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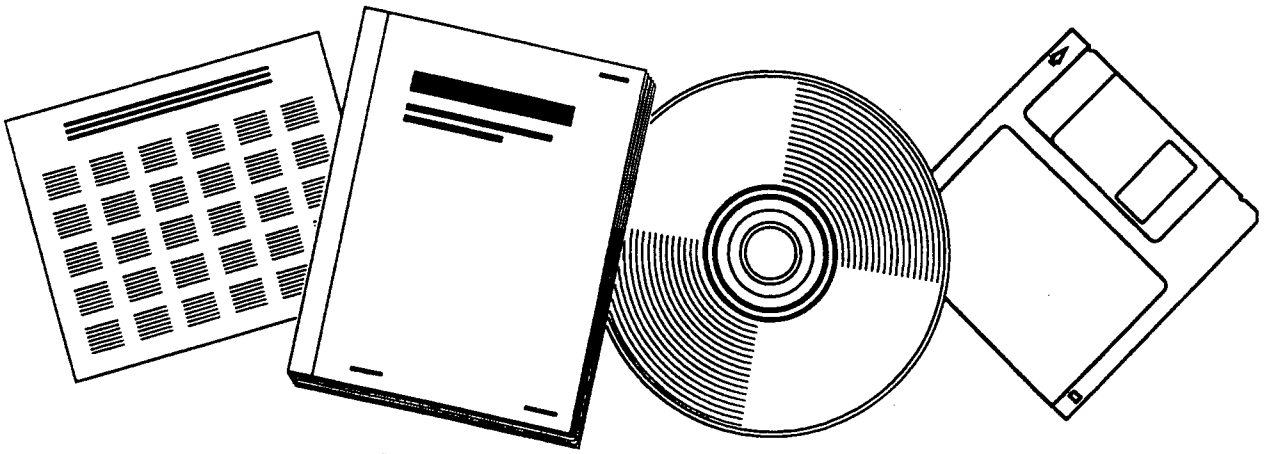
DEMONSTRATION PROJECT NO. 105: ADVANCED TRANSPORTATION MANAGEMENT TECHNOLOGIES INDUSTRY PARTNER TECHNOLOGIES

JUN 97



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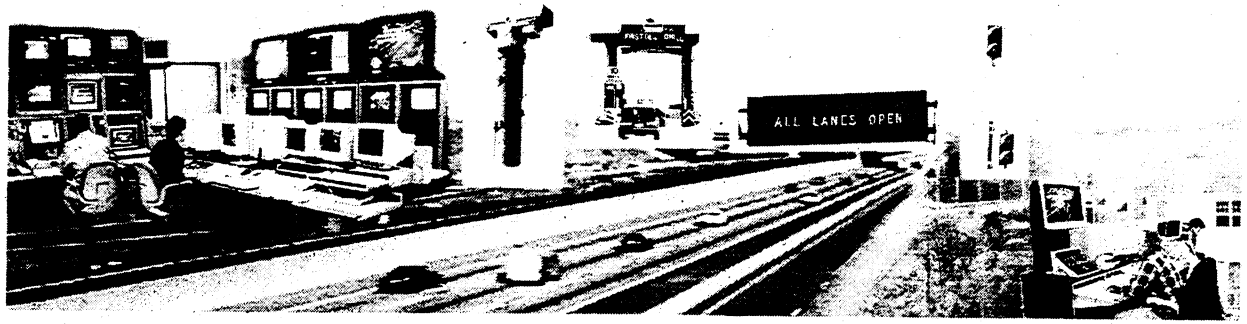

Advanced Transportation Management Technologies

Industry Partner Technologies

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16. Abstract

The Industry Partner Technologies was developed to provide participants with descriptions of each technology that is demonstrated in the DP 105 workshop, as well as sites where each of these technologies is deployed. The workshop is designed to provide participants with the following:

- Technology transfer on the state-of-the-practice transportation management techniques/technologies to improve mobility and safety;
- an awareness of the significant role of these management technoloies in improving mobility and safety; and
- hands-on demonstrations on the state-of-the-practice hardware and software in transportation management technologies

Participants of the workshop include:

- Decision makers from State and local Departments of Transportation (DOTs), Departments of Public Works (DPWs), and Metropolitan Planning Organizations (MPOs)
- State and local highway managers, planning policy makers, and administrators
- Highway and traffic engineers and engineering technicians

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TABLE OF CONTENTS

EASYSTREET BY ALLIED SIGNAL 1

METROVIEW BY BALL CORPORATION 3
METROVIEW DEPLOYMENT SITES 4

QUICNET/4 BY BI TRAN SYSTEMS, INC. 5
QUICNET/4 DEPLOYMENT SITES 8

CCTV CAMERA SYSTEM BY COHU 9
COHU CCTV DEPLOYMENT SITES 10

MONARC BY EAGLE TRAFFIC CONTROL SYSTEMS 12

SCOOT BY EAGLE TRAFFIC CONTROL SYSTEMS/SIEMENS 14

EPAC300 SERIES CONTROLLER BY EAGLE TRAFFIC CONTROL SYSTEMS 16

MODEL 2070 ATMS CONTROLLER UNIT BY EAGLE TRAFFIC CONTROL SYSTEMS 18

MODEL 170E ENHANCED CONTROLLER UNIT BY EAGLE TRAFFIC CONTROL SYSTEMS 19

MAGNUM BY EAGLE TRAFFIC CONTROL SYSTEMS 20
EAGLE TRAFFIC CONTROL SYSTEMS DEPLOYMENT SITES 21
EAGLE TRAFFIC CONTROL SYSTEMS/SIEMENS SCOOT DEPLOYMENT SITES 24

AUTOSCOPE BY ECONOLITE 25
AUTOSCOPE DEPLOYMENT SITES 29

MIST 2.0 BY FARRADYNE 35
MIST 2.0 DEPLOYMENT SITES 36

ICONS BY GARDNER-ROWE SYSTEMS, INC 37

ATMS SOFTWARE SYSTEM BY IBI 39

SMARTSONIC BY IRD 41
SMARTSONIC DEPLOYMENT SITES 43

G2 EXPERT SYSTEM BY KSD 44

ASSIST BY LOCKHEED MARTIN 45

ELECTRONIC TOLL COLLECTION BY MARK IV INDUSTRIES LTD. 47
MARK IV DEPLOYMENT SITES 48

DYNAMIC MESSAGE SIGNS BY MCCAIN TRAFFIC SUPPLY, INC. 51
MCCAIN DMS DEPLOYMENT SITES 51

NAVTECH DATABASE BY NAVIGATION TECHNOLOGIES 52
NAVTECH DATABASE DEPLOYMENT SITES 53

ATMS BY NET 55

MATS BY PEEK TRAFFIC 57
MATS DEPLOYMENT SITES 59

VIDEOTRACK-900 BY PEEK TRAFFIC 60

TRAFFICAM BY ROCKWELL INTERNATIONAL CORPORATION 62

ROAD WEATHER INFORMATION SYSTEM BY SURFACE SYSTEMS, INC. 63
SSI'S SCAN DEPLOYMENT SITES 65

SMARTTRACK SYSTEM BY TRANSPORTATION MANAGEMENT TECHNOLOGIES 68
TMS'S SMARTTRACK DEPLOYMENT SITES 70

OVERHEIGHT VEHICLE DETECTION SYSTEM BY TRIGG INDUSTRIES, INC. 71
TRIGG'S OVERHEIGHT VEHICLE DETECTION DEPLOYMENT SITES 72

