Appendix A: Signal Data Information for Modelling
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A.1 Introduction

The input of accurate traffic signal data is important in the calibration and validation of a base model and also in the assessment of proposed models. The Signal Data Information for Modelling document has been developed to provide detail of the options available for determining signal timings from SCATS\textsuperscript{1} data for an existing site and also for the calculation of signal timings for a proposed site. It is important to note that this document is intended for modelling purposes only.

For modelling an existing signalised intersection, the following information can be requested through Main Roads website:

**Light Maintenance drawings (LMA and LMB)**\textsuperscript{2} to identify:
- lane configuration
- permitted movements
- signal lantern configurations per signal group.

**SCATS site graphics** to identify:
- TCS number(s)
- SCATS region(s)
- phasing arrangement
- signal group numbers
- detector locations and numbers (for interpreting SCATS traffic volumes).

**SCATS Time Settings – Phase Times** to identify:
- late start
- minimum green
- early cut-off green
- yellow
- all-red
- maximum green.

**SCATS Time Settings – Walks** to identify:
- walk time
- clearance 1 and clearance 2 times
- protection time
- delay times.

---

\textsuperscript{1} SCATS (Sydney Co-ordinated Adaptive Traffic System) is an adaptive urban traffic management system that synchronises traffic signals to optimise traffic flow across a whole city, region or corridor.

\textsuperscript{2} LMA plans are traffic signal drawing plans that show the location of existing signal heads, SCATS detector loops and existing signal phases. LMB plans are signs and lines drawings showing the built geometry, carriageway widths and lane utilisation. LMA and LMB plans can be requested as a PDF or AutoCAD file.
**SCATS Time Settings – Special Times** which contains pedestrian protection time, if there is one.

**Phase Sequence Chart** which generally contains late start, delays, pedestrian protection and special facilities.

**SCATS Intersection Diagnostic Monitor (IDM)** or **History File data** to identify:
- phase lengths
- cycle times
- phase sequences
- traffic phase demand frequency
- pedestrian demand frequency (IDM and SCATS History Viewer).

**LX file** (for individual SCATS region) to identify:
- link plans
- offsets plans
- maximum flow (MF).

**Strategic Monitor** (system data) to identify selected link plans by SCATS
Appendix A: Signal Data Information for Modelling – Version 1.1

A.2 Average Signal Timing for Existing Sites

In the development of operational models the average timings are usually calculated for the relevant peak hour in the base model. This section of the information sheet provides information on how to calculate average signal timings based on SCATS data. These calculations should be included in the Model Summary Spreadsheet when the traffic models are submitted to Main Roads.

There are many ways to determine the average timings ranging from using very little data (five minute counts on site) to detailed analysis of SCATS data. For operational modelling Main Roads requires the use of SCATS data, such as History File or IDM, to determine the average signal timings.

A.2.1 SCATS History File

A SCATS history file is a log file which contains phase sequences and phase times at signalised intersections. These files are generally available for the last 12 months. SCATS History File Reader and SCATS History File Viewer allow the users to view the data, analyse and export them into a text or CSV file. These files can be generated after the required day.

As Figure A-1 shows, a history file (extracted from SCATS History Reader) contains date, start time, end time and duration of the phases. It also shows if a gap was detected during that phase.

Figure A-1: Example of SCATS History File (.txt)

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration</th>
<th>Phase</th>
<th>Gap</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sat 27-May-2017 00:00:00</td>
<td>00:00:00</td>
<td>00:00:15</td>
<td>15</td>
<td>A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:00:15</td>
<td>00:00:30</td>
<td>15</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:00:30</td>
<td>00:00:51</td>
<td>21</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:01:05</td>
<td>00:01:04</td>
<td>14</td>
<td>A</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:01:05</td>
<td>00:01:26</td>
<td>21</td>
<td>D</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:01:26</td>
<td>00:01:40</td>
<td>14</td>
<td>A</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:01:40</td>
<td>00:01:56</td>
<td>16</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:01:56</td>
<td>00:02:17</td>
<td>21</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:02:17</td>
<td>00:02:31</td>
<td>14</td>
<td>A</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:02:31</td>
<td>00:02:50</td>
<td>19</td>
<td>D</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:02:50</td>
<td>00:03:05</td>
<td>15</td>
<td>A</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:03:05</td>
<td>00:03:20</td>
<td>15</td>
<td>D</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:03:20</td>
<td>00:03:36</td>
<td>16</td>
<td>A</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 27-May-2017 00:03:36</td>
<td>00:03:54</td>
<td>18</td>
<td>D</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SCATS History Viewer is the newer version of SCATS History Reader and also provides an events file (.csv) which contains pedestrian information and activation of signal groups for the required day (Refer to Attachment A.1). This file can be used to calculate the pedestrian and alternative phase demands.

SCATS History Viewer files are usually available for the previous three months.
A.2.2 Intersection Diagnostic Monitor Data

The Intersection Diagnostic Monitor (IDM) is SCATS generated record of signal timing data such as phase sequence and phase duration. The IDM file (.idm) should be requested at least five business days prior to the survey date as there is a lead time for recording this information. Figure A-2 shows an example of an IDM file viewed in Microsoft Notepad.

**Figure A-2: IDM File Example**

![IDM File Example](image)

Figure A-3 shows an example of an individual cycle in an IDM file. The codes which are required for calculating average phase and cycle times are explained in Figure A-3.

In the text file, any line which contains date, time and traffic control signal (TCS) number indicates the start of a new cycle at the intersection (Refer to the 1st line in Figure A-3).

The proceeding lines in the text file which start with a letter present the phases which run during the cycle and their respective information. Numbers that are prefixed with “PT”, generally at the end of these lines, denotes phase length in seconds (Refer to the 2nd, 3rd and 4th lines in Figure A-3).

**Figure A-3: Example of a Cycle in an IDM File**

![Example of a Cycle in an IDM File](image)
In this example, A phase starts at 6:45:27 am and its total green time plus intergreen time was 23 seconds.

Figure A-4 shows the start time, end time and length of each phase as derived from the IDM file.

