Concept Definition Report  
Adaptive Urban Signal Control Integration (AUSCI) Project

Executive Summary -- August 1995

This summary highlights the work performed as part of the AUSCI Concept Definition Report. Additional supporting and background material is presented in a separate document entitled “Supplementary AUSCI Materials.”

The City of Minneapolis has successfully operated a computerized traffic signal control system for over 20 years. It controls the city-wide system of 715 intersections 24 hours per day, 365 days per year. Operator attended mode is provided for a 12-hour period for each weekday with unattended automatic mode provided for all other times except during significant special events.

Real-time monitoring and intersection control are provided from a centrally-located computer over a twisted pair media multiple intersection multiplexed communications system. This architecture and equipment configuration provides reliable and effective service.

The system provides table lookup, pre-determined timing plan library-type operation. Timing plans are selected from the timing plan library on the basis of manual override, time schedule and threshold level-type traffic responsive operation. Although approximately 1000 loop detectors are available in the existing system for traffic responsive control and data capture purposes, major sections of the system are operated on a time-scheduled basis. Time-scheduled operation is used because:

- A limited number of timing plans exist (AM, PM and OFF Peak period plans for example).
- It is difficult to identify small changes in traffic flows using the existing selection and detection scheme.
- It is difficult to regularly acquire the data and to manually develop, implement and update short term fluctuation based timing plans.
- The existing first generation traffic responsive operation can only select timing plans from the library of existing timing plans.
- The existing traffic-responsive plan selection scheme only identifies a condition after it has occurred.
- Loop detectors fail regularly, limiting the availability and accuracy of traffic flow measurements.

Construction of major business/commercial, sports, entertainment and convention facilities in the Minneapolis Central Business District (CBD) area over the recent past has increased traffic volumes and the importance of effective traffic control. The traffic for the CBD-located facilities creates different flow conditions than previously occurred in the CBD. Short term fluctuations, reverse direction flows, heavy traditional period usage surcharged by special events, off-peak hour event-driven flows and freeway-directed traffic flows occur regularly. These flow demands and rapidly changing conditions challenge the effectiveness of the existing system.

The observance of these conditions and the changing demand conditions indicate that a control deficiency is developing in Minneapolis. Although the existing system provides an effective way to control and monitor system equipment, it does not provide any timing plan development capabilities. Further, the existing detection scheme provides reasonable inputs for limited traffic responsive plan selection but does not provide sufficient data for off-line or automated timing plan development. After review, it was concluded that frequent manual development of new timing plans directed specifically at solving timing changes associated with the multiple flow conditions, although possible, was not practical due to a combination of limited staff and plan development complexity and expense.

Familiarity with other cities and urban conditions indicated that the Minneapolis problems were shared by other cities. Discussions with other cities and specialists in the field of traffic management and control
indicated that the potential exists to address the indicated problems by installing a control system with adaptive control features.

Adaptive-type system operation differs from the existing table lookup, timing plan library-type operation. Primarily, where table lookup operation effectively selects a predetermined timing plan, adaptive control develops new system timing in response to actual traffic flow conditions.

Adaptive control, if successful, would address each of the developing problem situations in Minneapolis.

A number of adaptive-type systems have been tested on an experimental basis. Two production type adaptive systems are currently commercially available, the Split Cycle Offset Optimization Technique (SCOOT) based system and the Sydney Coordinated Adaptive Traffic System (SCATS) based system. The SCOOT system was developed by the Transportation Research Laboratory in England and is available through several U.K. firms. Adaptive control using SCOOT exists for a 9 intersection arterial in Oxnard, California, and will be installed at a 21 intersection modified arterial system in Anaheim, California, as an ITS test project. The SCATS system was developed in Sydney, Australia, and is available from AWA Limited and Phillips Traffic Control Limited. SCATS is installed in Oakland County, Michigan, on a super grid suburban type surface street system and will be installed at approximately 60 intersections on segments of roadway along a portion of I-494 in Hennepin County, Minnesota. Advanced research and development efforts are currently underway in the United States under the direction of the US DOT Federal Highway Administration to examine the potential of advanced adaptive control systems. It is expected that the U.S. effort will produce an adaptive control system in the future.

