Delivery of Traffic Modelling 28  
3 **Scheme Considerations** 29  
3.1 Introduction 29  
3.2 Overarching Objectives 29  
3.3 Interested Parties 29  
3.4 Scheme Design 30  
3.4.1 Junction Layout 30  
3.4.2 Fixed Time and Adaptive Control 30  
3.4.3 Traffic Signal Timing Plans 31  
3.4.4 Contingency Signal Timings 31  
3.4.5 24/7 Operation 31  
3.4.6 Scheme Safety 32  
4 **General Traffic Considerations** 33  
4.1 Introduction 33  
4.2 Route Choice for Local Modelling 33
### 3 LinSig Modelling

- **3.1** Introduction
- **3.2** LinSig Version 3
- **3.3** Appropriate Use of LinSig
- **3.3.1** Skeleton Models
- **3.3.2** Isolated Junctions / Multiple Streams with Single Controller
- **3.3.3** Networks
- **3.3.4** Proposed Design Changes
- **3.4** LinSig Modelling Approach
- **3.5** Program Settings
- **3.5.1** Junction Details
- **3.5.2** Controller Details
- **3.6** Model Build
- **3.6.1** LinSig Model Structure
- **3.6.2** Traffic Flows
- **3.6.3** Routing / Lane Usage
- **3.6.4** Saturation Flows
- **3.6.5** Flare Usage
- **3.6.6** Priority Give-Way Parameters
- **3.6.7** Opposed Right-Turning Vehicles
- **3.6.8** Demand-Dependent Stages
- **3.6.9** Exit-blocking
- **3.7** LinSig Output
- **3.7.1** Link Results
- **3.7.2** Cyclic Flow Profile and Uniform Queue Graphs
- **3.7.3** Report Builder
- **3.8** LinSig Calibration Requirements
- **3.9** LinSig Validation Requirements
- **3.10** Developing Proposed Models
- **3.10.1** Cycle Time Optimisation
- **3.10.2** Signal Timing Optimisation
- **3.11** Additional LinSig Modelling Issues
- **3.11.1** Sliver Queues

### 4 TRANSYT Modelling

- **4.1** Introduction
- **4.1.1** TRANSYT 13
- **4.1.2** TranEd
- **4.1.3** Appropriate Use of TRANSYT
- **4.2** TRANSYT Modelling Approach
- **4.2.1** Program Settings
- **4.3** Model Build
- **4.3.1** TRANSYT Network Structure
- **4.3.2** TRANSYT Labelling Convention
- **4.3.2.1** Node Numbering
- **4.3.2.2** Traffic Link Numbering

---

*Page numbers are for internal reference only.*
### 4.3.2.3 Pedestrian Link Numbering 115
### 4.3.2.4 Exit Link Numbering 115
### 4.3.2.5 Priority Link Numbering 115
### 4.3.3 Node Input Data 116
### 4.3.3.1 Signalised Nodes 116
### 4.3.3.2 Non-Signalised Nodes 116
### 4.3.4 Link Input Data 116
### 4.3.4.1 Major Links 117
### 4.3.4.2 Minor Links 117
### 4.3.4.3 Signal-Controlled Links 118
### 4.3.4.4 Bottleneck Links 118
### 4.3.4.5 Give-Way Links 118
### 4.3.4.6 Flared Approaches 119
### 4.3.4.7 Pedestrian Links 119
### 4.3.4.8 Entry and Exit Links 120
### 4.4 Modelling Techniques 120
### 4.4.1 Flow Smoothing 120
### 4.4.2 Adjustment of Start and End Lags 121
### 4.4.3 Demand-Dependency 121
### 4.4.4 Exit-Blocking / Underutilised Green Time 122
### 4.4.5 Opposed Right-Turn Movements at Signals 122
### 4.4.5.1 Stop and Delay Weightings 123
### 4.4.5.2 Queue Limits 124
### 4.5 Public Transport 125
### 4.6 Calibrated TRANSYT Base Model 125
### 4.7 Validated TRANSYT Base Model 126
### 4.8 Developing Proposed Models 126
### 4.8.1 Modifying Network Structure 127
### 4.9 TRANSYT Network Optimisation 128
### 4.9.1 Cycle Time Optimisation 128
### 4.9.2 Signal Timing Optimisation 128
### 4.10 TRANSYT Output 129
### 4.10.1 .PRT File 129
### 4.10.2 Graphical Output 130