*Figure A-4: Example of a cycle in IDM*

- Total cycle length = 59 seconds
- Pedestrian Signal Group 1 one was called
A.2.3 Average Signal Timing Calculation

This section discusses the method that is recommended by Main Roads for calculating average signal timings for modelling. Calculations should be included in the modelling report for auditing purposes.

For modelling purposes, a complete cycle can be defined as from the start of the stretch phase\(^3\) of a phase sequence to the start of the next stretch phase. Figure A-5 shows an example of typical cycles of a signalised T-intersection with three phases. The stretch phase in this example is A phase. In cycle 2, C phase was skipped.

*Figure A-5: Cycles of a T-intersection with three phases*

The average cycle length and average phase lengths are calculated only for the completed cycles which start during the period. The last complete cycle may finish after the end of the modelling period, however, that will be included in the calculations. Therefore, ‘calculation period’ is defined from the start of the first stretch phase within the modelling period until the start of the first stretch phase after the end of the modelling period.

---

\(^3\) Every phase sequence has one stretch phase which will run in every cycle. The stretch phase uses all the time not used by the other phases in the sequence. Most of the time the stretch phase is A phase.
Figure A-6 shows an example of how the calculation period of average timings can fall outside of the modelling period due to the stretch phase of the last cycle to be included has started during the modelling period.

Figure A-6: Calculation period

The average length of the cycle time \( (c_t_A) \) during the time period can be calculated as below:

\[
 c_t_A = \frac{c_{T}}{n_C} \text{ (seconds)}
\]

Where:

- \( n_C \) is the number of complete cycles that occur during the calculation period. This is equal to the number of stretch phases that occur during the calculation period.
- \( c_T \) is total length of calculation period in seconds which is equal to the total length of complete cycles which starts during the time period. This is equal to the length of the time from when the first stretch phase occurred in the time period until the start of the first stretch phase which occurs immediately after the end of the time period (Figure A-6).
- \( t_i \) (e.g. for A phase, \( i = A \), for B phase, \( i = B \) etc.) is the average phase length for every phase in the sequence during the time period and it can be calculated as below:

\[
 t_i = \frac{p_t_i}{n_C} \text{ (seconds)}
\]

Where:

- \( p_t_i \) is the total time in seconds when \( i \) phase (\( i = A, B, ... \)) is active during the calculation period.
This activation time includes total green time and following intergreen time (early cut-off, yellow and all-red). The sum of the average phase lengths during a time period should be equal to average cycle length for that time period.

A.2.4 Pedestrian Demand Estimation

The IDM file (Figure A-3) and History Viewer Event file both record if a pedestrian signal group operates during a phase (e.g. W1). This can be used to estimate the pedestrian demand for modelling (i.e. when pedestrian signal groups are not run in every cycle).

In the IDM file, the number of pedestrian signal group activations during a time period may be estimated by counting the number of pedestrian codes (e.g. W1) recorded from the start of the first complete cycle until the end of the last complete cycle that started during the time period.

Attachment A.1 provides more information on pedestrian demand history file.
A.3 Signal Data Time Settings

For developing a well calibrated model of a signalised intersection, signal time settings in the model must be consistent with the current settings for an existing site or must be calculated carefully for a new site.

A.3.1 Vehicle Intergreen Times

Intergreen time is the period between the end of the green time of one phase and the beginning of the green time of the next phase. This transition time includes early cut-off time, yellow time and all-red time.

A.3.1.1 For New Sites

For new signalised intersections or existing signal intersections with proposed modifications, intergreen times may be changed. Therefore, for the new scheme, in order to minimise the risk of accidents, intergreen times should be calculated carefully. The formulae in the proceeding sections were published in Austroads 2016 Guide to traffic Management Part 9: Traffic Operations, Appendix G: Signal Timing.

A.3.1.1.1 Yellow Time

Yellow time provides sufficient warning of phase termination to drivers to decelerate and stop safely. A typical practical yellow time is defined from three to six seconds as recommended by Austroads.

The equation below from Austroads (AGTM09-16) shows how to determine the yellow time:

\[
 t_y = t_r + 0.5 \left( \frac{V_D}{3.6} \right) / (a_d + 9.8G) \quad \text{subject to } t_y \geq 3.0 \quad \text{(seconds)}
\]

\text{Equation: } A-1

where:

- \( t_y \) = yellow time (s)
- \( t_r \) = reaction time (s), (1.0 s – 1.5 s)
- \( V_D \) = design speed (km/h)
- \( a_d \) = the deceleration acceptable to the majority of drivers (m/s\(^2\)), commonly taken as 3.0 m/s\(^2\), but in the case of heavy vehicles a lesser value may be appropriate
- \( G \) = average approach grade over the stopping distance (per cent grade divided by 100)

\[
 \begin{cases} 
  G > 0 & \text{for uphill grade} \\ 
  G < 0 & \text{for downhill grade} 
 \end{cases}
\]

\text{e.g. -0.05 for 5% downhill}

\footnote{Early cut-off time is used at two stage traffic signals or advanced signal flashers. It may also be used to manage traffic in a network (gating etc.).}
It is recommended to round up the calculated yellow time from Equation: A-1 to the nearest 0.5 second for practical reasons. The same yellow time must be applied for the opposite traffic movements at an intersection on a grade.

Table A-1 shows appropriate yellow times for different approach grades to assist in implementation.

### Table A-1: Yellow time (Determined using \( t_r = 1.0 \) s and \( a_d = 3.0 \) m/s\(^2\))

<table>
<thead>
<tr>
<th>Approach grade</th>
<th>( V_D = 40 ) km/h</th>
<th>( V_D = 50 ) km/h</th>
<th>( V_D = 60 ) km/h</th>
<th>( V_D = 70 ) km/h</th>
<th>( V_D = 80 ) km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1% to 15% downhill</td>
<td>5.0</td>
<td>6.0</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
</tr>
<tr>
<td>6% to 10% downhill</td>
<td>4.0</td>
<td>4.5</td>
<td>5.5</td>
<td>6.0</td>
<td>6.5</td>
</tr>
<tr>
<td>4.1% to 5.9% downhill</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Level (0% to ± 4%)</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
<td>5.0</td>
</tr>
<tr>
<td>4.1% to 5.9% uphill</td>
<td>3.0</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>6% to 10% uphill</td>
<td>3.0</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>10.1% to 15% uphill</td>
<td>3.0</td>
<td>3.0</td>
<td>3.5</td>
<td>3.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Source: Main Roads Western Australia Website

The yellow time for signal groups with an early cut-off is equal to the yellow time of the phase in which the early cut-off operates.