VULTRON DYNAMIC MESSAGE SIGNS DEPLOYMENT SITES 73

EASYSTREET BY ALLIED SIGNAL

The mainframe software is responsible for providing several of the salient (detection, routing, analysis, display, storage and archiving) features of the system. The software supporting this program is an integration of tailored commercial-off-the-shelf products and custom code developed exclusively for this system. Both the commercial-off-the-shelf and custom developed software will work together to minimize risk and maintenance costs. The system is designed to be compliant with POSIX and OSF standards. The software analyses the roadway data (speed), volume, and occupancy) provided by the Local Control Units. Using a rolling average data smoothing technique, the software compares the incoming data to preset, day/time adjusted thresholds. When a threshold is crossed, in either direction, the system will automatically generate an alarm notification on the managers Management Control Unit for operator assignment or investigation.

Concurrent with the alarm generation process, the software will update the associated Map Display System screen on the Management Control Unit by changing the color of the roadway section where the incident occured. The color change is based on the severity of the incident. The Map Display System provides the manager the ability to zoom in on the effected area of the roadway. The system will also provide the manager with the current status of all field equipment in the area of the incident and will allow monitoring of the progress and success of the response. The manager selects which video camera is to be displayed on the video monitors installed in the console, and the system automatically switches the correct video camera output to the selected video monitor via the DS-3 Digital Matrix Switch. When the operator is confident in the details of the incident the operator can activate the scenario software package.

The scenario software gives the operator a comprehensive list of actions to be used to alleviate the congestion surrounding the incident. The system will have up to 123,000 pre-set scenarios stored in a data base. The scenario software will lead the operator through the selection of a scenario by asking the operator to provide the answers to such questions as; what type of incident is it? what lanes are effected? does demand exceed capacity? The answers to these questions will provide the system with the sort keys required to select the appropriate pre-planned scenario response from the data base. The system will then translate these actions into appropriate instructions to the field equipment (LCS, CMS, or traffic signals) to effect the desired changes, and monitor their implementation. The maps and displays will be automatically updated in near real-time, providing managers and operators in the control center with a complete picture of all incidents.

The system also provides several maintenance and support functions, which are used to maintain the systems underlying data structures.

The Map Display System provides an interfce supporting major roadway upgrades, changes or additions to the project boundaries. The interface will also allow the users to make minor changes to the Map Display System, within the scope of the existing project boundaries, using an interactive interface similar to the Intergraph user interface. There is an active security system maintained by access lists which limits access to processes and subprocesses as well as data, databases and files. The system also provides an interface, available to the project manager or designee only, which is used tomaintain and archive the data stored within the central database. The system prepares for

display the status and current data of all the field equipment within the project boundaries on 20 second intervals.

METROVIEW BY BALL CORPORATION

MetroView is a state-of-the-art map display workstation providing features needed for dispatch, fleet and traffic management applications. Designed and developed by Ball Systems Engineering Operations, it is based on over a decade of technology investments for the Department of Defense, plus recent research and development for FHWA.

MetroView provides the capability to display and manage vehicles, incidents, traffic events, and traffic conditions in a fully-integrated map graphics environment. The system enhances map displays with multiple colors to differentiate features and provide a familiar geographic perspective. Two simultaneous views are supported in a split-screen (tiled) or stacked configuration. Zoom levels ranging from 10-mile overviews to 200-foot close-ups are easily selected. The system quickly changes between different levels and provides increasing surface street detail at closer zoom levels. A large, high-resolution display makes the maps easy to read and reduces operator fatigue.

Ball's MetroView™ can use maps from any of the generally available data sources, including the U.S. Census Bureau (TIGER), Etak, ARC/INFO, MapInfo, and Thomas Brothers. Maps can then be customized with landmark icons and area boundaries, enhancing operational efficiency.

MetroView's display shows real-time traffic conditions by color-coding directional segments of the roadway. The user may view this information from repaired raw data in the forms of occupancy, speed, or volume, and may also view the data quality associated with each directional road segment. Ball has also developed an advanced algorithm to aid in viewing traffic congestion, providing a smooth and stable indicator of the traffic conditions within the directional segment.

A sophisticated graphical user interface for management of traffic events is also provided in MetroView. This feature allows information pertaining to incidents, planned events such as closures and maintenance activities, and wide-area messages such as weather notices to be entered by the operator, stored for future reference, and output to mobile devices within the system.

All of these features are fully integrated with MetroView's core map display, which presents vehicles and incidents both graphically on the map and in tabular form. Vehicle and incident types are represented by unique icons, and color indicates status at a glance. A mini-CAD capability is also included, allowing the operator to communicate digitally with the vehicles and to perform administrative controls on the mobile devices.

METROVIEW DEPLOYMENT SITES

Ball Corporation has been installing Advanced Mobile Communications and Fleet Tracking Systems since 1990 and now support many major installations in North America. Ball has installed systems for:

- San Francisco Bay Area Freeway Service Patrol - 64 tow trucks patrol the Bay Area freeways. As systems integrator, Ball Corporation supplied all components and introduced its MetroView AVL display.
- Las Vegas Fire Alarm Center - Ball supplied a network of MetroView workstations to support this combined Fire Alarm Facility supporting multiple agencies in Clark County, Nevada.
- Minnesota Highway Helper Program for Minneapolis
- Minnesota Trilogy workstations delivered to MnDOT
- Secretaria Seguridad Publica, Mexico City - Presently a pilot program, this program expects to outfit 4500 police vehicles, supported by a large network of MetroView workstations.

QUICNET/4 BY BI TRAN SYSTEMS, INC.

BI Tran System's QuicNet/4 is a full featured, hybrid, multi-tasking transportation management system (traffic signals, ramp meter, signs, etc.), designed to provide traffic operations personnel with intuitive, quick access to the functions that they use the most. QuicNet/4 is a fully functional Windows NT application which makes extensive use of the "point and click", "tear off" and "drop down" menus, and features direct dat access from the display maps. The system allows a flexible definition of Coordination Groups and powerful Traffic Responsive capabilities, and may be configured with "direct-connected" and/or Field Master communications. The system is available in both a single user and networked versions, and can be furnished as a multi-agency and/or multi-database system.