#### 5 VISSIM Modelling 132

#### 5.1 Introduction 132
#### 5.1.1 Appropriate Use of VISSIM 132
#### 5.2 Developing Base Models 133
#### 5.2.1 Model Boundaries 133
#### 5.2.2 Model Time Periods 133
#### 5.2.3 Data Collection 134
#### 5.2.4 Site Observation 134
#### 5.2.5 Network Layout 135
#### 5.2.6 Traffic Flows and Turning Proportions 135
#### 5.2.7 Traffic Flow Compositions 135
#### 5.2.8 Signal Timings 135
5.2.9  Saturation Flows 136
5.2.10 Journey Times 136
5.2.11 Cycles and Powered Two-Wheelers 136
5.3  Model Building Process 137
5.3.1 Network 137
5.3.1.1 Simulation Parameters 137
5.3.1.2 Time Period 138
5.3.1.3 Simulation Resolution 138
5.3.1.4 Units 138
5.3.1.5 Links and Connectors 138
5.3.1.6 Link Driving Behaviour 139
5.3.2 Traffic Data 140
5.3.2.1 Vehicle Models, Types, Categories and Classes 140
5.3.2.2 Functions and Distributions 140
5.3.2.3 Compositions and Demand 141
5.3.2.4 Pedestrian Modelling 141
5.3.2.5 Reduced Speed Areas and Desired Speed Decisions 141
5.3.2.6 Routing Decisions 142
5.3.3 Control Infrastructure 142
5.3.3.1 Controller Logic 142
5.3.3.2 Demand-Dependent Stages 143
5.3.3.3 Placement of Signal Heads 144
5.3.3.4 Priority Rules and Conflict Areas 144
5.4 Calibration and Validation of Base Models 144
5.4.1 Base Model Calibration 145
5.4.2 Validated Model Requirements 145
5.4.2.1 Saturation Flows 146
5.4.2.2 Traffic Flows 147
5.4.2.3 Demand-Dependency 147
5.4.2.4 Journey Times 147
5.4.2.5 Queue Data 147
5.5 Considerations During Calibration and Validation 148
5.5.1 Use of Seed Values 148
5.5.2 Error Files 148
5.5.3 Use of Multithreading during Validation 149
5.6 Dynamic Assignment 149
5.6.1 Convergence 149
5.7 Proposed Models 150

6  **Highway Traffic Assignment Modelling** 151
6.1 Introduction 151
6.1.1 HTA Modelling in TFL Streets 152
6.2 HTA Modelling Software 152
6.3 HTA Data Collection 152
6.4 Network Development 153
6.4.1 Zones and Connectors 153
6.4.2 Nodes and Links 154
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4.3 Signalised Junctions</td>
<td>155</td>
</tr>
<tr>
<td>6.4.3.1 Junction Geometry</td>
<td>157</td>
</tr>
<tr>
<td>6.4.3.2 Capacity Considerations</td>
<td>158</td>
</tr>
<tr>
<td>6.4.4 Priority Junctions</td>
<td>159</td>
</tr>
<tr>
<td>6.4.5 Public Transport</td>
<td>160</td>
</tr>
<tr>
<td>6.5 Calibration</td>
<td>161</td>
</tr>
<tr>
<td>6.6 Assignment</td>
<td>161</td>
</tr>
<tr>
<td>6.6.1 Realistic Delay using Equilibrium Assignment in Congested Networks</td>
<td>162</td>
</tr>
<tr>
<td>6.6.1.1 Blocking Back</td>
<td>163</td>
</tr>
<tr>
<td>6.6.2 Convergence</td>
<td>163</td>
</tr>
<tr>
<td>6.7 Model Validation</td>
<td>164</td>
</tr>
<tr>
<td>6.7.1 Assignment (Route Choice) Validation</td>
<td>165</td>
</tr>
</tbody>
</table>

**CLOSING SUMMARY**

**GLOSSARY**

**APPENDICES**

Appendix I: Underutilised Green Time (UGT) Calculation 171
Appendix II: Proposed Model Optimisation Process 173
Appendix III: Flow comparison (The GEH Statistic) 175
Appendix IV: VISSIM Dynamic Assignment Convergence Methods 180