#### A.3.1.1.2 All-red Time

The second part of the intergreen time is all-red time which provides sufficient time for vehicles crossing the stop line at the end of the yellow time of a phase or signal group to clear the conflict area with vehicle and pedestrian traffic of the next phase.

The recommended method by Austroads (AGTM09-16) to calculate all-red time is shown in the equation below:

\[
t_{ar} = 3.6 \frac{L_c}{V_D} \quad \text{subject to } t_{ar} \geq 1.0 \quad \text{(seconds)}
\]

Equation A-2

where:

\( t_{ar} \) = all-red time (s)

\( L_c \) = clearance distance between the stop line and furthest point of potential conflict with vehicle and pedestrians of the next phase (m)

\( V_D \) = Design speed (km/h)

For implementation purposes in Western Australia, the following steps are required to be taken to calculate all-red time:

**Step 1:** measure the clearance distance between the stop line and furthest point of potential conflict with vehicles and pedestrians of the next phase;
Step 2: based on the traffic design speed limit, divide the measured length by the value provided in Table A-2.

Table A-2: Factors to calculate all-red time

<table>
<thead>
<tr>
<th>Design Speed (km/hr)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 km/hr</td>
<td>11</td>
</tr>
<tr>
<td>50 km/hr</td>
<td>13</td>
</tr>
<tr>
<td>60 km/hr</td>
<td>16</td>
</tr>
<tr>
<td>70 km/hr</td>
<td>19</td>
</tr>
<tr>
<td>80 km/hr</td>
<td>22</td>
</tr>
</tbody>
</table>

Step 3: round the result up in increments of 0.5 seconds (Refer to Attachment A.2).

For unusual traffic conditions, longer all-red times can be justified.

A.3.1.2 For Existing Sites

For existing intersections, intergreen times and minimum green can be found in SCATS Phase Times window which can be requested via Main Roads website.

SCATS Phase Times window shows late start (Refer to section A.3.2), minimum green, early cut-off green, yellow, all-red, and maximum green for all the phases for the intersection. Figure A-7 shows an example of SCATS Phase Times window.

Figure A-7: SCATS Phase Times window (TCS 5)
### A.3.2 Late Start

The late start setting is typically used as a pre-defined time to delay the introduction of some signal groups at the start of a phase.

Two examples of late starts are:

- to delay the start of the northbound left turn signal group because of the intersection geometry (Figure A-8)

*Figure A-8: Example of left turn signal group late start*

- to delay the start of the filtering right turn.

Examples of phasing sequence which includes late start applied on filtering right turn are shown in Figure A-25 and Figure A-29.

Proposing late start for a new or an existing intersection requires Main Roads’ agreement. For the existing signalised intersection, late start is defined in SCATS Phase Times window (Figure A-7).

Phase sequence chart (.doc) which can also be requested through Main Roads website often contains late start information. This document may specify any signal groups on which late start time is applied. Site observation is required to confirm that these timings have been applied correctly.
A.3.3 Pedestrian Timings

Pedestrian timings include:

- Walk time (invitation to cross) when pedestrians begin their crossing (green figure on pedestrian lantern);

- Clearance time (clearance 1 + clearance 2) which is the time period for pedestrians who stepped off the kerb at end of the walk time to safely complete their crossing (flashing red figure or countdown timer for mid-block signalised crossing); and

- Pedestrian protection time which is delay of commencing the green time of the vehicle signal groups conflicted with a pedestrian signal group in a parallel walk phase.

A.3.3.1 For New Sites

For new signalised intersections or existing signal intersections with proposed modifications, pedestrian timings may be changed. Therefore, in order to minimise the risk of accident, those timings should be calculated carefully. Information on how to calculate the pedestrian timings are provided in sections A.3.3.1.1 to A.3.3.1.4.

Figure A-9, Figure A-10 and Figure A-11 show the relationship between vehicle traffic signal timing and pedestrian timings for different situations.

Figure A-9: Parallel walk with minimum green time

Figure A-10: Parallel walk with extended green time
A.3.3.1.1 Delay

Delay time will be applied before pedestrian walk time wherever all-red time of the previous phase is not sufficiently long to clear the conflict area with a parallel pedestrian crossing of the proceeding phase. For example, Figure A-12 shows an example of delay time where the pedestrian conflict area is further away from the vehicles conflict area and how delay would be applied for the pedestrian signal group during the phase transition.
A.3.3.1.2 Walk Time

Walk time (invitation to cross) is usually six seconds in Western Australia, but may be increased in locations if deemed necessary, perhaps where vulnerable road users or mobility impaired users are prevalent. This is subject to Main Roads policy and guidance.

A.3.3.1.3 Clearance Time

The pedestrian clearance time is based on the pedestrian crossing length measured from pushbutton pole to the ramp on the opposite kerb.

Pedestrian clearance times can be calculated as follows (decimal calculated total clearance time should be rounded up):

\[
\text{Clearance 1} + \text{Clearance 2} = \text{Total Pedestrian Clearance Time} = \frac{\text{Full Crossing Length (A)}}{1.2}
\]

Where:

\[
\text{Clearance 2} = \text{Early Cut Off Green} + \text{Yellow} + \text{All Red} - 1
\]

Therefore:

\[
\text{Clearance 1} = \text{Total Pedestrian Clearance Time} - \text{Clearance 2}
\]

For implementation purposes in Western Australia, the clearance time for a new site should be calculated by referring to Attachment A.3.

