This is a pre-copyedit version of an article published in Traffic Engineering and Control. The definitive publisher-authenticated version is included in Traffic Engineering and Control 43(4), p135-137.

Improved Network Monitoring using UTC detector data 'RAID'

(Remote Automatic Incident Detection)

Tom Cherrett, Ben Waterson, Mike McDonald
Transportation Research Group, University of Southampton

Russell Clarke, Alex Bangert
Siemens Traffic Controls Limited

Ray Morris
Southampton City Council

As part of the 5th Framework PRIME project[1] (**P**rediction Of Congestion And Incidents In **R**eal Time, For **I**ntelligent Incident **M**anagement And **E**mergency Traffic Management), a new incident detection algorithm has been developed using the 250-ms digital data produced by UTC detectors. The contributors to this part of the project were the University of Southampton, Southampton City Council and Siemens Traffic Controls.

Why RAID?

INGRID developed by the Transport Research Laboratory[2,3] has been available to Local Authorities in the United Kingdom for several years. It detects incidents using two algorithms, one examining real-time values of flow and occupancy for sudden changes and the other using historic reference data stored by the ASTRID database. Both algorithms use standard deviations and means to determine a confidence level against which to assess the current flow and occupancy values derived from the detector data each signal cycle. The rules in INGRID state that an incident is indicated if the 'trigger' conditions exist for one-minute. When these conditions exist for three consecutive minutes, more weight is given to the incident report. To detect incidents INGRID needs flow and occupancy data from consecutive loops in order to detect incidents in the road space between them.

RAID differs from INGRID in that it uses the more detailed raw 250-ms data produced by the detectors to derive values of 'average loop-occupancy time per vehicle' (ALOTPV) and 'average time-gap between vehicles' (ATGBV) every 30-seconds[4]. These parameters are used by RAID to identify 'abnormal' periods of congestion in relation to an operator defined rules file containing threshold 'trigger' values of ALOTPV and ATGBV for given time durations. Unlike INGRID, RAID does not require data from up and down stream detectors before incidents can be detected in the section between. RAID is designed to alert the operator to abnormal conditions existing over individual detectors. It has a function where 'group' incidents can be declared where multiple detectors are affected by similar levels of congestion e.g. over roundabouts or arms of a signalised junction.

RAID like INGRID produces incident text messages which appear in the UTC SCOOT output window to alert the operator. As part of PRIME a graphical user interface has been developed for RAID using the UTC map editor facility. This allows the operator to link RAID to existing maps of the urban area controlled by UTC and RAID incidents appear in the form of flashing detectors on the map. RAID can also be linked to CCTV to allow pre-set positioning in response to triggers.

This is a pre-copyedit version of an article published in Traffic Engineering and Control. The definitive publisher-authenticated version is included in Traffic Engineering and Control 43(4), p135-137.

How RAID works

RAID operates by identifying single inductive loop detectors which show a critical increase in ALOTPV coinciding with a critical decrease in ATGBV. The ALOTPV for a 30-second period is determined by totalling the number of 250-ms occupancies (1's) produced by the loop and dividing by the number of vehicles (1/0 or 0/1 'switches'). The ratio produced ranges from 1 to 120, an ALOTPV of 1 indicating one 250-ms of occupancy during the 30-second period, an ALOTPV of 120, 30-seconds of solid occupancy. ATGBV uses the same process for calculating ALOTPV but in reverse. The values of ALOTPV and ATGBV were developed as part of an EPSRC 'LINK' funded project and led to the current UTC U06 message.

ALOTPV can be used to accurately identify the point when a detector becomes saturated. Figure 1 shows the U06 output from a detector situated on the A33 Bassett Avenue in Southampton between 06:45 and 09:23. The point at which queuing reaches the detector can be seen at approximately 07:58 at which point ALOTPV rises sharply. Using historical values of ALOTPV, simplistic rules files can be developed taking the 85 percentile values of ALOTPV as potential incident 'triggers' (Figure 2). These are used by RAID to identify 'abnormal' periods of congestion, when elapsing for pre-determined time periods, set by the operator. The rules file allows the operator to set rules for individual and groups of detectors for different periods of the day.

Figure 1. 30-second based speed, percentage occupancy and ALOTPV data from a single inductive loop detector on the A33 Bassett Avenue, Southampton.

