Signalling change

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LinSig has been the traffic signal design tool of choice in the UK for over 25 years and during this period has undergone significant development and improvement. The most recent version – LinSig3 – when released in June 2009 introduced a range of new features including lane based modelling and the ability to model larger networks of up to 15-20 junctions. Since the initial release of version 3 almost two years ago LinSig has been updated a number of times to incorporate additional ongoing research on the LinSig traffic model and optimiser which has led to large improvements in model run times, and to add new features such as SCATS™ based terminology and Google Maps integration

Traffex 2011 sees the launch of the first more significant update to LinSig3 – Version 3.1. This new version includes a number of new major features as detailed in this paper as well as the usual range of smaller improvements. What's more LinSig3.1 will be available free of charge to all users with current LinSig3 support.

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GENERAL CAPABILITIES OF LINSIG3

LinSig is a traffic signal design and modelling tool for single junctions and networks of junctions. It has been designed to allow engineers to use the software to reach the best design for a junction as rapidly as possible whilst exploring sufficient options along the way. A key feature of LinSig is that whilst carrying out all of the necessary modelling and 'number crunching' it deliberately does not hide engineering decisions from the engineer. In many cases traffic signal design decisions need intuition, judgement and experience all of which computers are very poor at. LinSig uses the strategy of supporting the engineer in this process by providing detailed modelling results and statistics but also making it very easy to 'play' with the model allowing variants of options and ideas to be quickly tried and explored.

Key features of LinSig

It is not possible to provide a detailed look at all of LinSig's features here but key concepts and features in LinSig are:

- **Detailed Traffic Model**. A network traffic model which models the detailed behaviour of traffic on each lane providing predictions of capacity, delay and queuing. LinSig uses the Cyclic Flow Profile method of modelling similar to that used in TRANSYT and can therefore model coordination between junctions.
- **Detailed Signal Controller Model.** A sophisticated Controller Model based on the UK Department for Transport TR2500 specification capable of modelling multiple stage streams and multiple controllers.
- **Pedestrian Modelling.** LinSig can model delays to pedestrians and also assist with assessing coordination and linking of pedestrian crossings within a junction.
- **Traffic Signal Optimiser.** Many signal modelling packages utilise general 'off the shelf' optimisation methods to optimise signal times within a network of signal junctions. LinSig uses a special custom designed optimiser to optimise signal times. This allows the optimiser to fully take into account all of the unique behaviours of a signal network potentially leading to better, more stable, green times with shorter run times.
- **Equilibrium Assignment.** Where a trip matrix is available for the network being modelled LinSig can assign the matrix to the network using the equilibrium assignment method as used in strategic models such as SATURN. This uses modelled delays to estimate how traffic will reroute when changes are made to the network.
- **Matrix Estimation.** Where a matrix doesn't already exist for a network LinSig can estimate a 'best fit' matrix using the standard maximum entropy method.

Although LinSig contains much more than the above, these features and concepts form the backbone of LinSig for Version 3.

LINSIG PRIORITIES MOVING FORWARD

JCT have always recognised that user feedback is vital in ensuring LinSig provides what users need. Development priorities are set for LinSig from three main sources:

- Internal feedback from JCT's own consultancy staff who use LinSig every day.
- Suggestions and comments from clients who may have specific needs unique to themselves or to a group of similar clients.
- Software Support monitoring. A careful eye is kept on incoming software support questions for any common threads which may indicate fruitful areas for improvement.

As part of this process a number of priorities were established for the next major set of improvements after the initial release of LinSig3. These are:

- **Faster model run times and signal optimisation.** When originally released LinSig3 provided the ability to model signal networks in great detail albeit with longer run times than earlier more basic versions of LinSig. Although feedback showed that most users preferred more detail even if run times were longer, they preferred even more to have more detail with faster run times. Research was done into improving the efficiency of the model algorithms resulting in significant improvements to model and optimiser run times. These improvements were significant enough to release the first batch of improvements early in mid 2010.
- **Additional flexibility when defining traffic flows.** A number of LinSig users wanted more flexibility in how traffic flows were defined. Many had existing traffic flow information which defined flows on a lane by lane basis and wanted to directly enter these flows for each lane rather than produce and assign a matrix based on these flows. Others wanted a hybrid approach where base model flows were derived from traffic counts and directly entered as lane flows but future year and development flows were specified as a matrix and assigned to the base network on top of base traffic flows. LinSig3.1 will introduce a number of new ways of defining traffic flows to address this as described below.
- **Tools for Auditing & Calibrating models.** Transport for London (TfL) has developed an auditing procedure

