Regional Transport Models

Alison Cox
Roger Himlin

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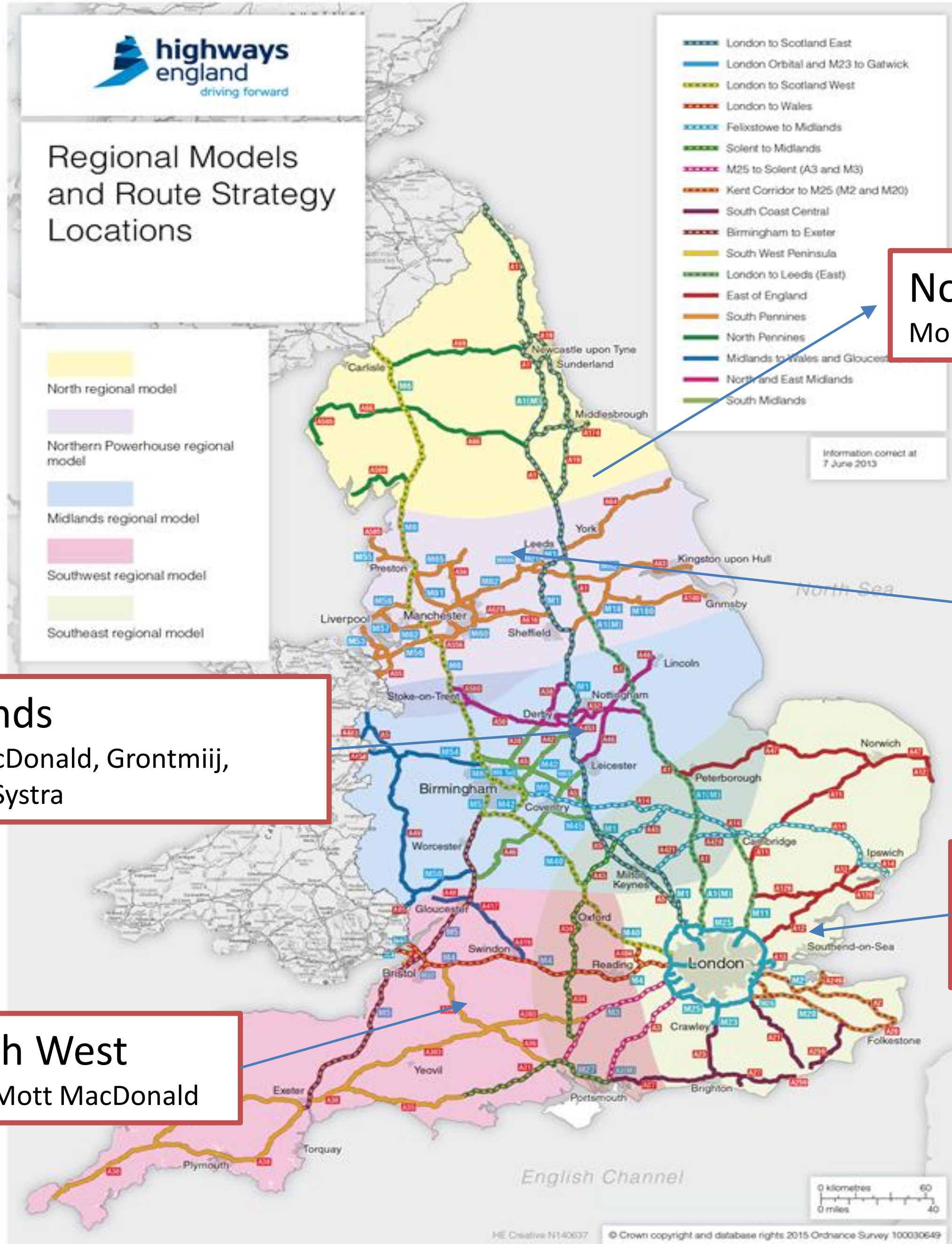
Background and Objectives

- **Background**
  - Highways England tasked with delivering over 100 major schemes within RIS1 2015 – 2020.
  - Historically building individual scheme models is time consuming
  - Required approach to speed up the modelling and appraisal process
  - Regional modelling approach will give scheme appraisal a head start
  - Schemes will either be assessed entirely within RTMs or as donor model
  - Will enable national impact of RIS 1 to be understood
  - Will inform the development of RIS 2
- **Model Objectives**
  - To use a common software platform
  - To follow a common approach
  - To use common data sources
  - To maximise RTM model use for scheme appraisal
  - To use GIS front end for visual presentation