A.3.3.1.4 Pedestrian Protection Time

Western Australia has a number of different types of pedestrian crossing facilities at signalised intersections. Below are examples of the commonly configured pedestrian protection used at these crossing facilities:

- Full Protection (exclusive pedestrian phase or where geometry / phasing arrangements allow)
- Parallel Walk with Time Separation Protection
- Parallel Walk with Time Separation Protection and Flashing Yellow
- Timed Red Arrow Protection
- Timed Red Arrow Protection and Flashing Yellow
- Full Red Arrow Protection

Similar to pedestrian clearance time, pedestrian timed protection and traffic green start times are determined by the length of the pedestrian crossing. Figure A-13 describes the measurements required to determine these values.
Measurements are:

- **A**: full crossing length (from push button to the kerb) - for calculating total clearance time and timed red arrow protection with flashing yellow,

- **B**: length from push button before entry lane(s) to 1.0m past the median, or 55% of the full crossing length A (whichever is greatest) – for calculating timed red arrow protection with flashing yellow,

- **C**: length from push button before entry lane(s) to the middle of the road on the exit lane(s) - for calculating timed red arrow protection.

To calculate the crossing time required for each of pedestrian crossings A, B and C above, refer to Attachment A.3.

The following examples show how protection time is determined for each crossing type.

In these examples the western pedestrian crossing length (pedestrian signal group 1) is 20 metres. Therefore, as explained in the Section A.3.3.1.2 and A.3.3.1.3, walk time and clearance time are six seconds and 17 seconds, respectively.
A.3.3.1.4.1 Full Protection

Figure A-14 shows full protection case.

Figure A-14: Full Protection

A.3.3.1.4.2 Time Separation Protection

Generally a time separation protection of five seconds is applied in Western Australia (refer to Figure A-15).

Figure A-15: Parallel Walk with Time Separation Protection

A.3.3.1.4.3 Parallel Walk with Time Separation Protection and Flashing Yellow

For a new site with flashing yellow, a time separation protection of three seconds should be applied in Western Australia (refer to Figure A-16). After three seconds, the vehicular signal group which has conflict with the pedestrian crossing displays both a green light and a flashing yellow light. The flashing yellow light is displayed during the walk time and clearance time and warns drivers to proceed with care.
**Figure A-16: Parallel Walk with Time Separation Protection and Flashing Yellow**

A.3.3.1.4.4 Timed Red Arrow Protection

The red arrow should be displayed to provide enough time to the pedestrians who started their crossing from the far side of the road to pass the median and reach the middle of the road on the exit side (“C” movement in Figure A-13).

Red arrow time will be calculated as below:

\[
\text{Red Arrow Protection time} = \frac{\text{Length to middle of road on exit}(C)}{1.2 \text{ m/s}}
\]

In this example length of C is 17 metres; therefore, red arrow should be displayed for 14 seconds (refer to Figure A-17).

**Figure A-17: Timed Red Arrow Protection**

A.3.3.1.4.5 Timed Red Arrow Protection with Flashing Yellow

In this case the red arrow should be displayed to provide enough time to the pedestrians who started their crossing from the far side of the road to pass the median. Afterwards, the vehicular signal group which has conflict with the pedestrian crossing displays both green and flashing yellow signals. The flashing yellow signal is displayed during walk time and clearance time and warns drivers to proceed with caution.
Red arrow time with flashing yellow will be calculated as below:

\[
Red\ Arrow\ time = \frac{Either\ (B)\ or\ 55\% \times (A),\ whichever\ is\ longer}{1.2\ m/s}
\]

In this example length of B is 14 metres; therefore, red arrow should be displayed for 11 seconds (Figure A-18).

**Figure A-18: Timed Red Arrow Protection with Flashing Yellow**

![Figure A-18](image)

A.3.3.1.4.6 Full Red Arrow Protection

In this case, red arrow should be displayed during the entire time of walk time and clearance time (Figure A-19).

**Figure A-19: Full Red Arrow Protection**

![Figure A-19](image)
A.3.3.2 For Existing Sites

For existing intersections, pedestrian timing data can be found in SCATS Walks window which can be requested via Main Roads website. SCATS Walk window shows delay, walk time, clearance 1 and clearance 2 for individual pedestrian signal groups for the intersection. Figure A-20 shows an example of SCATS Walk window.

*Figure A-20: SCATS Walks window (TCS 5)*

Pedestrian Protection time is usually shown in the SCATS Special Times window. Generally, cell 11 used for this purpose, however, others cells can also be used when more than one pedestrian protection time is defined for that intersection.

*Figure A-21: SCATS Special Times window (TCS 5)*

Phase Sequence Chart (.doc) which can also be requested through Main Roads website often contains pedestrian protection information. Controller Personality Phase Sequence Chart document may specify any signal groups on which pedestrian protection time is applied. Site observation is required to confirm that these timings have been applied correctly.
A.4 Signal Phasing Sequences

For new signalised intersections and also for proposed modifications to existing signalised intersections, signal phase sequences must be approved by Main Roads. Examples of phase sequences that are compatible with SCATS are provided in this section. This will assist the modeller with determining the most appropriate phasing sequence. It should be noted that this stage is for modelling purposes only.

Figure A-22 introduces all the possible movements and their signal groups used in Figure A-23 to Figure A-34.

*Figure A-22: Legend*
A.4.1 Conventional

Figure A-23 shows a conventional phasing sequence with two phases (A and B). Right turn movements are filters.

*Figure A-23: Conventional two phase*

To have more complex phasing sequences for an intersection, based on its geometry and peak hour demand, one or both two phases in the conventional phasing sequence can be replaced with the following phasing sequences.
A.4.2 Leading Right Turn

Figure A-24 shows the leading right turn with filter right turn phasing sequence for the eastbound approach. If it suits the intersection geometry and U-turn is not permitted, the northbound left turn signal group can run during A phase (e.g. aggro arrow, refer to Section A.4.9).

Figure A-24: Leading Right Turn with filter right turn (EB)
Leading right turn with late start (refer to Section A.3.2) is shown in Figure A-25. If it suits the intersection geometry and U-turn is not permitted, the northbound left turn signal group can run during A phase (e.g. aggro arrow, refer to Section A.4.9).

Figure A-25: Leading Right Turn with late start (EB)
A.4.3 Lagging Right Turn

Figure A-26 shows the lagging right turn phasing sequence for the eastbound approach. This sequence is recommended when there is no opposed right turn. If it suits the intersection geometry and U-turn is not permitted, northbound left turn signal group can run during B phase (e.g. aggro arrow, refer to Section A.4.9).