If you want to know more about LinSig3.1, you will be able to catch up with Paul and colleagues at Traffex

for LinSig network models, which will be known as LinSig Model Audit Process (LMAP). LMAP will provide rigorous guidelines for calibrating and validating LinSig network models intended for submission to TfL. Whilst developing LMAP TfL requested a number of potential new features for LinSig to enable this process. The majority of these features have been included in LinSig3.1 as described below

- **A basket of other smaller improvements** that would provide significant benefits to subsets of users, an example being multiple intergreen sets which are useful in modelling puffin crossings.

The remainder of this paper describes how some of the above improvements have been delivered in LinSig3.1.

MAJOR NEW FEATURES IN LINSIG3.1

New Traffic Flow Definition Methods

To address the above priorities relating to traffic flow definition a new structured system of traffic flow entry has been developed. This introduces a completely new way of specifying flows on a lane-by-lane basis as well as allowing different flow definition methods to be mixed together within the same model.

Lane Based Flow Definition

As described above a requirement was identified to enter traffic flows on a lane-by-lane basis as an alternative option to the existing matrix based method of flow definition. This raised a number of issues as when similar systems of specifying traffic flows have been used in the past in other models they have suffered from a number of shortcomings. One of these was the large amount of numerical data entry was required which could be tedious, error prone and time consuming.

Because flow continuity is not guaranteed as is the case with matrix based methods it is the user's responsibility to ensure consistency between traffic flows on connecting traffic movements.

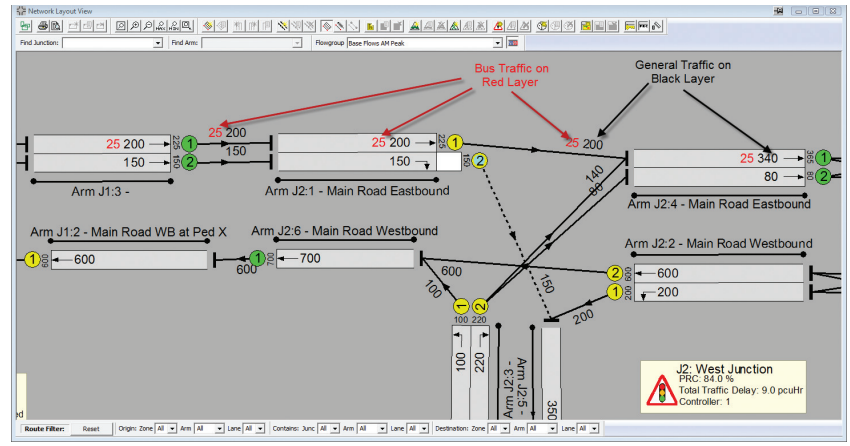
If traffic flow information changed a large amount of re-editing of numerical data was necessary to re-enter flows. This can be very common when dealing with development models as development generated traffic flows can change frequently as developers explore different land use options.

To address these issues a considerable amount of work has been done to develop a graphical flow entry system which aims to allow rapid entry of lane based traffic flow data and also to provide checks on flow data quality.

Using the new system traffic flows are entered separately for each lane using a combination of two methods.

Another issue was the graphical flow entry method which allows flows be defined by dragging traffic flows between lanes to define movements and traffic volumes on these movements. LinSig aims to assist as much as possible by making intelligent guesses as to what the users intentions are (such as how much flow to move and whether it should be added or moved from other lanes) at each step allowing data entry with the minimum of mouse clicks where these guesses are correct. Where it is not possible for LinSig to infer exactly what the user is doing the user is asked to confirm or change LinSig's initial guess. This system of using assisted intelligent guesses allows very rapid data entry for common or typical situations where LinSig is able to work out what is going on whilst providing flexibility to easily override LinSig where flow patterns are more atypical.

As well as the new graphical method LinSig also provides a flow management dialog box which allows the details of traffic flows be changed at any point including detail which would be too cumbersome to edit graphically. This two-level approach works well as it allows the best features of different methods to be used in a complementary manner.