QuicNet/4 provides numerous benefits for the city. Some of the major advantages are:

- State-of-the-art computer operating system. QuicNet/4 runs on the Windows NT platform, and has been written to take advantage of NT's full 32 bit operating system.
- Full Windows Implementation. It is very "user friendly", and makes full use of "point and click" access to its functions. All operations begin from the city-wide display map, which allows direct access to the detailed intersection displays, timing sheets, and system operations.
- Flexible communication line layout. With the elimination of Field Masters, communication lines may be laid out in the most efficient manner, without regard to conforming the commu nication channels to the coordination groups. Any intersection in the system may coordinate with any other intersection, on any communication channel. This especially advantageous when running in a Traffic Responsive mode.
- Traffic Responsive. Traffic Responsive operation is very flexible. In addition to allowing any Sample Detector in the system to be utilized in controlling any Coordination Group(s), Traffic Responsive operation may run simultaneously with Time-of-Day selections.
- Flexible Report generation. Reports are generated using Microsoft Access/Excel. This allows customized reports and printouts as to topic, time period, and format.

The QuicNet/4 Features include:

System Management

- Fast, secure upload and download - Full verification of each download data item. The ability to download is password protected.
- Automatic comparison of controller database and central database. Differences are high lighted for easy comparison
- Easy copying of timing data between intersections

- Custom real-time displays for a city-wide map, user defined area system maps, and intersec tions. These displays can be easily modified and/or updated by the user. Supports ArcView as the interface (option).
- AutoCAD and other existing custom drawn graphics may be easily used as real-time display backgrounds.
- Supports custom "hard wired" display maps.
- Multi-level, fully configurable, password security.

Operations Management

- Real-time graphic displays of vehicle and pedestrian movements; along with vehicle, pedes trian, and preemption calls.
- Real-time display of coordinated data - timing plan, offset, coordination status, and cycle clocks.
- As the intersection and map displays are "windows", they can be run as individual full-screen displays, or their size can be reduced so that a mix of maps and/or intersections can be shown simultaneously.
- Real-time remote display of all 44 vehicle, pedestrian, preemption and auxiliary inputs to the controller.
- Real-time remote display of controller front panel and cabinet Input Files.
- Real-time graphic display of intersection and area status. Status of all intersections shown simultaneously on one, or more, city-wide map(s).
- Real-time display of alarm status and controller operation status.
- Operator notification of critical alarms - even if other applications are running.
- Supports automatic pager operation for alarm notification.
- Real-time traffic adaptive control (option).

Reporting

- Alarm History Report - with user-specified selection and sorting for dates, locations, and alarm types.
- Operations Report - with user specified selection and sorting.
- System Detector Volume and Occupancy Report.
- Traffic Responsive selections.

- Count Data Report from up to 32 detectors per intersection.
- Phase Green "split time" Report.
- Supports SQL interface for custom reports (option).
- Equipment Inventory Reports (option).
- Maintenance Management Reports (option).

System Analysis

- Automatic collection of System Detector Volume and Occupancy.
- Turning movement diagram generation.
- Detector count tabulation.
- Speed studies.
- Real-time split monitoring.
- Allows pre-implementation modeling of Traffic Responsive operation.
- "Measures of Effectiveness" reports based on actual stops and delays (option).
- Real-time computed Level of Service with map display (option).

Capabilities

- Scalable - Each Communications Server can support up to 1024 intersections.
- Field proven - Over 120 QuicNet Systems have been installed, several installations having more than 500 intersections.
- Coordination Groups and Traffic Responsive Sample Detectors are completely independent from the intersection's communication network. This allows any Sample Detector in the system to be used for Traffic Responsive control of any intersection(s).
- Traffic Responsive operation may run simultaneously with Time-of-Day selections. This permits a traffic responsive calculation to monitor for abnormal conditions, and to assume that such conditions are detected.
- Up to 32 phase and 8 system detectors per controller.
- Supports all makes of Model 170 controllers, running Traffic Signal Program 200, 233, c*, and others; along with NEMA controllers.
- Supports private twisted pair, leased line, dial-up, microwave, VHF, spread spectrum radio, and fiber optic in mixed-mode configuration.

- On line, context sensitive, HELP screens.
- Local Area Network support.
- Multi-user support with multiple workstations.
- WWV Receiver for standardized time clock (option).

QUICNET/4 DEPLOYMENT SITES

- Modesto, California
- Vallejo, California
- Ft. Worth, Texas
- Dekalb County, Georgia
- 6 other systems scheduled for 1997

CCTV CAMERA SYSTEM BY COHU

The Cohu Traffic Management Video System demonstrates the fundamental equipment used in a video surveillance system for incident management in an advanced corridor management system. Cohu manufactures high-performance closed-circuit television (CCTV) cameras and systems for traffic surveillance and incident verification projects.

CCTV is the critical component of incident verification. Reliable CCTV cameras and systems allow a traffic management team to rapidly and efficiently analyze situations, respond with precise action, and keep traffic flowing.

An effective video system includes a cameras, positioners, communications and control devices, and monitors. The DP-105 demonstration is a working system that includes the following Cohu products:

1/4" sensor color CCTV camera, which provides 470 lines of resolution;

sealed and pressurized housing to protect the camera components and ensure

reliable operation;

pan and tilt unit to position the camera;

camera control receiver. This component provides the communication link between the camera site and the Operations Center. It is typically installed in a 330-type cabinet near the camera, and provides local control of the camera and pan and tilt positioning, as well as direct viewing of the camera signal. It is designed to reduce the cost of CCTV system installa tion and improve command and control of operations;

a computer display that demonstrates and explains the CCTV system.

Designing a CCTV system and incorporating all its components can be complicated, but cooperation between the designer and the manufacturer results in a system with superior performance and reliability. Cohu provides "Specs on Disk" and a Video Planner to support specification preparation specifically for transportation professionals.

Cohu, Inc./Electronics Division is a U.S. manufacturer of closed circuit television cameras and control equipment. We have been in business more than 40 years and are highly regarded for our innovative and reliable CCTV solutions to traffic management. Cohu video systems for traffic surveillance are in operation from coast to coast and border to border, on bridges, turnpikes, tunnels and freeways.

COHU CCTV DEPLOYMENT SITES

L.A. Department of Transportation

Traffic management system consisting of cameras with MPC control.

Washington State Department of Transportation

I-90 Freeway Traffic Management system using cameras with fiber optics and with MPC control. The camera controls and pan/tilt functions are being controlled via a customer supplied micro VAX computer.

Mt. Baker Tunnel Project using cameras with fiber optics and MPC control. The camera controls and pan/tilt functions are being controlled via a customer supplied micro VAX computer.

Caltrans - District 4

Traffic management system monitoring the Dunbarton bridge. System consists of a variety of cameras with MPC control. The camera controls and pan/tilt functions are being controlled via a customer supplied computer.