Figure A-26: Lagging Right Turn
Lagging right turn with filtering is shown in Figure A-27 (refer to Section A.3.2). If it suits the intersection geometry and U-turn is not permitted, northbound left turn signal group can run during B phase (e.g. aggro arrow, refer to Section A.4.9).

*Figure A-27: Lagging Right Turn with filtering*
A.4.4 Lead – Lag Right Turn

Figure A-28 shows the lead – lag right turn phasing sequence for the eastbound approach. If it suits the intersection geometry and U-turn is not permitted, northbound and southbound left turn signal groups can run during A and C phases, respectively (e.g. aggro arrow, refer to Section A.4.9).

*Figure A-28: Lead - Lag Right Turn*
Lead – lag right turn with filtering lagging right turn is shown in Figure A-29. Filtering leading right turn is not allowed. If it suits the intersection geometry and U-turn is not permitted, northbound and southbound left turn signal groups can run during A and C phases, respectively (e.g. aggro arrow, refer to Section A.4.9).

Figure A-29: Lead – Lag Right Turn - With filtering lagging turn
A.4.5 Repeat Right Turn

If right turn movement is heavy, the same signal groups can be repeated in a new phase. Figure A-30 shows repeat right turn phasing sequence with no opposed right turn. If it suits the intersection geometry and U-turn is not permitted, northbound left turn signal groups can run during A and C phases (e.g. aggro arrow, refer to Section A.4.9).

*Figure A-30: Repeat Right Turn*
A.4.6 Trailing Right Turn

Figure A-31 shows the trailing right turn phasing sequence for the eastbound approach. If it suits the intersection geometry and U-turn is not permitted, northbound and southbound left turn signal groups can run during B and C phases, respectively (e.g. aggro arrow, refer to Section A.4.9).

*Figure A-31: Trailing Right Turn - No filtering right turn*
A.4.6.1 Yellow Trap

Filtering right turn is not permitted for trailing right turn phasing sequence as the opposed movement has overlap to the next phase. For example filtering westbound right turn during A phase can be a potentially dangerous situation during the intergreen time (Yellow Trap). When a circular yellow signal (during intergreen) is displayed to drivers heading west, they may attempt to complete a left turn as they assume the opposite direction faces yellow light, and that approaching traffic will stop. However the opposite approaching traffic will not stop and this leads to higher crash probability (Figure A-32).

*Figure A-32: Yellow trap*
A.4.7 Split Phasing

Figure A-31 shows the split phasing sequence. If it suits the intersection geometry and U-turn is not permitted, northbound and southbound left turn signal groups can run during A and B phases, respectively (e.g. aggro arrow, refer to Section A.4.9).

Figure A-33: Split Phasing
A.4.8 Diamond

Figure A-34 shows the diamond overlap phasing sequence. Depending on the demand three phasing sequences can occur:

A, A1, and B: when eastbound movement traffic flows are heavier than westbound movement (purple path in Figure A-34);

A and B: when eastbound and westbound traffic flows are balanced;

A, A2, and B: when westbound movement traffic flows are heavier than eastbound movement (blue path in Figure A-34).

If U-turn is not permitted, northbound and southbound left turn signal groups may also run during A/A1 and A/A2 phases, respectively (e.g. aggro arrow, refer to Section A.4.9).

Single diamond phasing sequence is when only one of the phases in the conventional phasing sequence (Refer to Section A.4.1) is replaced with diamond overlap and double diamond is when both of them are replaced with diamond overlap.
### Figure A-34: Diamond Overlap

- **Phases:** A, A1, B
- **Phases:** A, B
- **Phases:** A, A2, B

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<td>EB/WB – R</td>
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</table>
A.4.9 **Aggro Arrow**

A shared signalised left turn/through lane can be controlled by two individual signal groups (left turn and through movement signal groups). During a phase, only left turn signal group can operate, while, through movement signal group is not activated. This situation is called aggro arrow. Figure A-35 shows an example of aggro arrow on a T-intersection.

*Figure A-35: Aggro arrow*

For example where the northbound left turn and through movements share a signalised lane, an aggro arrow can operate during phases when the eastbound right turn signal group is activated except when a U-turn is permitted.

Aggro arrow can operate on different phase sequences, such as:

- leading right turn
- lagging right turn
- lead-lag right turn
- repeat right turn
- trailing right turn
- split phasing
- single or double diamond.
A.5 SCATS Linking and Offsets

For modelling networks, in particular for existing intersections, it is important to understand how SCATS operates in order to replicate coordination between two or more adjacent intersections. Information regarding existing coordination can be extracted from LX files which is generated daily at 1 am by each SCATS regional computer (refer to Attachment A.4). For base models, SCATS linking input data should be used.

Coordination can be either relative to the start or the finish of a phase. Site coordination can be described in two different categories:

1. Coordination of sites within a subsystem\(^5\) (non-slaved sites or slaved sites\(^6\) coordination), and,
2. Coordination of sites which belong to different subsystems (either within a region or external to the region)

Figure A-36 illustrates an example of SCATS coordination system.

\(\text{Figure A-36: Example of SCATS Coordination System via offsets}\)

Currently in WA, most subsystems contain only one site for operational purposes. Therefore, the first type of coordination is not common in Western Australia and it is not discussed in this document. Sections A.5.1 to A.5.4 describe how to determine offset settings for modelling purposes.

A.5.1 Link Plans

Link plans are used to achieve subsystem coordination. Subsystems have four link plans. The convention is as follows:

- **Link Plan 1**: light / night time traffic flow (low cycle time)
- **Link Plan 2**: afternoon peak
- **Link Plan 3**: balanced flow between both directions
- **Link Plan 4**: morning peak

\(^5\) Subsystems are groups of sites combined because of proximity, and when common cycle lengths will give optimum two-way progression.
\(^6\) A site may be slaved to the demand of a phase at another (master) site. All data for slave operation is entered in the slave site only.
To calculate offsets for different times of the day, the relevant link plan should be used. For the base model, the link plan(s) which was used by SCATS during the modelling period, can be determined using the strategic monitor graph (refer to Attachment A.5).