Internationally, adaptive control has been provided in a number of locations. Its potential benefits are recognized as they apply to the urban situations in other countries, but a number of questions remain to be answered concerning the potential for adaptive system operation in the U.S. Although not necessarily in order of interest, questions regarding adaptive system control include:

- Does adaptive control work in the U.S.?
- Can adaptive control be effectively and accurately monitored?
- How does adaptive control work in a densely signalized urban control situation?
- How effective is adaptive control?
- What effect does the application of adaptive control have on system staffing levels?
- What are the major cost factors in the installation and operation of an adaptive system?
- What is the level of special training necessary to design, implement and operate an adaptive based control system?
- Can an adaptive control system be retrofitted to an existing traffic signal system?
- What is the required level of detectorization necessary to implement and operate an effective adaptive system?

This information was presented to the Minnesota Guidestar division of the Minnesota Department of Transportation for consideration. Minnesota Guidestar administers the US DOT Intelligent Transportation System (ITS) program in Minnesota. An adaptive control system implementation project was approved as a test project in Minnesota in late 1994 under the title of the Adaptive Urban Signal Control Integration (AUSCI) project.

The AUSCI project consists of the installation and test operation of adaptive signal system operation in a portion of the CBD area of the City of Minneapolis. The test area is a 56-intersection integrated network of local streets, freeway ramps, HOV facilities and parking garages. It includes the termini of I-394 and T.H.
55 from the western suburbs and includes connections with I-94 and T.H. 52 to the suburbs in the northwest. Both corridors serve large numbers of rush-hour business and commercial center commuters, as well as attendees at major events in the CBD including events at the Metrodome, Minneapolis Convention Center and the Target Center Arena. The SCOOT adaptive control program was selected as the adaptive control element for implementation in Minneapolis for several reasons including:

- SCOOT is a known-performance, commercially available product.
- SCOOT is available through the Minneapolis system supplier, Fortran Traffic Systems Limited., thereby facilitating the hardware and software adaptation of SCOOT to the existing Minneapolis control system.
- SCOOT can be attached to the Minneapolis traffic signal control system as an extension of the existing control system.
- With SCOOT attached as a piggyback timing plan development extension, the existing Minneapolis T2000C system operation can be retained as the traffic signal control system for all traffic signals in the City. Under this arrangement SCOOT generates new timing for SCOOT operation with T2000C operation continuing for all other signals. This system configuration minimizes the requirements to learn a totally new control system.
- This adaptation of SCOOT with the T2000C system does not require the use of any special traffic controllers to incorporate SCOOT into the existing system. However, controllers and cabinets will be upgraded from EF70 dial-type units to EPAC solid state devices as part of the City’s phased controller upgrade project.
- SCOOT will be installed and test operated on a 56-intersection CBD test area. However, capacity will be provided as part of the initial system installation to allow future tests of adaptive control in other areas of the City.
- The SCOOT proposed implementation will allow use of SCOOT as a timing plan generation and evaluation tool.

Version 3.0 of SCOOT will be furnished as part of this project.

SCOOT requires special detection inputs to support its traffic flow modeling operation. New detection will be added to support the increased need for real-time traffic flow information within the SCOOT controlled test area. Although, loop detectors could be installed to provide the SCOOT detection inputs, video based detection is recommended for this installation. Video detection was recommended for the following reasons:

- Video detection will provide the zone of detection accuracy required by SCOOT and will allow variations in detection zone layout for model testing purposes.
- Video detection will allow each lane of the intersection approach to be independently detected.
- Video detection will allow fine tuning adjustments to be made to the final detector locations by software repositioning of the zone of detection.
- Video detection supports alternate detector arrangements and location schemes.
- Installation of video detection in the Minneapolis CBD can be installed with the lowest level of disruption to traffic flow in the area (no in-street construction).
- Detection is critical to the successful operation of the adaptive control system. Video detection allows maintenance support of the detection system in all weather.
- The video detection system will provide independently collected traffic flow and performance data to verify system performance as part of the system evaluation effort.