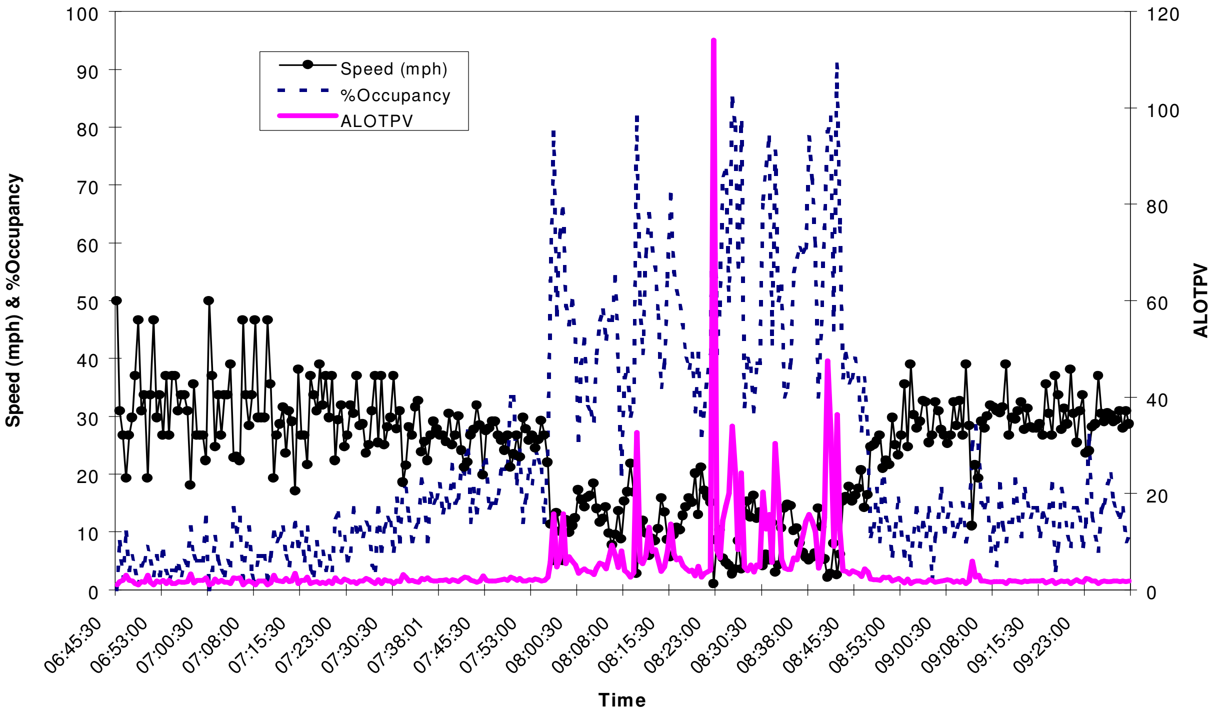
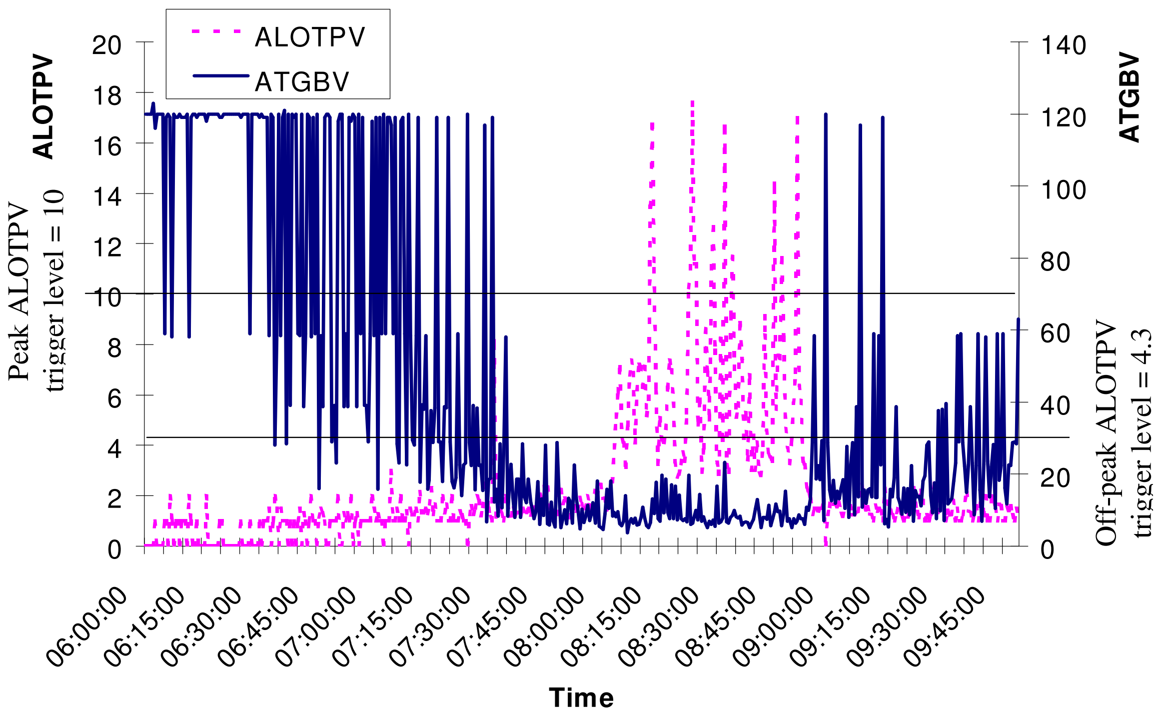