### A.5.2 Coordinated Phase

Offset plans in SCATS can be used to determine the coordinated phase and its coordination reference point (i.e. at the start or at the end of the phase). Each site has four offset plans. The offset plan (which has the same number as the corresponding link plan as determined in Section A.5.1) should be used to determine the coordinated phase.

Offset plans can be found under the site data section in LX file (i.e. PPn=a,b^c!, n is plan number – 1 to 4) (Refer to Attachment A.4). For the relevant offset plan (offset plan number = link plan number), c is the coordinated phase which ends at the specified offset value. If the coordinated phase is preceded by ^, its start is coordinated.

For example, PP4=0,0^A! means that the coordination point is the start of the A phase while offset plan 4 is being applied.

### A.5.3 Reference Site and Phase

A link plan, LPn=a,bcd! (n is the link plan number 1, 2, 3 or 4), in the LX files specifies:

- first offset (a) - an asterisk (*) instead of a numeric value means that the link is to be broken;
- second offset (b) - an asterisk (*) instead of a numeric value means that the link is to be broken;
- reference phase:
  - (c) – when the link refers to the end of the phase
  - (^c) – when the link refers to the start of the phase.
- reference site (d is site’s TCS number).

If the link plan data is zero, e.g. LP1=0!, the subsystem is not linked.

A letter X after the reference site (d) means the link is external to a site from a subsystem in another region.

### A.5.4 Offset length

Link plan offset is dynamic and is calculated based on cycle length for each link plan.

In LX files, PSn=x,y! is used to specify the offset lengths, where:

- PSn is PS number n for link plan n (i.e. LPn=a,b!, n = 1, 2, 3 or 4)
- x is the cycle length below which offset plan a is used
- y is the cycle length above which offset plan b is used.

y is always greater than or equal to x.
Each subsystem has four PS. PS (which has the same number as the corresponding link plan as determined in Section A.5.1) should be used to specify the offset lengths.

For modelling purposes, if fixed signal timing is being modelled, the offset time should be calculated based on the average cycle time for the modelling period.

There are two offset length calculation methods used in SCATS:

- **Method one**, which is the default method and is linear interpolation between the first offset \((a)\) and second offset \((b)\) for cycle lengths between \(x\) and \(y\).

**Figure A-37: Offset length and cycle length relationship (where \(a>b\))**

- **Method two** only works when an up-arrow (^) symbol follows \(x\) (i.e. \(\text{PSn}=x^,y!\)). Here offset \(a\) will operate at cycle lengths below \(x\) seconds. Offset \(b\) will operate only when the cycle length rises to \(y\) seconds and will be maintained until the cycle length falls below \(x\) seconds, when offset \(a\) will operate.

### A.5.5 Determining offset data using LX file

For fixed time modelling purposes, to find offset data for intersection \(\alpha\) (TSC number) using the LX file and strategic monitor the following steps should be taken:

1. Select the relevant link plan for the modelling period, using strategic monitor (Refer to Attachment A.5). The offset plan number and PS number are the same as the link plan number.
2. Calculate cycle time for modelling period (Refer to Section A.2)
3. Extract the relevant site data (where INT=\(\alpha\)) from the LX file i.e. subsystem number \((\text{S#}=\beta)\) and offset plans \((\text{PPn}=a,b^,c! - \text{coordinated phase})\).
4. Extract the relevant subsystem data (where SS= \(\beta\)) in the LX file, i.e. link plan data \((\text{LPn}=a,bcd! - \text{reference site and phase})\) and PS plan \((\text{PSn}=x,y! - \text{offset length based on estimated cycle time})\).

---

\(^7\) Subsystem number also can be found in the SCATS Site Graphics.
A.5.5.1 Example of finding coordination data

Example of finding coordination data for site 359 for 8-9 am, on 18 January 2018:

**Step 1:** Strategic monitor (Figure A-38) shows link plan 4 and therefore offset plan 4 and progress speed 4 were active during the modelling period (Refer to Attachment A.5).

*Figure A-38: TCS 359 Strategic Monitor*

*Step 2:* Average cycle time of 115 seconds was calculated for TCS 359 using SCATS history file (Refer to Section A.2).
Steps 3: Site data section for TCS 359 in LX file is shown in Figure A-39 (where INT=359!).

Figure A-39: Site Data example

![Site data example](image)

Subsystem number is 4 (S#=4!). The Offset plan for the intersection between 8-9 am is PP2=0,0C!. Therefore, end of C phase is coordinated for site 359.

Step 4: Subsystem data section for subsystem 4 is shown in Figure A-40 (where SS=4!).

Figure A-40: Subsystem Data example

![Subsystem data example](image)
Link plan data and PS plan for the intersection between 8-9 am are \( \text{LP}_2 = 23,17\text{F220!} \) and \( \text{PS}_2 = 90,110! \), respectively.

Therefore, end of C phase at site 359 (step 3), was coordinated to end of F phase at site 220 (TCS).

The offset time is:

- equal to 23 seconds if the cycle time is less than or equal to 90 seconds, and
- equal to 17 seconds if the cycle time is greater than or equal to 110 seconds.

Therefore, for an average of 115 seconds cycle time (Step 2) from 8-9 am, the offset length is 17 seconds. This means, C phase at site 359 ends 17 seconds after the end of F phase at site 220. Figure A-41 shows the time coordination between the intersections.

*Figure A-41: Coordination Example*

![Coordination Example Diagram](image-url)
## References

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**Attachment A.1. SCATS History Viewer – Events**

When it is available, SCATS History Viewer provides the recorded history of signal group activation for all signal groups (including pedestrian signal groups, labelled as Walk). This file is called Events file and it is in .csv format.

- $SG_i$ was signal group $i$
- $SG_i$=On was recorded when signal group $i$ is activated.
- $SG_i$=Off was recorded at the end of green time for signal group $i$.
- Walk $j$ is pedestrian signal group $j$
- Walk $j$: Demand=On was recorded when demand for pedestrian signal group $j$ is detected (e.g. push button is pressed).
- Walk $j$: Demand=Off Active=On was recorded when demand for running pedestrian signal group $j$ has responded.
- Walk $j$: Active=Off was recorded at the start of clearance 1 for the pedestrian signal group $j$.