Traffic layers can be defined manually and the new graphical interface used to manually split traffic between these layers.

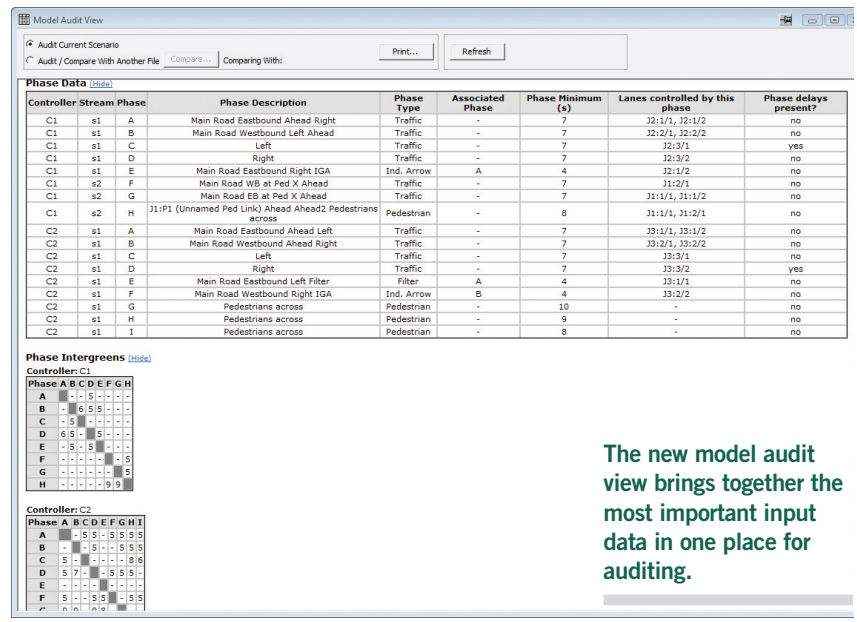
Layered Flow Definition

One of the benefits of using a trip matrix to define traffic flows in LinSig is LinSig's ability to automatically keep different traffic movements or types of traffic separate in the traffic model. For example in a model of a 4 arm signalled roundabout traffic travelling from each entry arm to each exit arm remains identifiable throughout the entire modelling process. LinSig in effect models different types of traffic or traffic movements as separate 'layers' of traffic. Interactions between traffic on different layers is fully modelled within queues etc. but each layer is separately identifiable throughout the modelling process. This improves the accuracy of the model as each layer has its own modelled traffic profile on each lane rather than simply being taken as a proportion of an aggregate profile encompassing all layers. TRANSYT users may recognise this system as being a more advanced version of the shared link system used in TRANSYT.

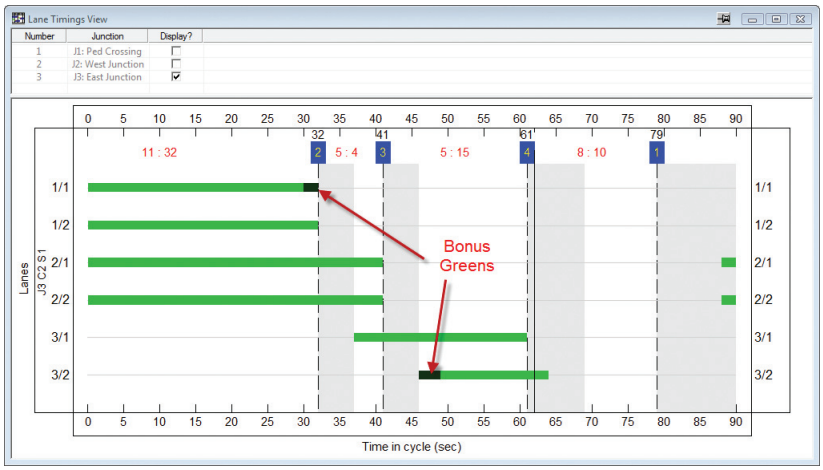
When using a trip matrix in LinSig the layered system is implemented automatically with no extra work splitting non-layered flows into layered flows.

Layered Flows in a Lane Flow based System.

When traffic flows are defined by lane LinSig only knows



The new model audit view brings together the most important input data in one place for auditing.