**LIST OF FIGURES**

Figure 1 Transport modelling hierarchy 22
Figure 2 Flow profiles showing 'normal' (blue) and 'congested' (orange) conditions 73
Figure 3 Congested conditions as modelled in LinSig or TRANSYT with UGT 74
Figure 4 Incorrectly reduced saturation flow analogous to UGT applied in Figure 3 74
Figure 5 Schematic diagram outlining a generalised approach to traffic model development for TfL 80
Figure 6 Development and evaluation of a proposed traffic model for TfL 83
Figure 7 Overview of a proposed approach to traffic model optimisation 88
Figure 8 Relationship between junction delay and degree of saturation 90
Figure 9 Example junction showing arms, links and lanes in LinSig 99
Figure 10 Formation of a sliver queue in a LinSig uniform queue graph 106
Figure 11 The same queue as Figure 10 with a de-sliver threshold of 1.0 PCU 107
Figure 12 The TRANSYT optimisation process, adapted from Binning et al 110
Figure 13 TRANSYT Node and Link labelling system (shown for J05/066) 114
Figure 14 Cyclic Flow Profile graph, as shown in TranEd 131
Figure 15 VISSIM Simulation Parameters for an example model 137
Figure 16 Correct (left) and incorrect (right) connector usage for modelling lane gain or loss 139
Figure 17 Adjustment of timings in VISSIM to account for Red/Ambger (R/A) 143
Figure 18 A VISUM main node – as on-street (left) and within the model (right) 156
Figure 19 Examples of incorrect and correct network coding using a dual carriageway junction in VISUM 158
Figure 20 A bi-level approach to traffic assignment with operational-level turn delays 162
2.6.1.2 Junction Storage Effects

Storage in front of stoplines for opposed turners are frequently modelled as ‘bonus’ green, in order to account for vehicles clearing during the intergreen period. Where storage bonuses have been modelled, they should not be removed from any optimisation steps unless physical layout or staging changes within a proposal prevent the storage in front of the stopline from being used.

2.6.1.3 Cycle Time Optimisation

Scheme designers should choose an optimum cycle time that balances road traffic demand with pedestrian delay. If a change to cycle time is under consideration then it is important to understand its impact upon delay to pedestrians, linking to other signals and the overarching objectives outlined in the Mayor’s Transport Strategy 2010.

The entire UTC control group should be modelled where a cycle time change is anticipated for a proposed scheme. Only SCOOT compatible cycle\(^{47}\) times should be considered, even in UTC fixed time and non-UTC areas.

Cycle times should be kept as low as practically reasonable to minimise pedestrian delay, and ideally pedestrian waiting times should not exceed 83 seconds. The lowest UTC-compatible cycle time is 32 seconds. SCOOT nodes require an additional 4 seconds over and above the summation of SCOOT stage minima, meaning cycle times of lower than 64 seconds prohibit SCOOT double cycling.

Pelican sites should be designed to double cycle where appropriate. Designers can explore the possibility of increasing a junction cycle time to produce pedestrian benefits at other sites within the group. An increase in cycle time can facilitate double cycling, asymmetrical double greening or allow the provision of an extra stage that directly benefits pedestrians. Similarly a proposed cycle time increase at one junction, in order to accommodate a proposed pedestrian facility, should not have a detrimental effect on other facilities within the operational group. This may create additional delay to pedestrians and result in net disbenefit across the operational group.

2.6.1.4 Junction Performance

It is useful to be aware of the relationship between traffic delay and DoS in order to best optimise junction performance during proposal development. The relationship illustrated within Figure 8 strengthens the considerations outlined in Part A, which highlight the role stable network performance can play in maintaining journey time reliability. Engineers should be mindful that delay begins to increase exponentially above approximately 85% DoS. At junctions operating close to zero Practical Reserve Capacity (PRC), corresponding to approximately 90% DoS, small reductions in capacity can result in a significant increase in delay. For this reason a DoS of 90% represents an upper limit of practical capacity for signalised junctions. Unsignalised junctions typically have a lower practical capacity limit, with DoS in the range 80–85%. Junction capacity relationships are important when designing schemes in order to ensure that new proposals perform capably within the existing network.

---

\(^{47}\) Allowable SCOOT compatible cycle times, in seconds, are: 32, 36, 40, 44, 48, 52, 56, 60, 64, 72, 80, 88, 96, 112 and 120.
2.6.2 Optimisation Fine Tuning

The fine tuning stage of optimisation allows a modeller to manually influence the initial settings automatically generated by a software algorithm. It is at this stage where engineering judgement can maximise an opportunity to fully utilise the proposed design. The major design decisions have been completed and acknowledged as fit for purpose so this stage of the process evaluates how minor modifications to the proposal can maximise network performance relative to the base. The following subsections outline a few approaches to fine tuning which can be employed to generate an operable signal strategy.

2.6.2.1 Balancing the Network

A modeller can seek to achieve more balanced loading of the network if model output indicates that queue storage problems are apparent after initial optimisation. The available network capacity can be manually adjusted (e.g. through changes to green splits) during fine tuning, with the model then undergoing offset only optimisation to ensure good platoon progression but with a fixed network capacity.

Fixed relationship junction groups should not be changed from a validated base model without prior consultation with TD NP as these permanent offsets may be a prerequisite for any proposed timing plan.