Traffic management system monitoring the Oakland Bay bridge. System consists of cameras with fiber optics and with MPC control. The camera controls and pan/tilt functions are being controlled via a customer supplied computer.

Traffic management system monitoring the San Mateo - Hayward bridge. System consists of cameras with fiber optics and with MPC control. The camera controls and pan/tilt functions are being controlled via a customer supplied computer.

Golden Gate District

Traffic management system monitoring the Golden Gate bridge.

Port Authority of New York, New Jersey

Traffic management system monitoring the George Washington bridge.

Traffic management system monitoring the Lincoln Tunnel.

Traffic management system monitoring the Gothels Bridge.

Traffic management system monitoring the Outer Reach Bridge.

Traffic management system monitoring the Holland Tunnel.

City of New York, Department of Transportation, Bridges Division

Traffic management system monitoring the 59th Street Midtown Bridge from Manhattan to Long Island.

Traffic management system monitoring the Verazano Bridge.

Traffic management system monitoring the Tappen Bridge.

City of New York, Department of Transportation, Streets and Highways Division

Traffic management system monitoring the Kennedy Airport.

Traffic management system monitoring the Van Wyck Expressway between LGA and Kennedy.

Traffic management system monitoring the Newark Airport.

Traffic management system monitoring the LaGuardia Airport.

Ministry of Transportation, Downsview, Ontario

Highway 401 Freeway Traffic Management system from Martingrove road easterly to Yonge Street in Toronto.

Michigan Department Of Transportation, Detroit, Michigan

Using cameras to monitor traffic in the Detroit area.

CalTrans - District 11

Traffic management system monitoring the Coronado Bay Bridge.

County of Alameda, Public Works Department, Alameda, California

Traffic management system monitoring the Miller Sweeney Bridge

Illinois Department of Transportation

Kennedy Expressway Reverse Lane Closure Monitoring

City of High Point, North Carolina

City Traffic Intersection Signal Control System

City/County of Honolulu, Department of Transportation, Honolulu, Hawaii

Kalanianaole Highway add-on

MONARC BY EAGLE TRAFFIC CONTROL SYSTEMS

MONARC (Master Office Network Adaptive Real-Time Control) is a flexible, easy-to-use management system that can provide effective responses to traffic conditions and incidents, analyze trends and changing requirements, and accommodate future needs as conditions change. MONARC provides a single source for all your management needs, including hardware and software components, training programs, and technical assistance. The system can utilize a wide variety of communications capabilities, including standard telephone lines, fiber optic lines, spread spectrum radio, microwave radio, and FSK.

MONARC is so advanced, it is simple. Because it works with off-the-shelf hardware and is fully compatible with a wide range of traffic control equipment, the system can be as basic or as complex as traffic patterns and budgets demand. A basic MONARC system can be installed initially with the potential to evolve into a sophisticated, Intelligent Transportation System (ITS) managing a broad array of traffic devices and subsystems as traffic patterns change and grow over time.

Features of the MONARC System

- Window-based user interface allowing simultaneous execution of multiple tasks.
- Multiple full function workstations (remote or networked) with conflict checking to ensure only single user data access and system security provided via user ID's with password and associ ated privilege levels.
- Upload and download of data from and to EPAC and EPIC controllers, masters, and remote interface units.
- Direct support of Type 170 controllers directly.
- Unlimited number of intersections per group, sync pulses for all groups referenced to a common time, intersections switchable between groups.
- Area graphics displays with current intersection, detector and group status, including dynamic zoom, and multiple layers.
- Intersection graphics displaying real-time signal and detector status. Multiple window dis plays allowed.
- Great flexibility in defining intersection diagrams, features and text.
- Systems events, Operator Commands, Time-Based Commands and Quick Response Com mands, all logged to disk and optionally to windows on workstations.
- Maintenance of historical detector data.
- Quick Response/Incident Management Software. User-definable triggering criteria and command execution to handle special traffic conditions.

- Traffic Analysis package providing time/space plots and timing plan generation based on historical/current detector data.
- Traffic responsive mode up to 48 traffic patterns per group.
- Time-Base Control allowing schedule assignment up to a year in advance.
- Automatic Daylight Savings Time and leap year adjustment.
- Extensive content-sensitive help windows and additional user aids, i.e., undo, copy, compare,
- Cable layouts and cabinet wiring diagrams using CAD or graphic programs.
- Maintenance and Inventory Management via a central database (SQL compatible).
- Intersection descriptions provide graphics and/or text to further document intersection.
- Automatic Vehicle Identification capabilities.
- System Analysis: Traffic flow MOEs and extensive system detector logging and reporting.
- Utilize a variety of graphic formats allowing system incorporation of user generated graphic files, e.g., DXF-based area maps.

Sample of Modules that MONARC Systems Currently Incorporate

- Traffic Analysis
- Maintenance and Inventory Database
- Incident Management (Quick Response)
- Video Surveillance
- Dynamic Message Signs
- Ramp Metering
- Traveler Advisory Systems (Highway Advisory Radio, Highway Advisory Telephone, Internet)

MONARC System Options

- GIS
- Reversible Lane Control
- Mass Transit Interface
- High Occupancy Vehicle (HOV) Lane Control

SCOOT BY EAGLE TRAFFIC CONTROL SYSTEMS/SIEMENS

SCOOT (Split-Cycle-Offset-OptimizationTechnique) was conceived in the early 1970s. It utilizes many of the methodologies and concepts developed for TRANSYT. However, SCOOT continuously measures traffic demand on all links in a coordinated network, optimizing signal timings in real time for actual traffic conditions.

Recent extensive 'before and after' studies on three pilot networks in Toronto, Canada, revealed significant improvements in stops, delays, and fuel consumption. SCOOT, not only provides better real time adaptive traffic control, it saves man-years of effort required to continually update timing plans.

SCOOT operation is based on the following philosophy:

Cyclic Flow Profiles (CFP) can be measured on the street as they occur,

An on-line model runs in real-time and calculates the queues at the stop line,

Any changes are incremental and frequent. The SCOOT coordination plan is elastic and can be 'stretched' or 'shrunk'. For a 100 intersection network, SCOOT makes over 10,000 small decisions every hour.

The SCOOT traffic model requires data to be collected four times a second from presence detectors placed upstream (or midstream) on every significant link in the network. Three separate Optimizers calculate the most suitable Split, Offset and Cycle times.

The split optimizer works on the traffic model just before each phase change.

Once a cycle, the offset optimizer predicts the queue lengths for all the links upstream and downstream of a particular intersection. Congested links are given priority in the offset optimizer.

The cycle optimizer will usually run every 5 minutes and, if necessary, increase or reduce the cycle time by a small step. There is a provision within SCOOT for the optimizer to run twice as often, if appropriate.