North
Mouchel, PBA, JMP, SDG

Trans Pennine South
Atkins/AECOM/Systra

Midlands
Mott MacDonald, Grontmiij, AECOM, Systra

South East
Hyder, CH2M, Atkins, AECOM

South West
Arup, Mott MacDonald

Key Challenges to Delivery

- Tight Timescale

- Size of Models
  - Software Requirements
  - Hardware Requirements
  - Run times
  - Number of Zones

- New Sources of Data
  - Mobile Phone
  - Data fusion

- CONSISTENCY

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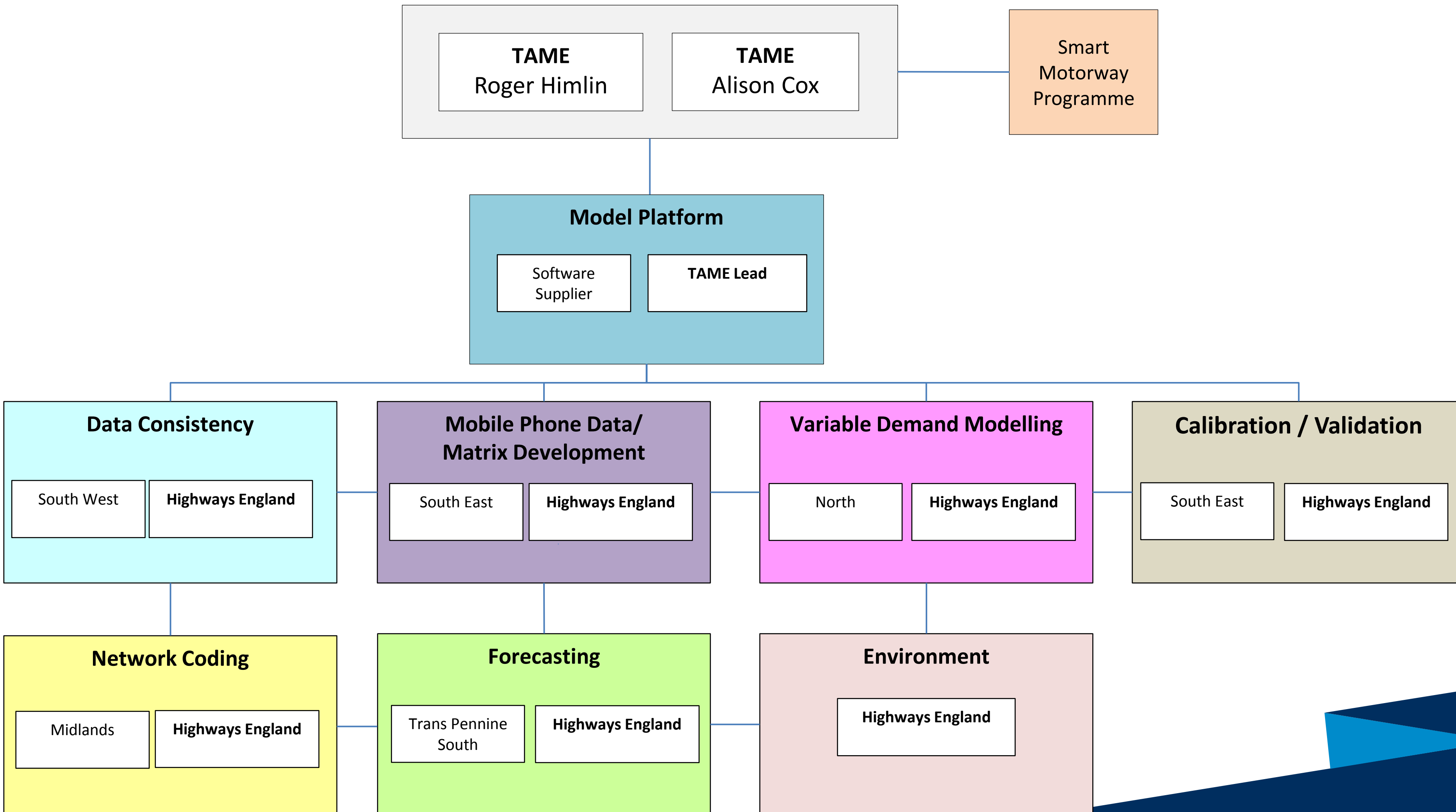
Key Objective - Technical Consistency