Figure 2 shows the ALOTPV and ATGBV plotted for a detector on the A33 Bassett Avenue in Southampton between 06:00 and 09:50. The graph shows clearly the lack of traffic between 06:00 and 07:15 and the carriageway at the detector location operating at its most optimal between 07:40 and 08:05, when both ALOTPV and ATGBV are at a minimum indicating that vehicles are travelling close together at speed. Analysis of the data in this way suggested that an appropriate trigger level of ALOTPV for off-peak periods (19:00 – 07:00 and 09:30 – 16:00) would be 4.3 (4.3, 250-ms periods of occupancy per vehicle every 30-seconds) whereas peak periods (07:00 – 09:30 and 16:00 – 19:00) would be 10.00. From the historic U06 data files the operator could also determine the typical durations of these peak congestion periods. Initial trials suggested that if the trigger value of ALOTPV were breached for more than 3 consecutive minutes an alarm should be raised to the operator.

Figure 2. 30-second ALOTPV and ATGBV data from detector N03214A on the A33 Bassett Avenue, Southampton.



RAID alarms to the operator

RAID alerts the control room operator to detectors reporting traffic conditions that have breached the trigger thresholds listed in the rules file. This is done via a SCOOT output message (U15) which states the time the alarm trigger threshold was breached, the affected detector and the relevant rule group in the rules file.

-WARN- 13:47:30 detector N03214E incident detected by rule 5.

When the abnormal traffic conditions have cleared according to the length of time (stipulated by the operator) for which ALOTPV and ATGBV values have been maintained below the trigger threshold, the U16 SCOOT output message alerts the operator accordingly.

-GONE- 14:22:30 detector N03214E incident cleared.

INGRID also produces similar text alarms but with the wealth of information presented to the control room operator it was considered necessary to use a more user friendly medium to present the alarm information. As part of the developments within the PRIME project, Siemens created an interface between RAID and the UTC map editor to enable the U15 alarm messages to be represented on maps of the network via flashing detectors or links (Figures 3 and 4). In addition to this an interface was created to link the U15 message to the CCTV pre-set positioning system. This enables operators to define camera pre-sets that over look individual or multiple detectors. When RAID produces a U15 message alert, the appropriate CCTV will re-position its view to the affected link, alerting the operator.

Figure 3. The RAID map created using the UTC map editor for the West Quay area of Southampton. (When a detector in the area of the map triggers an alarm, the particular road section flashes red. The operator then uses the mouse to click on the relevant section which takes him/her into a more detailed schematic (Figure 4.))