The latest version of SCOOT includes new features such as gating and bus priority. ASTRID is a new database designed to collect the wealth of information generated by the SCOOT model, and to store it for later retrieval and analysis. New developments also include INGRID, a software that automatically detects incidents in urban areas and provides information such as time, location and duration of the incident.

In short, there are several reasons why SCOOT is the solution for modem traffic control:

SCOOT uses a real time model of traffic behavior to predict stops and delays within the network,

- SCOOT has consistently shown to provide the greater benefits over the 'best' previous system,

- SCOOT is successfully operating in different environments in major metropolitan areas throughout the world,
- SCOOT provides detailed traffic statistics for planning and operation,
- SCOOT is a proven approach, not R&D.

EPAC300 SERIES CONTROLLER BY EAGLE TRAFFIC CONTROL SYSTEMS

The EPAC300 Series Controller Unit is a fully actuated controller unit with a full complement of operational, programming, and diagnostics capabilities. The unit exceeds both NEMA TS 1-1989 and TS 2-1992 Actuated Controller Unit Standards. Programming is easy and error free using English Language Menus. Within a menu, each parameter can be viewed and a cursor moved to that parameter for changes. Related parameters are visible simultaneously, making verification an easy matter. The screen provides both programming area identification and editing prompts.

Features

Six Modes of Coordination

Permissive Mode

Yield Mode

Permissive Yield Mode

Permissive Omit Mode

Sequential Omit Mode

Full Actuated Mode

Adaptive Traffic Control

16 Vehicle Phases

16 Pedestrian Phases

4 Timing Rings

16 Overlaps

80 Detectors

Adaptive Maximum Routines

Adaptive Protected/Permissive

Routines

Coordination Virtual Split Routine

Time Base Control

250 Events

99 Day Programs

10 Week Programs

Preemption/Priority

6 Preempt Routines

6 Priority Routines

Diagnostics

Monitor Compatibility Programming

Diagnostics

Monitor Field Status Diagnostics

Cycling Diagnostics

Detector Diagnostics

Port 1 Message Display

Port 2 Comm Status Display

Port 3 Comm Status Display

Hardware I/O Status Display

Reports

Date and Time of Occurrence

Local Alarm Log

Comm Fault Log

Detector Fault Log

System Detector Log

MOE and Cycle MOE Logs

Speed Log

Volume Count

MODEL 2070 ATMS CONTROLLER UNIT BY EAGLE TRAFFIC CONTROL SYSTEMS

The Model 2070 ATMS Controller Unit is an advanced ruggedized field processor and communications system configurable for traffic management applications. It exceeds CALTRANS' latest transportation electrical equipment specifications and is NEMA controller compatible with the addition of an interface module.

Highlights

Approved by CALTRANS

Open Architecture insures compatibility with off-the-shelf products

VME Hardware

--Standard VME interface modules from multiple vendors

OS-9 Software

--Standard software modules from multiple sources

Easy system upgrades with additional VME boards and software extensions

Large back lighted liquid-crystal display -- 4 lines, 40 char/line

Flexible design to meet specific user needs

Multitasking -- each 2070 unit can control multiple traffic devices

Multiprocessing -- each 2070 unit can accommodate multiple traffic CPUs

Designed and built for unattended operation in harsh environments

Physically compatible with NEMA controller using interface module

Physically compatible with CALTRANS Model 170, 170E controllers and facilities

MODEL 170E ENHANCED CONTROLLER UNIT BY EAGLE TRAFFIC CONTROL SYSTEMS

The Model 170E enhanced controller unit is a general purpose, ruggedized microcomputer that is designed to operate in hostile environments. The open-architecture design allows the unit to execute a wide range of third-party software to control traffic, toll counters, etc.

Features

Approved by CALTRANS

Compatible with all third-party Type 170 software

Option of 1,2,3 or 4 ACIA serial communication ports

Option 1 of ACIA serial communication port accessible from the front panel on a 9 pin "D" connector

Option of CALTRANS "E Option" module

Accepts CALTRANS standard 412C Memory Module

Internal memory allows operation without 412C Memory Module

Design utilizes fewer electronic components for greater mean time between failures

Separate Input and Output Modules for lower replacement cost in case of damage

Single backplane connection for all plug-in modules (no cables to remove)

Modern power supply design is twice as efficient for cool operation and long life

Super capacitor backup, minimum of 72 hours

MAGNUM BY EAGLE TRAFFIC CONTROL SYSTEMS

To enhance 170 and 170E controller capabilities

The MAGNUM card enhnaces a 170 or 170E controller unit's processing power simply by plugging it into the program memory slot. Enhanced capabilities include adaptive traffic control, additional modes of coordination, internal time base control, internal preemption/priority routines, and extensive data reports.

Highlights (same as EPAC300)

Hardware features include:

NEMA Port 2 computer interface for communications at 1200 to 19200 baud

NEMA Port 3 Wide Area Network for communications to other controllers

Dual port memory for seamless interface to the Type 170 Motherboard

Motorola 68000 family 16/32 bit 16 Mhz microprocessor

Battery-backed Real-Time Clock for time and calendar

Full EPAC firmware programming using notebook computer connected to Port 2 or via system to Port 3

Safety features such as Power-On Reset, Power Monitor, and Watchdog Timer

Uses the existing Type 170 CPU, Input and Output Modules, and cabling

No additional third party software or PROM sets required

512K bytes of PROM containing the EPAC300 firmware expandable to 1024K

32K expandable to 256K bytes of battey-backed RAM for data logging

8K expandable to 32K bytes of NOVRAM for retention of user set-up data

EAGLE TRAFFIC CONTROL SYSTEMS DEPLOYMENT SITES

Montgomery County, Maryland

In 1980, EAGLE Traffic Control Systems installed the county's first computerized traffic control system. It utilizes an open architecture in a UNIX environment to allow multiple subsystems and future ITS technologies to be integrated into the project. Transportation control features of the Montgomery County ATMS project include:

- Capacity to handle 1500 intersections with 700 intersections currently on-line
- Accident and Incident Management with automatic notification of emergency response agencies
- Manual reconfiguration of Traffic Management Center when a signal malfunctions
- Global Positioning System equipment in the county's 250 transit buses to allow monitoring of bus progress and enable traffic signal adjustments to keep buses on schedule.