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Network Development

- Common buffer network from ITN layer

- Software capabilities and model run times drive level of network coding and zoning

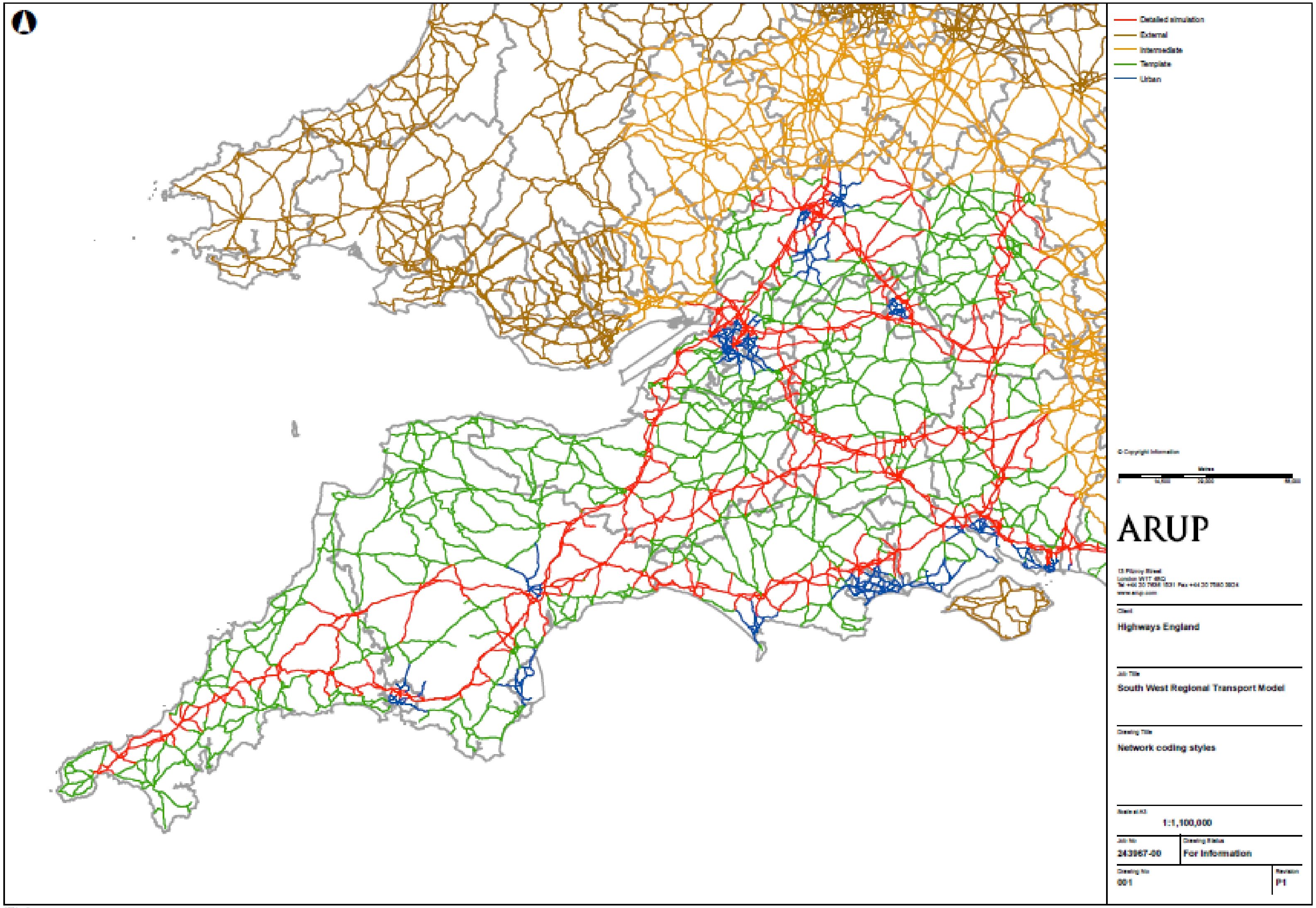
- Detailed simulation coding focussed on SRN and RIS scheme areas with graduated zoning system applying away from SRN

- All junctions on SRN are coded in simulation allowing for blocking back/flow metering.