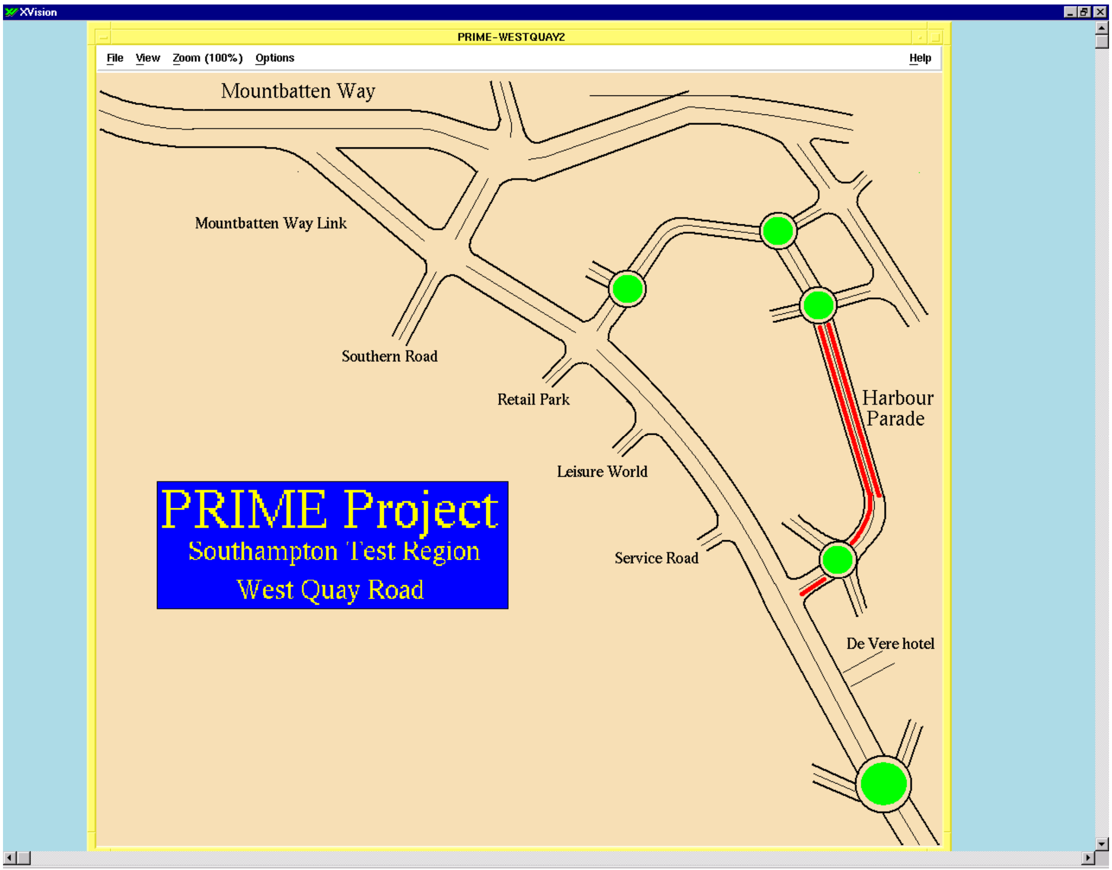
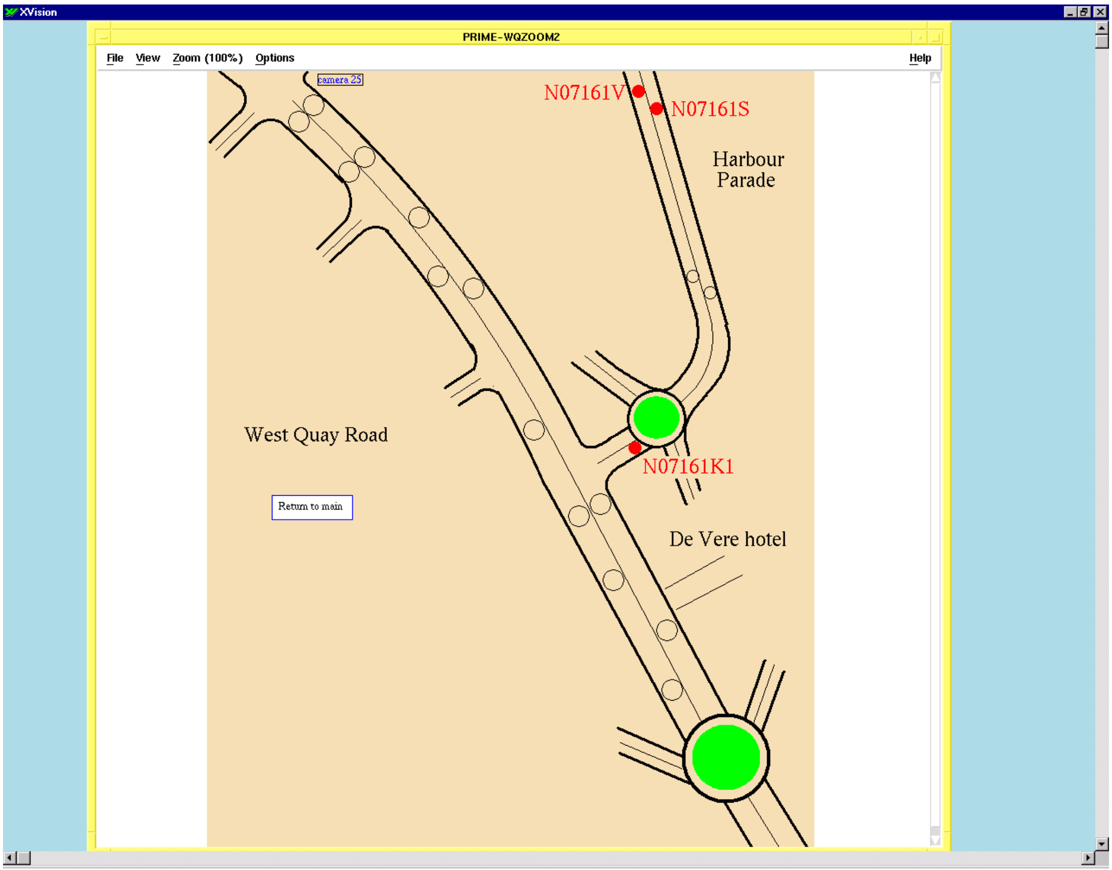