Monitoring features of the Montgomery County ATMS project include:

- 50+ video surveillance cameras deployed along major roadways, with an additional 150 cameras to be installed by the year 2000
- Video surveillance airplanes that send video feeds to the Traffic Management Center
- 1000 loop detectors installed with an existing capacity for an additional 2000

Features designed to communicate traffic and transit information to the public include:

- 12 Highway Advisory Radio systems tied together via a local cable system
- County Access cable television channel broadcasts live video, audio from the HAR system, and transit information during morning and evening peak periods
- Live video feeds and traffic information are provided through direct connections with local television stations
- Information is shared and coordinated with local commercial information services

Richmond, Virginia

The Richmond ATMS includes a capacity for 500 intersections of which 270 intersections are currently on-line in the metropolitan area. EAGLE Traffic Control Systems developed the software, supplied all of the central control hardware, and supplied all of the intersection controllers for this project. The software features of the system include:

- Graphical User Interface

- Multi-tasking capabilities
- Area and intersection graphics
- Report generation
- Monitoring and adjustment of system traffic parameters
- Emergency vehicle route preemption timing plans

The hardware and equipment features of the system include:

- Four computer workstations with identical functionality
- Two laptop computers with remote access capabilities via telephone lines
- 10' large screen graphic projector which provides real-time display of system operations
- Telephone connections at all control cabinets with off-hook indicators to allow field techni cians to communicate with the control center or the maintenance shop
- Continuous real-time inputs to the system from various communications links

Spokane, Washington

The Spokane ATMS includes a capacity for 300 intersections of which 180 intersections are currently on-line in the metropolitan area. The features of this system are:

- Graphical User Interface
- Multi-tasking capabilities
- Area and intersection graphics
- Traffic analysis
- Quick response (Incident Management)
- Database for maintenance and inventory management
- System linked to the City's existing Novell network
- Video Surveillance capabilities are scheduled to be added to the system in the near future

Carrollton, Texas

The Carrollton ATMS is a completely wireless system with a capacity for 150 intersections of which 80 intersections are currently on-line. The features of the system are:

- Graphical User Interface

- Multi-tasking capabilities
- Area and intersection graphics
- Quick response (Incident Management)
- Traffic analysis
- Video surveillance at 7 intersections with video links to control center via microwave radio
- Communications with intersections accomplished via spread spectrum radio
- Remote workstation located in the city hall that is capable of viewing live video

Utah DOT, Ogden - MONARC/ATMS Traffic Control System with all communications accomplished via a fiber optic network and direct connect to all controllers

Utah DOT, Salt Lake City - MONARC/ATMS Traffic Control System currently running intersection sub-masters

Aurora, Colorado - MONARC/ATMS Traffic Control System with 250 intersections and 100 intersections and local masters on-line

Marieta, Georgia - MONARC/ATMS Traffic Control System with 500 intersections capacity and 64 intersections on-line. This was the original Beta test site for the MONARC system.

Jackson, Mississippi - MONARC Traffic Control System with 500 intersections capacity and 200 intersections with 7 MARC360 on-street masters on-line. The city plans to add 47 intersections to the system in the future.

Johnson City, Tennessee - MONARC/ATMS Traffic Control System with 500 intersections capacity and 25 intersections on-line.

Farmers Branch, Texas - MONARC/ATMS Traffic Control System

Dayton, Ohio - MONARC/ATMS Traffic Control System with 300 intersections capacity and 145 intersections on-line.

Raleigh, North Carolina - Centralized/Computerized Traffic Control System (Central UTCS type) with 600 intersections capacity and 400 intersections on-line in the Central Business District

Arlington, Texas - Centralized Traffic Control System with 256 intersections capacity and 120 intersections on-line

Seattle, Washington - Centralized/Computerized Traffic Control System with 500 intersection and 200 intersections on-line in the Central Business District

Peoria, Illinois - Centralized Traffic Control System with 250 intersections capacity and 100 intersections on-line.

Fort Wayne, Indiana - Centralized/Computerized Traffic Control System with 250 intersections and 160 intersections on-line.

Fairfax, Virginia - MONARC/ATMS Traffic Control System

Racine, Wisconsin - MONARC/ATMS Traffic Control System

Ann Arbor, Michigan - MONARC/ATMS Traffic Control System

EAGLE TRAFFIC CONTROL SYSTEMS/SIEMENS SCOOT DEPLOYMENT SITES

The cities of Anaheim, California (in progress), San Diego, California (in progress), Minneapolis, Minnesota (in progress), Oxnard, California, and Toronto, Ontario, Canada have been selected for SCOOT Adaptive Traffic Control Systems.

AUTOSCOPE BY ECONOLITE

The core of Autoscope detection system is an image processor-a box that contains the microprocessor-based CPU, specialized boards, and software used to analyze video images. The unit fits in an outdoor traffic cabinet and accepts video signals from multiple roadside video cameras. The system can detect traffic in multiple locations within the camera's field-of-view. These locations are specified by the user using a mouse and interactive graphics by placing virtual detectors on the video image displayed on the computer monitor, displaying the traffic scene. Since these detection lines exist only on the monitor and not in the pavement, they can easily be removed or adjusted following initial placement. Each detector represents a zone-either a wide-area zone or a short zone that in the simplest form emulates an inductive loop. For most practical applications, there is virtually no limit to the number of zones (100 or more) that can be assigned to an Autoscope processor. Once the system is set up, a detection signal is generated each time a vehicle crosses one of these virtual detectors. The Autoscope processor analyzes the incoming video images to generate traffic data. and vehicle classification. The Autoscope is able to receive live or recorded roadway images and analyze them in real-time to detect vehicles and to pass vehicle detection data to a supervisor computer or another device such as a traffic controller. The Autoscope is able to determine the following traffic data: traffic volumes; vehicle classification; occupancy; stopped vehicle detection; queue-length measurements; speed measurements; headway over time; turning movements; vehicle detection for traffic signals (loop emulation). Autoscope provides the following applications: freeway surveillance; tunnel and bridge surveillance; entrance ramp metering control; intersection control; incident detection; simultaneous monitoring of multiple traffic lanes; traffic counting and classification; energy auditing; support for variable message signs.

Key features and Benefits include: wireless detection; non-destructive to road structure since installation is above ground; camera coverage can be verified with video monitor-ability to see what you detect; wide area coverage by a single camera-up to six lanes over a long section; accurate and reliable data transmission with minimum maintenance; provides versatility of video signal transmission-coaxial cable, fiber optic, twisted pair wire, wireless RF, microwave; multidrop communications; can be used as a portable detection system during road construction or repairs without disruption to traffic; detection is not interrupted by adverse weather conditions; variety od detector types and applications; detectors are easily adjusted, moved or resized to meet new traffic demands.

The Autoscope detection is programmed using a supervisor program that is an easy to use menu-driven application running under Windows on a 386 or 486 based PC. The supervisor computer is connected to Autoscope through an RS-232 link, either directly via hard wire, or from a remote location via modem. Once detectors are set up and the detector configuration has been downloaded into Autoscope, the supervisor computer and video monitor may be disconnected, and Autoscope continues to operate automatically on its own providing detector outputs and storing traffic data in its internal non-volatile memory to protect against power failure. When the supervisor computer and video monitor are connected, traffic data may be recorded directly on disk and be displayed on the computer screen in numeric format. Vehicle detections superimposed on the image of traffic may be observed on the computer screen. The collected traffic and detection data will be made available in readily-accessible ASCII format. The supervisor computer software provides file management routines for efficiently filing, retrieving and reporting of the collected traffic data. Selection of the data to

be displayed on the computer screen is done by pull-down menus and are in the form of windows under Microsoft Windows 3.1 graphics operating environment. It is possible to save on hard disk the complete time data or actuation data for each vehicle detection.