![Figure A-42: Example of SCATS History Viewer Event file for pedestrian signal groups](image-url)
Attachment A.2. All Red Time Settings

Table A-3 provides all red time based on distance measured from stop line to last point of conflicts.

Table A-3: All-red Time

| All-red (Distance measured from stop line to last point of conflict) |
|---------------------|-----------------|
| 40 km/h – d/11      | 50 km/h - d/13  |
| DISTANCE* (Metres) | TIME (Seconds)  | DISTANCE* (Metres) | TIME (Seconds)  |
| up to 11            | 1.0             | up to 13            | 1.0             |
| 12 to 17            | 1.5             | 14 to 19            | 1.5             |
| 18 to 22            | 2.0             | 20 to 26            | 2.0             |
| 23 to 28            | 2.5             | 27 to 32            | 2.5             |
| 29 to 33            | 3.0             | 33 to 39            | 3.0             |
| 34 to 38            | 3.5             | 40 to 45            | 3.5             |
| 39 to 44            | 4.0             | 46 to 52            | 4.0             |
| 60 km/h - d/16      | 70 km/h - d/19  |
| DISTANCE* (Metres) | TIME (Seconds)  | DISTANCE* (Metres) | TIME (Seconds)  |
| up to 16            | 1.0             | up to 19            | 1.0             |
| 17 to 24            | 1.5             | 20 to 28            | 1.5             |
| 25 to 32            | 2.0             | 29 to 38            | 2.0             |
| 33 to 40            | 2.5             | 39 to 47            | 2.5             |
| 41 to 48            | 3.0             | 48 to 57            | 3.0             |
| 49 to 56            | 3.5             | 58 to 66            | 3.5             |
| 57 to 64            | 4.0             | 67 to 76            | 4.0             |
| 80 km/h - d/22      |
| DISTANCE* (Metres) | TIME (Seconds)  |
| up to 22            | 1.0             |
| 23 to 33            |                 |
| 34 to 44            | 2.0             |
| 45 to 55            | 2.5             |
| 56 to 66            | 3.0             |
| 67 to 77            | 3.5             |
| 78 to 88            | 4.0             |

Attachment A.3. Clearance Time Settings

Table A-4 provides pedestrian crossing time based on crossing distances.

Distance measured from pushbutton pole to ramp on opposite side.

Table A-4: Clearance time settings

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Source: Downer Mouchel and Main Roads WA
Attachment A.4. LX Files

LX files provide operational settings of every signalised intersection in a SCATS Region\(^8\). A backup LX file is generated daily at 1 am by each SCATS regional computer. Main Roads can provide the file upon request for a specific date, if it is available. LX files can be requested through the Main Roads website and it can be viewed in Microsoft Notepad.

Each LX file contains commands and data used to operate SCATS over the last 24 hours. Commands end with an exclamation mark (!). Some of the relevant commands are described in this section. For full descriptions of all commands, refer to SCATS 6.9.2 Operation Instructions: A guide to SCATS commands and alarms, Roads and Maritime Services.

The following data can be extracted from an LX file:

- General data;
- Site data;
- Split Plan information
- Subsystem data;
- Strategic Input data;
- Other data;
- Strategic Approach data
- Link data
- Scheduled events data

---

\(^8\) Region is a conceptual geographic area controlled by a SCATS regional computer.
General Data

**NAME=** The name of the monitored region. The current regions in Western Australia are listed in Table A-5.

**Table A-5: SCATS Regions in WA**

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</table>

**ID=** SCATS Region version number.

**TIM=** Day of week (*Mon, Tue, Wed, Thu, Fri, Sat, and Sun*), date ([dd-mm-yyyy]) and time ([hh:mm:ss] which is 1:01:01 in the backup file) when the file is generated.

**KEYn=** SCATS user access level for user *n*. 
Appendix A: Signal Data Information for Modelling – Version 1.1

Site Data

The first part of the LX files contains site data.

**SLOT**\(_n=x, y, z!\) Where:

- \(n\) is the slot number (each site has its own slot number in a region);
- \(x\) is the number of phases (2 to 7)
- \(y\) is the number of split plans
- \(z\): is the number of walks (signalised pedestrian crossings) (0 to 8).

**INT=\(n!\)** Where \(n\) is the site TCS (traffic control signal) number. TCS number is a unique identifying number for each site which can be found in SCATS graph.

**LS=** Lamp (traffic lights) status:

- FY: Flashing Yellow, and
- ON: Normal operation

**S#=\(n!\)** Where \(n\) means subsystem number. Subsystems are groups of sites combined because of proximity, and when common cycle lengths will give optimum two-way progression. Subsystem number can be also found in SCATS graph.

**LM=** Link mode:

- I: Isolated operation, when the controller operates in vehicle-actuated mode, identical to an uncoordinated site;
- F: Flexilink operation (coordinated controller with other sites);
- MI: Masterlink operation (master site controller) with fallback to isolated operation, and
- MF: Masterlink operation (master site controller) with fallback to Flexilink operation.

**VOLS=** Detector numbers for data collections. This can be a range separated by a dash (-).

**AT=\(n!\)** Phase clearance for \(A\) phase – time between the call to and the start of the next phase and is the sum of early cut-off green, yellow and all-red times for that phase. Similarly, BT for \(B\) phase, CT for \(C\) phase etc.

**W1=6ABF** 

In this example,

- ‘6’ (number) is the length of walk time setting in SCATS for pedestrian signal group 1.
- ‘ABF’ (letter(s)) describes the phase(s) into which the walk can overlap which are A, B and F phases in this example.
Appendix A: Signal Data Information for Modelling – Version 1.1

W1 is for pedestrian signal group 1, W2 is for pedestrian signal group 2, etc.

\[ W1T = x \]

Where \( x \) is clearance time (i.e. clearance 1 + clearance2) for pedestrian signal group 1.