- The simulation network includes
  - all the motorways and A roads managed by Highways England;
  - Other "A" roads and "B" roads with material role in allowing traffic to access SRN;
  - any local roads or "C" roads that are necessarily included in order to capture local traffic routing realistically.

- Network outside the region of focus mainly modelled as simplified simulation network
  - Speed/flow curves
  - Dummy nodes with max turning saturation flow to avoid unrealistic junction delay
  - Urban areas coded as fixed speeds derived from Trafficmaster data

Network Detail



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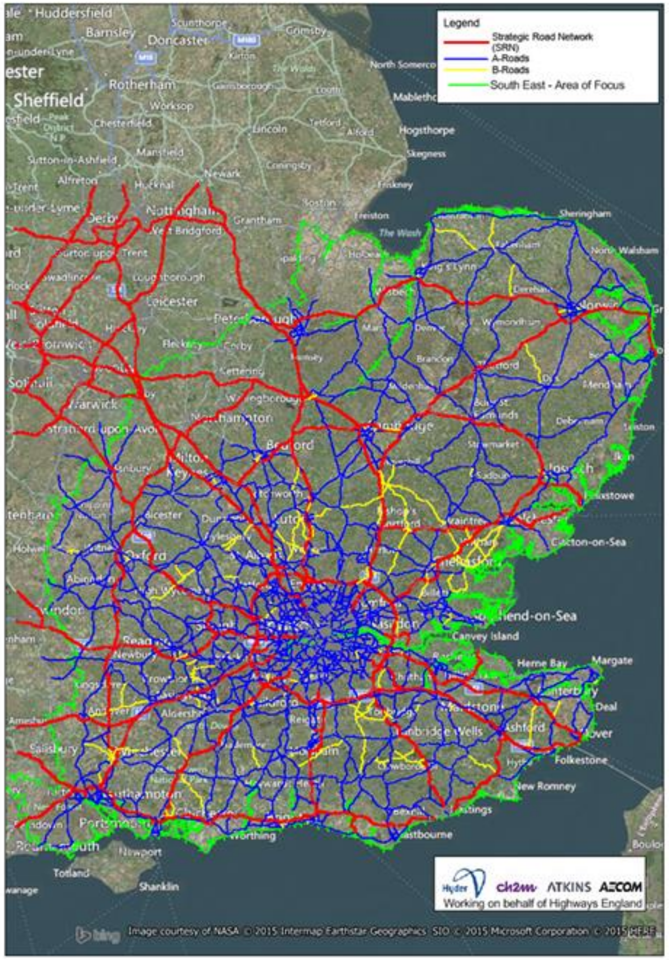
Network Development

- RTM common coding manual to ensure consistency
- SATCODER being used by some of model teams.
- Common network validation checks