The **Video Detection System** provides flexible detection zone placement anywhere and at any orientation within the combined field-of-view of the image sensors. Preferred presence detector configurations are lines placed across lanes of traffic or lines placed inline with lanes of traffic. A single detector line is able to replace one or more conventional detector loops connected in series. In addition, detection zones have the capability of implementing logical functions including AND, OR, NAND, N of M and delay/extend timing. Placement of detection zones is done by means of a supervisor computer in the Microsoft Windows 3.1 graphics environment and a mouse. The VGA monitor will show images of the detection zones superimposed on the video image of traffic. The detection zones are capable of being sized, shaped and overlapped to provide optimal road coverage and detection. It is possible to save the detector configurations on disk, to download detector configurations to the Autoscope Processor (control unit), and to retrieve the detector configuration that is currently running in the control unit. It is also possible to use the supervisor computer's mouse to edit previously defined detector configurations so as to fine-tune the detection zone placement size and shape. Once a detection configuration has been created, the supervisor computer will provide a graphic display of the new configuration on its own VGA screen. When a vehicle is under a detection zone, the detection zone changes in color or intensity on the VGA monitor thereby verifying proper operation of the detection system. Color changes are also used to indicate detection delay and extension timing. The video detection system reliably detects vehicle presence when the image sensor is mounted 30 feet or higher above the roadway, when the image sensor is adjacent to the desired coverage area, and when the length of the detection area or field-of-view is not greater than ten times the mounting height of the image sensor. The image sensor is not required to be mounted directly over the roadway. A single image sensor, placed at the proper mounting height with the proper lens, is able to monitor six to eight traffic lanes simultaneously. Overall performance of the video detection system is comparable to inductive loops. Using standard image sensor optics and in the absence of occlusion, the system is able to detect vehicle presence with 98% accuracy under normal conditions (day and night) and 96% accuracy under adverse conditions (fog, rain, snow).

The autoscope package has the following main components:

- The **Autoscope Processor** - a special-purpose video image-processing computer (a self-contained control unit) that processes real-time traffic images from image sensors and sends detector outputs to a controller or remote computer. The Autoscope processor analyzes the video signal from one or multiple (up to six) image sensors to detect vehicles and to calculate traffic parameters. The video will be digitized and analyzed at a rate of 30 times per second. The time-interval data will be retained in the non-volatile EEPROM flash memory within the control unit for later uploading to the supervisor computer for analysis. Retrieval of data stored in the non-volatile memory of the control unit will be via a serial communications port. Provision is made for downloading of data via modem and dial-up telephone lines, via private cable or fiber optic network, or via direct connection to another computer by cable. It com municates with the supervisor computer to receive instructions and send back vehicle detec

tion data. It can also communicate with a traffic controller to send traffic detection data and receive traffic signal phasing data. The control unit has the capability to capture a video image (snapshot) from a selected image sensor input and transmit the image to the supervi sor computer for display. The captured video image is compressed to minimize the time needed to transmit the image. An option is provided to allow continuing or suspending detection while the video image is being compressed and transmitted.

The control unit is shelf or rack mountable. Serial communications to the supervisor com puter is through an RS-232/RS-422 serial port. This port is able to download traffic data stored in non-volatile memory as well as the real-time detection information needed to show detector actuations. A 9-pin D subminiature connector on the front of the control unit is used for serial communications. The control unit is equipped with a NEMA TS1 detector interface for 32 detector outputs. Output level is compatible with NEMA TS1, NEMA TS2 Type 2, Type 170 and Type 179 standards. A 37-pin D subminiature connector on the front of the unit is used for interfacing to these outputs. NEMA red/green inputs for up to 16 phases is avail able as inputs to provide controller state information for detection and extend/delay timing functions. A 37-pin D subminiature connector on the front of the unit is used for these inputs. The control unit is equipped with four RS-170 (B&W)/NTSC (color) composite video inputs, so that signals from four image sensors or other synchronous or nonsynchronous video sources can be processed in real-time. A fifth video input is provided to allow connec tion of a local surveillance camera or other non-detection video source. The video from this auxiliary video input is not processed for detection. BNC connectors on the front of the control unit is used for all video input. The unit is equipped with a single RS-170/NTSC composite video output. This output is capable of being switched to correspond to any one of five video inputs, as selected remotely via the supervisor computer or front panel switch. A BNC connector on the front of the unit is used for video output.

- The **Supervisor Program** - to define where you want the Autoscope processor to detect vehicles on the video image of the roadway; to define what type of information you want the Autoscope to exchange with your traffic controller; and to extract the traffic data saved in the Autoscope processor memory and sore the data in files on the supervisor computer.

- The **Supervisor Computer** - the Autoscope software programs are designed to run on a PC-compatible running DOS and Microsoft Windows. This supervisor computer sends instructions to the Autoscope processor and receives traffic data from the Autoscope. The supervisor computer can be disconnected from the Autoscope processor after initial installa tion, and it can serve multiple Autoscope processing units. It is possible to capture and store as a file the video currently being displayed at the supervisor computer. Communications with the supervisor computer is done via either a point-to-point or multi-drop communications architecture. Minimum specifications for the supervisor computer include: PC-compatible, 486 processor; MS DOS 6.2; Microsoft Windows 3.1; one free full-size AT-compatible expansion slot; VGA color monitor; Keyboard; mouse; 8 MB of RAM, 250 MB HD, 3.5", 1.44 MB and 5.25", 1.2 MB floppy disk drive. A video digitizer board will be installed in the supervisor computer to capture and display in real-time video images. The digitizer board permits defining detector regions and viewing of real-time vehicle detections overlaying live

roadway video on the supervisor computer's VGA monitor. The board fits in the full-size AT-compatible expansion slot.

- The **Image Sensor (Video Source)** - The video signal can come from either image sensors or a video recorder. The video signal is input to the Autoscope processor through BNC connectors. The video detection system uses medium resolution, monochrome or color, image sensors as the video source for real-time vehicle detection. Images are produced with a CCD sensing element with horizontal resolution of at least 500 lines and vertical resolution of at least 350 lines. Images are output as a video signal conforming to RS-170 or RS-170A specs. The image sensor is equipped with an auto-iris lens with fixed focal length. The maximum aperture of the lens is less than f300. The image sensor is prefocused at infinity at the factory. The image sensor and lens assembly is housed in an environmental enclosure.