Conceptually, use of video detection will support the classification of vehicles for special adaptive control testing purposes. Since a bus priority feature will be available in the Minneapolis traffic control system,
video detection may be used as one form of bus detection without requiring any special equipment on the bus or at the intersection.

The video detection system may also allow a snapshot picture, video stillframe of the detector location to be viewed at the traffic control center for detector location and position record purposes. Although the video stillframe will not be useful for dynamic surveillance purposes, it will be extremely valuable for record keeping of various detector configurations and can be used to adjust detector locations from the traffic control center using data uploading.

Data will be captured from the video detection system and logged on a data file server located at the traffic control center. Once captured, the data can be analyzed by the evaluation contractor. Evaluation methods, procedures and support software will not be provided as part of the video data collection system. Collection and use of data from an independent source will allow verification of the SCOOT generated evaluation numbers. This approach provides a totally unbiased resource for comparison and evaluation of systems equipped with adaptive features.

Eight pan-, tilt- and zoom-equipped cameras will be situated throughout the test area for video surveillance purposes. Two of the eight cameras and video switching and control equipment will be installed as part of other work in the area. Each camera will be located to permit viewing of traffic flows along both cross streets in both directions. Full motion surveillance video will be returned to the traffic control center. Video will be used to observe traffic flow and for visual verification of traffic flow problems or the lack thereof as indicated by the adaptive control system. In addition to qualitative traffic flow observations, the collection of flow movement information from the surveillance video system for linked evaluation with other data collection operations as a system evaluation test will be assessed.

The City will manage and operate the traffic signal control system. The T2000C system will manage and control all 715 of the existing signalized intersections in the City. Standard T2000C features, functions and operation will be provided for all intersections. In addition, the SCOOT module and related detection facilities will provide on-line, real-time timing plan development for 56 of the 715 intersections. The T2000C system will enable the system operator to select SCOOT adaptive operation or to operate under standard T2000C system control. As SCOOT becomes operational, City staff will commence day-to-day operation of the test area under SCOOT control. Additional technical staff will be assigned to the project during detector testing and calibration efforts specifically directed at the SCOOT system detector implementation.

City materials and services will be provided to perform controller swap and connection operations. City forces will upgrade all traffic signal controllers in the area as part of the City’s phased controller upgrade project. Controllers and related equipment will be provided from City shelf stock supplies. Video detector and surveillance related construction services will be provided by Contractor work forces. Video surveillance cameras and equipment will be provided as purchased equipment. Video detector and SCOOT/T2000C software equipment and services will be provided under the partnership arrangements. Modifications to the T2000C system will be provided by Fortran Traffic Systems Limited, under terms of the existing T2000C system license agreement. Fortran Traffic Systems Limited, will also furnish and implement the SCOOT module under terms of the existing T2000C license agreement and a newly implemented license agreement between the City, through Guidestar, and Fortran Traffic Systems Limited and Siemens Traffic Control Limited, the SCOOT provider.
The AUSCI project will be managed by Minnesota Guidestar with technical assistance furnished by the Transportation Division of the City of Minneapolis Department of Public Works. The City will continue to own and operate the system. Westwood Professional Services will serve as the Project Engineer providing preliminary and final design and technical assistance during project construction and test periods. Strgar-Roscoe-Fausch, Inc., will serve as the independent Evaluation Contractor.

Other features of the modified SCOOT/T2000C system will include access to a user terminal for use by the Center for Transportation Studies (CTS) ITS lab research staff and a proposed connection to the Minnesota Department of Transportation (Mn/DOT) Traffic Management Center through an ITS TRILOGY system.

Connection to the CTS lab staff will extend interaction with the SCOOT/T2000C system for research, development and further testing purposes. Currently, the City of Minneapolis operates a heavily-instrumented intersection in the south Minneapolis area for CTS research purposes.

Proposed use of a TRILOGY computer system at the traffic control center will provide real-time traffic incident information to the City from the Mn/DOT Traffic Management Center. The proposed addition of the TRILOGY system will extend the type and amount of information available to the City for strategy application and management purposes. Availability of this information combined with regular interagency meetings will be used to further develop effective interagency control strategies and automatic linkages.