Figure 4. A detailed ‘inner’ map showing the detectors registering a RAID alarm.

This is a pre-copyedit version of an article published in Traffic Engineering and Control. The definitive publisher-authenticated version is included in Traffic Engineering and Control 43(4), p135-137.



Initial testing results

As part of the PRIME project, RAID was tested on signalised and non-signalised road sections in Southampton. The on-line test took place between 17/5/01 and 31/10/01 between 07:00 and 19:00 daily (167 consecutive days) and involved some 74 detectors situated along the A33 Bassett Avenue and A35 Winchester Road. All incidents, (defined as either vehicle-on-vehicle impacts, vehicle breakdowns, illegal parking or unloading and emergency works) detected by RAID were recorded by the control room operators in an MS Access database.

Over these 167 consecutive days, 181 and 334 RAID triggers were recorded on the A33 Bassett Avenue and A35 Winchester Road respectively. The operator log showed that between 17/5/01 and 31/10/01, 32 incidents were recorded on the A33 Bassett Avenue and 49 on the A35 Winchester Road. The RAID detection rate of verified incidents was 69% and 92% respectively. The low detection rate on the A33 was due to five incidents which caused no congestion and therefore could not be detected by RAID.

55% (100) of the A33 Bassett Avenue RAID detections were caused by abnormally heavy congestion attributed to bad weather, special events and football matches. Further analysis of the log showed such warnings were beneficial to the control room operators as one in every 3.8 of these RAID warnings resulted in either a Variable Message Sign (VMS) strategy or a radio traffic bulletin being issued by the control room operator to the general public.

Other applications and further work

RAID has proved successful for identifying a range of detector faults. Rules files can be created to identify not only common hard faults (when the detector either registers 100% occupancy or unoccupancy) but detectors whose sensitivity has not been set correctly during installation, registering to much or to little occupancy per vehicle.

Future modifications will involve the ability to create rules files for specific days to cater for special events such as home football games. The automation of the rules generation process is also being addressed with the potential for 'smart' rules that self adjust, when given updates of historical U06 data.

Contacts : If you require more information about using the RAID alogorithum please contact Russell Clarke at Siemens on 01202 782439 or email: russell.clarke@poole.siemens.co.uk

References

1. http://www.prime-project.gr

2. Bowers, D.J., and Bretherton R.D. (1995). The ASTRID/INGRID incident Detection System for Urban Areas. Proceedings of the 2nd World Congress on Intelligent Systems, Yokohama, Japan. pp 134 – 139.

3. Bretherton, D (1996). Current Developments in SCOOT: Version 3. *Transportation Research Record* 1554, National Research Council, Transportation Research Board. pp 48 – 52.

4. Cherrett T, Bell H, McDonald M (2000). Traffic management parameters from single inductive loop detectors. *Transportation Research Record* 1719, National Research Council, Transportation Research Board.