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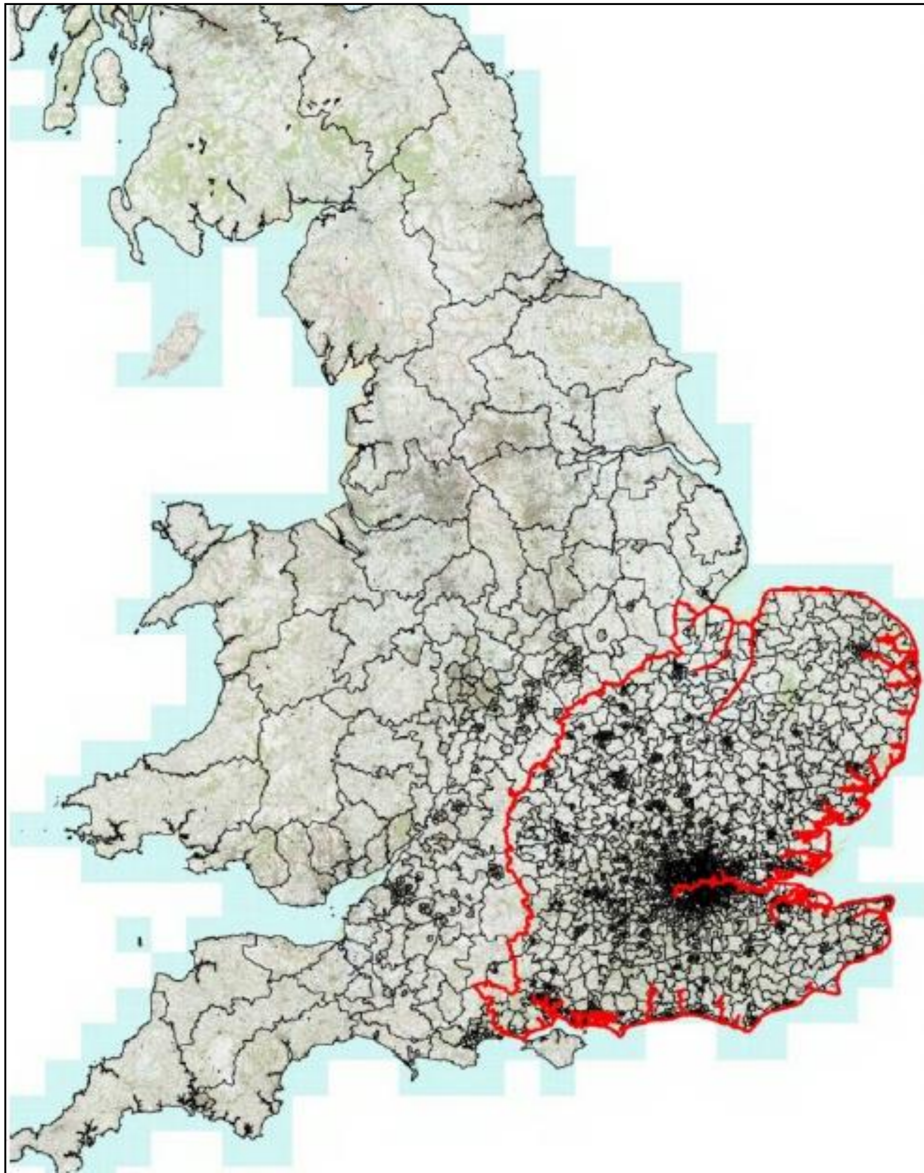
Model Zoning



Regional Traffic Model	Total Zones	Total Internal Zones
South East	2,268	2,172
South West	1,901	1,627
Midlands	1,481	1,166
TPS	1958	~1,833
North	1,253	1,161

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Highway Model Trip Matrix Development

- Highways England mobile phone data contract awarded to Telefonica – Jacobs

- Mobile phone data to form the backbone of the trip matrices

- Matrices being developed with provisional data
  - Average 20 weekdays March
  - HBW, HBO, NHB
  - Road based
  - Granularity MSOA, start time

- Short distance trips being infilled using synthetic matrices

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Issues with Mobile Data to date….

- Key strengths of data compared to conventional data sources
  - Wider geographical coverage
  - Higher sample size, capturing day-to-day variability of trips
  - Potential time and cost savings for data collection and processing
- Weaknesses/Uncertainties
  - definition of a trip
  - spatial resolution and data accuracy
  - short trip
  - mode, vehicle type and vehicle occupancy
  - trip purpose
  - expansion
  - stochastic rounding due to privacy

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Mobile Phone Data Verification Checks

- Trip-ends & symmetry
- Trip rates
- Trip distribution pattern
- Trip length profile
- Trip Purpose allocation
- Daily profile of trips
- Level of vehicle flows

Table 3-1: *Description of Provisional Data Verification Tests and the Acceptance Criteria*

Test ID	Demand Indicator	Data Check / Comparison	Analysis Approach	Geographical Level	Criteria	Purpose of Test / Problems to Identify	See Note
A	Removal of Rail Trips	All day HBW from-home origins and destinations vs. Census JTW 'home' and 'work' locations, separately for JTW data with and without rail trips	Regression analysis / scatter plots	MSOA / Model Zones / LA Districts	No criteria, comparison of R^2 values, look for outliers	• Verify removal of rail trips	1
	Trip-ends	All day from-home trip origins and to-home trip destinations vs. Census population, separately for HBW and HBO trips.	Regression analysis / scatter plots	MSOA / Model Zones / LA Districts	$R^2 \geq 0.90$, slope close to unity and small intercept (at LA district level only)	• Verify usability of the data • Spatial accuracy of trip allocation to MSOAs • Inform requirements for defining mobile data sectors as aggregations of MSOAs.	2
		All day HBW from-home origins and to-home destinations vs. Census JTW 'home' locations					
		All day HBW from-home destinations and to-home origins vs. Census JTW 'work' locations					
		All day trip origins and destinations vs. customised NTEM trip-ends, separately for HBW, HBO, and NHB.	Regression analysis / scatter plots	Model Zones	$R^2 \geq 0.90$, slope close to unity and small intercept		
	Symmetry	From-home vs. to-home (all day, all purposes)	Regression analysis / scatter plots	MSOA	$R^2 \geq 0.95$, slope close to unity and small intercept		
		From-home vs. to-home (all day, HBW)					
		All origins vs. all destinations (all day, all purposes)					
		Undertake the test for matrix cells			No criteria		