W1T is for pedestrian signal group 1, W2T is for pedestrian signal group 2, etc.

\[ PP_n = \]

Offset plans define the offsets between sites within a subsystem.

\[ PP_n = a, b^c \]

defines offset plan for a non-slaved site, where:

- \( n \) is plan number – there are four offset plans in the site data – PP1 to PP4, and each has two offset values.
- \( a \) is the first offset value in seconds (within the range of +/- 127 seconds) from the subsystem cycle generator zero reference point.
- \( b \) is the second offset value.
- \( c \) is the phase whose end is to be coordinated i.e. this phase is to finish at the specified offset value. If preceded by ^, the start is coordinated.

\[ PP_n = xSL_c p \]

defines offset plan for a slave site, where:

- \( x \) is the offset in seconds and cannot be negative
- \( SL \) is indicates a slaved site
- \( c \) is the master site.
- \( p \) is the phase call at the master site that releases the slaved phase.

Split plans

\[ I=n! \]

Where \( n \) is the site TCS number.

\[ PLAN=n! \]

Where \( n \) is the plan number.

\[ SF= \]

Special facilities. SF=DC! for a split plan, means site operates double cycling (DC).

\[ XSF= \]

Extra special facility (XSF) flags.

\[ A=nPDB! \]

For A phase, \( n \) means allocate \( n\% \) of the cycle length to A.

\( n# \) means that the phase length is \( n \) seconds (only for exclusive pedestrian phase).

If \( n=0 \), means A phase is the stretch phase and will use all the time not used by the other phases and will not gap.

---

9 A site may be slaved to the call of a phase at another (master) site. All data for slave operation is entered in the slave site only.
If $n = 1$, then the phase is a skipped phase, e.g. $B=1C$!

**PD** means place a permanent demand on A phase.

$B$ is the next phase in sequence.

Other split plan phase features:

- **NS**: No skip,
- **AS**: Anti skip,
- **FS**: Forced skip,
- **PD**: Permanent demand,
- **TG**: Time gain (unused time from phases between the stretch phase and this phase),
- **NG**: No gap,
- **FG**: False green, and
- **NGFG**: Used on stretch phase to guarantee false green if the next phase is not required.

### Subsystem Data

The third part of the LX file is subsystem data.

- **SS** = $n$!
  
  Where $n$ is the subsystem number. Subsystems are groups of sites combined because of proximity, and when common cycle lengths will give optimum two-way progression. Subsystem number can be also found in SCATS graph.

- **LCL** = $x$!
  
  $x$ is the minimum cycle length.

- **HCL** = $y$!
  
  $y$ is the maximum cycle length.

- **SCL** = $a, b$!
  
  $a$ and $b$ are alternate minimum cycle lengths referred to as alternate minimum 1 cycle length and alternate minimum 2 cycle length.

- **XCL** =
  
  Stretch cycle length.

- **PS** $n$ = $x, y$!

  PS is used to specify the cycle lengths at which either of the two offset plan offsets and the two link plan offsets are to be selected.

  where:

  - **PS** $n$ is PS number $n$ for offset plan $n$ and link plan $n$ (i.e. $PPn=a, b!$ and $LPn=c, d!$) $n$ can be 1, 2, 3 or 4.

  - $x$ is the cycle length below which offset plan $a$ and link plan $c$ are used.

  - $y$ is the cycle length above which offset plan $b$ and link plan $d$ are used.
Appendix A: Signal Data Information for Modelling – Version 1.1

\[ y \text{ can only be greater than or equal to } x. \]

\[
\text{LP}_n = a, bcd!
\]

Link plan data for each plan, where:

- \( n \) is the link plan number 1, 2, 3 or 4.
- \( a \) is the first link plan offset – range = \(-127 \) to \(+127\) seconds. An asterisk (*) instead of a numeric value means that the link is to be broken.
- \( b \) is the second link plan offset – range = \(-127 \) to \(+127\) seconds. An asterisk (*) instead of a numeric value means that the link is to be broken.
- \( c \) is the end of phase to which the link refers.
- \(^c\) is the start of phase to which the link refers.
- \( d \) is the site from the subsystem to which linking is required.

Note that a subsystem will not marry if the link plan data is zero, e.g. \( \text{LP1}=0! \)

A letter X after \( d \), specifies the link is external to a site from a subsystem in another region.

**Strategic Input Data**

A strategic input belongs to a site.

\[
\text{Sin}=yz!
\]

Strategic input \( n \) belongs to site \( y \) and gathers data when \( z \) phases are running. \( z \) may be one or more phases.

\[
\text{SIn}=y,z!
\]

where:

- \( n \) is the strategic input number
- \( y \) is the site
- \( z \) is the signal group number (1 to 16)

\[
\text{D#}=a!
\]

Detector numbers at the site forming this strategic input. A strategic input can have between 0 and 4 detectors:

- A comma separates data for individual lanes in all cases

\[
\text{MF}=b!
\]

Maximum flow

\[
\text{NF}=c!
\]

Lane calibration factors for degree of saturation.

- A comma separates the data for each lane.

\[
\text{KP}=d!
\]

Average lane occupancy in seconds/100 per vehicle when MF occurred.

- A comma separates the data for each lane.
AV=e!

Average daily lane volumes for weekdays only.

A comma separates the data for each lane.

Other Data

Strategic approaches optionally control split plan selection and cycle length control for a subsystem.

Links control the selection of a link plan for linking one subsystem to another subsystem. A link plan can optionally be used to select offset plans for offsets between sites within a subsystem.

Scheduled events include the action lists which are scheduled at specified times on selected days and dates.

For more information about Strategic Approach data refer to SCATS 6.9.2 Operating Instructions: A guide to SCATS commands and alarms, Roads and Maritime Services.
Attachment A.5. Strategic Monitor

The strategic monitor graph shows recorded split plans, link plans and cycle length\textsuperscript{10} voted by SCATS over 24 hours for a subsystem. It can be requested through Main Roads website for a specific day(s).

\textbf{Figure A-43: An example of Strategic Monitor Graph}

\textsuperscript{10} SCATS voted cycle length may be different from operated cycle length on site, therefore, strategic monitor graph should not be used to calculate average cycle length for modelling.