The bonus green facility allows any lane to have its effective start or end of green offset to start earlier or later than just the signal timings would dictate.

the total flow on a lane, the previous lane the flow has come from and the next lane the flow is going to. As none of the routing information associated with the matrix based method is available it is necessary to manually define how flows are layered when defining flows by lane.

LinSig addresses this by allowing traffic layers to be defined manually and the new graphical interface used to manually split traffic between these layers. Layers can define different traffic types, such as car or bus, or traffic movements such as 'traffic from entry A', or any other reason to disaggregate traffic. The new graphical user interface is very important here as the ability to visualise and manage all the flow information in an efficient manner is vitally important.

Bus modelling using Layers

The introduction of layered flow definition in LinSig also makes it significantly easier to model bus traffic separately within LinSig. Buses can be defined as their own separate layer with appropriate modelling of bus cruise speeds and stopping times for bus traffic on this layer whilst traffic on other layers is modelled with standard cruise speeds.

Structured Flow Definition

One important priority which complements the new lane based method of traffic flow definition is the ability to mix and match different flow definition methods within the same model.

Since the release of version 2 LinSig has had a system of structured flow definition using formula flow groups. Different component flow groups can be developed for different flow components, for example base model flows, or development flows before being combined using simple formulae into different composite flow groups. If any component flow group changes (typically the development generated traffic) all dependent flow groups will automatically be recalculated to include the changes.

Version 3.1 adds significantly more flexibility to this system by not only allowing each flow group to be either matrix based or lane flow based but also allowing each flow group to cover different areas of the modelled network. This allows great flexibility in defining traffic flows as the most appropriate method of defining flows can be used for any particular section of the network or for any particular type of traffic.

For example consider a network consisting of a signal roundabout connected to a corridor of signal junctions with a new development at the end of the corridor. Assuming traffic turning counts for each junction, an origin-destination count for the signal roundabout and projections of traffic generation for the new development are available. One option could be to enter all of the turning counts into LinSig and use matrix estimation to estimate a matrix for the entire network. This is probably too detailed in this situation as although the origin-destination pattern is important for the signal roundabout it is probably unnecessary to know OD information for the whole combined network. It is however probably important to consider the whole network when considering how development traffic will route away from the development especially when having to manage a large number of development options.

LinSig3.1 now allows a matrix based flow group to be used for the signal roundabout, a new lane based flow group for the corridor together with several development traffic flow groups each of which covers the entire network. These flow groups can be defined independently and then merged together to provide a full definition of traffic flows within the modelled network. At any point any of these component flow groups can be changed with new overall traffic flows being automatically recalculated. This new system also helps isolate changes to traffic flows to sub areas of the network avoiding the need to recalibrate the whole network when changes occur in only one small area.

AUDITING & CALIBRATION/VALIDATION TOOLS

A key requirement of Transport for London's LMAP process is robust efficient auditing of a LinSig model. To meet this objective a number of new tools were developed to help with auditing models. These include:

Model Audit View. This new LinSig view brings together the most important input data in one place for auditing. The layout is also standardised avoiding the need for the checking engineer to familiarise themselves with many different custom report formats.

Bonus Greens. A key part of the LMAP procedure is allowing for underutilised green time and demand dependency at signal junctions. TfL have traditionally allowed for these effects in TRANSYT models by either modifying start/end lags or using the bonus green facility in JCT's TranEd interface for TRANSYT. The bonus green facility allows any lane to have its effective start or end of green offset to start earlier or later than just the signal timings would dictate. To provide continuity with previous methods LinSig3.1 provides a new more advanced bonus green facility allowing fine control and calibration of congested networks whilst maintaining the integrity of the original interstage design. As well as model calibration the bonus green facility has numerous other uses including more detailed modelling of intersections using partially protected pedestrian facilities as are common in Australia and New Zealand.

Comment & Note Logging. It is important that users are encouraged to fully document assumptions within a LinSig model and also to document and control changes to a validated model. LinSig3.1 therefore adds a new Audit History View which allows an audit trail of notes detailing changes to model. There are also a number of additional opportunities to add notes to model items such as controllers and junctions.

CONCLUSION

LinSig3.1 is the first major release of LinSig since LinSig3 was released in June 2009. This paper has detailed some of the new features being provided in this new version and the rationale behind some of these new features. All of the new features will be on show on our stand at Traffex 2011 for anyone who would like to see more of the new features or discuss anything from this paper.