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Creation of Prior Matrices

- Matrix Adjustments
  - Excluding bus and rail
  - Spatial resolution
  - Infilling short trips
  - Expansion

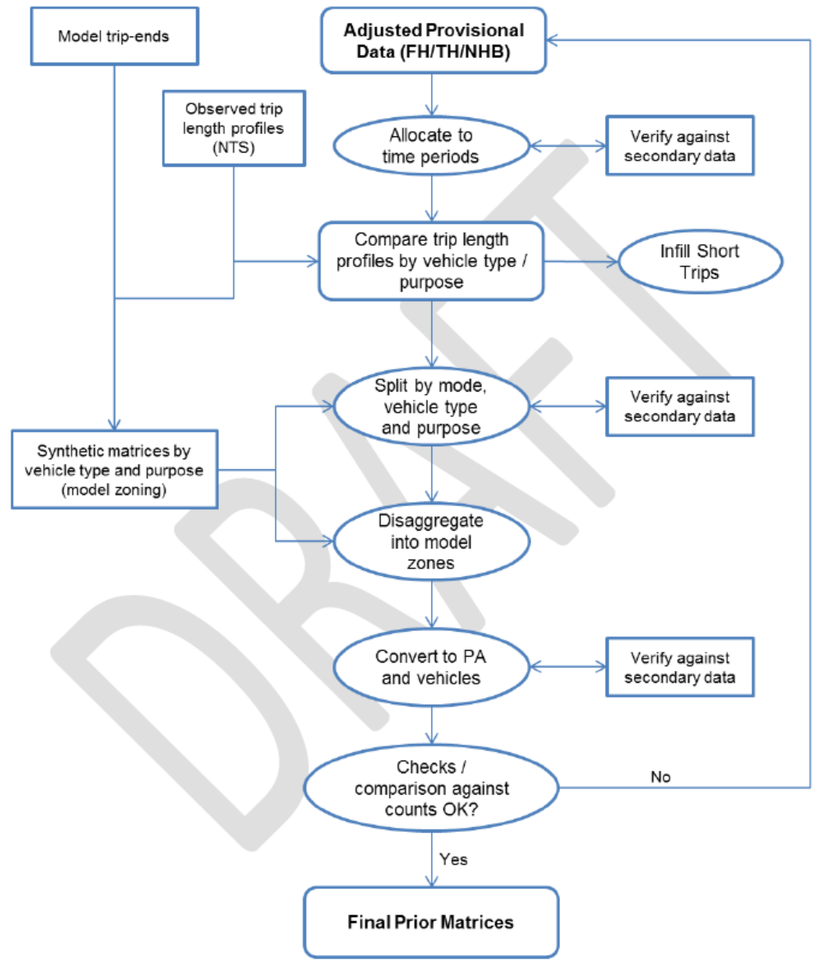
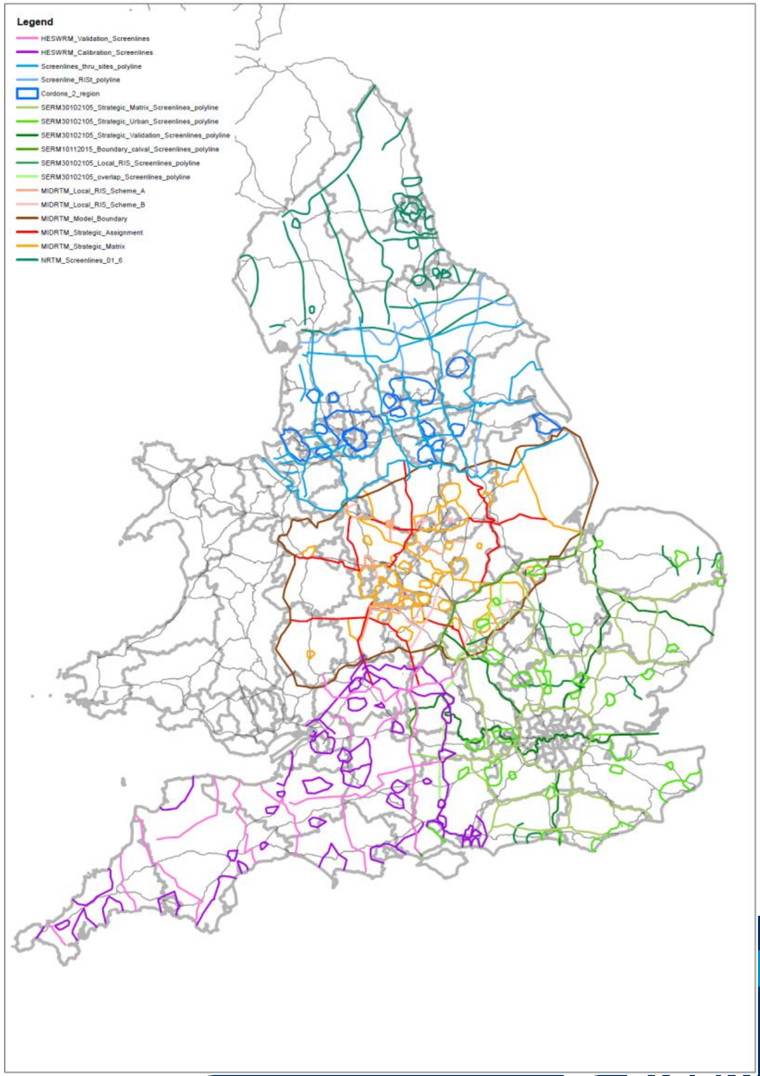


Figure 4-1: *Summary of Matrix Development Process*

Model Calibration and Validation

- **Emerging principles and levels of acceptability from TCG**
  - Consistent screenlines between models at boundaries
  - Internal inter urban screenlines

- **Validation will be aggregated into different areas of interest**
  - Focus on the areas where RIS schemes are proposed and SRN



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Variable Demand Model

- DIADEM
- Public Transport represented by cost changes
- DIADEM enhancements desirable:
  - initiated from a command line
  - able to undertake the same lognormal function that is being considered for the derivation of the synthetic matrices
  - providing greater flexibility in definition of vehicle occupancies (e.g. by time period and distance, or by matrix cell\sector)
  - providing greater flexibility in period to hour factors
  - providing the option to specify fixed costs for some time periods (particularly Off Peak so that DIADEM does not need to run an OP assignment)

- Creating a common process by which input and output files are managed, stored and processed – VBA?
- New VoT represented by continuous distance function

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Run Times?

- Quick straw poll:

Who here has played a modern computer game or seen one being played?

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Run Times?

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Run Times?

- Reasonable resolution monitor
  - 1920 x 1080
- 60 frames per second minimum (demo maxed at 200fps)
- ~125-415 million calculations per second

- CPU: Maximum of 16 cores? Roughly
- Current cutting edge GPU?

Run Times?

- NVIDIA Titan X: 3,072 cores!
- 1.5 teraFLOPS – equivalent to the supercomputers of 1996!

- So why can't we use this brute force already?
- GPU languages ≠ CPU languages
- But!

Run Times?

- NVIDIA CUDA
- ‘Wrapper’ for CPU languages.
- What have other industries seen?
- Hydrographic modelling:
  - speed up factors of x 90 with a single GPU (7 days → 1.8 hours)
  - speed up factors of x 125 with two GPUs (7 days → 1.3 hours)
- CUDA Fortran released in 2009
- The chance for SATURN to run on a GPU!

Run Times?

- Not all areas of traffic modelling are ‘massively parallel’, but certainly large areas are!
- Highways England / Transport Systems Catapult / University of Sheffield (NVIDIA) / Science & Technology Facilities Council & Atkins – proof of concept for transport modelling
- What else consists of massively parallel calculations?...VDM
- DIADEM

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