AUTOSCOPE DEPLOYMENT SITES

There are over 1300 Autoscopes installed worldwide. Applications have included intersection detection, freeway detection and surveillance, incident detection for both freeways and tunnels, construction zone detection, portable detection, and various data collection applications. Following are some of these installations with autoscope type and type of application:

Arizona

- City of Mesa - Autoscope 2004; construction installation
- City of Tempe - Autoscope 2004; intersection
- City of Tucson - Autoscope 2004; intersection research
- University of Arizona - Autoscope 2004; Intersection University study

California

- City of Anaheim - Autoscope 2004; intersection
- City of Brea - Autoscope 2003; intersection
- City of Bakersfield - Autoscope 2003, 2003LE, 2004; intersection
- City of Burbank - Autoscope 2004; intersection
- Caltrans, District 12 - Autoscope 2003; freeway, intersection
- City of Campbell - Autoscope 2004; intersection
- City of Carlbad - Autoscope 2004; intersection
- City of Cerritos Autoscope 2004; intersection
- City of Cino - Autoscope 2003, 2004; intersection
- City of Clovis - Autoscope 2004; intersection
- City of Daly City - Autoscope 2004; intersection
- City of Fontana - Autoscope 2003, 2004, 2004ID; intersection
- City of Fresno - Autoscope 2003LE, 2004; intersection
- City of Hammond - Autoscope 2003; intersection
- City of Hayward - Autoscope 2004LE; intersection

- City of Henderson - Autoscope 2004; intersection
- City of Irvine - Autoscope 2003; intersection
- City of Lancaster - Autoscope 2003, 2004; intersection
- City of Lodi - Autoscope 2004LE; intersection
- City of Long Beach - Autoscope 2003, 2004; intersection
- City of Merced - Autoscope 2003LE; intersection
- City of Ontario - Autoscope 2003, 2004; intersection
- City of Orange - Autoscope 2004; intersection
- City of Palmdale - Autoscope 2004; intersection
- City of Pasadena - Autoscope 2004; intersection
- City of Rancho Cucamonga - Autoscope 2004; intersection
- MTA/Rail Safety Council - Autoscope 2004; Rail application
- City of Sacramento - Autoscope 2004; intersection
- City of Santa Ana - Autoscope 2003; intersection
- San Bernardino County - Autoscope 2004; intersection
- Santa Barbara County - Autoscope 2003, 2003LE, 2004; intersection
- City of Santa Clarita - Autoscope 2004; construction
- City of Southgate - Autoscope 2004; intersection
- City of Stockton - Autoscope 2004; intersection
- City of Ventura - Autoscope 2004; intersection research
- City of Vernon - Autoscope 2004LE; intersection

Colorado

- City and County of Denver - Autoscope 2003; intersection, Bridge
- City of Westminster - Autoscope 2003LE, 2004; intersection

Delaware

- Delaware DOT - Autoscope 2004; intersection

Florida

- Florida Department of Transportation - Autoscope 2003; freeway
- Lee County DOT - Autoscope 2004; intersection
- University of Florida - Autoscope 2003; University Lab

Georgia

- Georgia DOT - Autoscope 2003; freeway

Iowa

- City of Council Bluffs - Autoscope 2004LE; intersection

Idaho

- University of Idaho - Autoscope 2003; intersection, traffic studies

Illinois

- DuPage County - Autoscope 2004; intersection research
- City of Peoria - Autoscope 2003; intersection, construction
- Illinois DOT - Autoscope 2003LE; intersection, construction

Indiana

- City of Hammond - Autoscope 2003; intersection
- City of Indianapolis - Autoscope 2003, 2003LE; intersection, construction
- City of Mishawka - Autoscope 2004; intersection
- Elkhart County - Autoscope 2003LE; intersection
- Indiana DOT, Crawfordsville District - Autoscope 2004; intersection
- Indiana DOT, La Porte District - Autoscope 2003, 2003LE; intersection

Maryland

- Maryland State Highway Administration - Autoscope 2004; intersection
- Montgomery County - Autoscope 2003; freeway, incident detection

Michigan

- Road Commission for Oakland County - Autoscope 2003; intersection
- Michigan DOT - Autoscope 2003; intersection, freeway

Minnesota

- City of Bloomington - Autoscope 2003; intersection
- City of Minneapolis - Autoscope 2003; intersection
- City of St. Cloud - Autoscope 2004; intersection
- Hennepin County - Autoscope 2004; intersection
- Minnesota DOT - Autoscope 2003; intersection, freeway, research
- Minnesota "GuideStar" ITS Program - Autoscope 2003; intersection, freeway

Missouri

- City of St. Peters - Autoscope 2004LE; intersection
- Missouri Highway & Transportation Department - Autoscope 2003; counting

Nebraska

- University of Nebraska - Portable Autoscope; research

Nevada

- City of Las Vegas - Autoscope 2003, 2004; intersection
- City of Sparks - Autoscope 2003; intersection
- City of Reno - Autoscope 2003, 2004; intersection
- Nevada DOT - Autoscope 2004; intersection

New Jersey

- New Jersey Turnpike Authority - Autoscope 2003; detection

- Port Authority of New York & New Jersey - Autoscope 2004; count stations
- TRANSCOM - Autoscope 2003; data collection
- The Garden State Parkway - Autoscope 2003; intersection

New Mexico

- Bemalillo County - Autoscope 2004; intersection
- City of Albuquerque - Autoscope 2003; intersection
- City of Campbell - Autoscope 2004; incident detection
- City of Hobbs - Autoscope 2004; intersection

New York

- New York City Gowanus Expressway - Autoscope 2004; incident detection

North Carolina

- Charlotte DOT - Autoscope 2003, 2004; intersection
- North Carolina DOT - Autoscope 2003; intersection

Ohio

- Ohio DOT - Autoscope 2004; intersection

Oregon

- Corvallis - Autoscope 2004LE; intersection
- Lane County - Autoscope 2003, 2004; intersection

Texas

- City of Corpus Christi - Autoscope 2004LE; intersection
- Harris County - Autoscope 2004; intersection
- Houston - Autoscope 2004; freeway
- Texas DOT, Del Rio - Autoscope 2004; intersection
- Texas DOT, Laredo - Autoscope 2003, 2004; intersection
- Texas DOT San Antonio - Autoscope 2003; intersection, construction

- Metropolitan Transit Authority - Autoscope 2003; intersection

Utah

- Brigham Young University - Autoscope 2003; research

Virginia

- Virginia DOT - Autoscope 2004; intersection

Washington

- City of Auburn - Autoscope 2003, 2004; intersection
- City of Kent - Autoscope 2004; count station/freeway
- City of Redmond - Autoscope 2004; intersection
- Clark County - Autoscope 2004LE; intersection
- Spokane County - Autoscope 2004; intersection
- Washington State DOT, Northwest Region/Signals - Autoscope 2004; count station/freeway
- Washington State DOT, Eastern Region - Autoscope 2003; intersection
- Washington State DOT, South Central Region - Autoscope 2003; intersection, construction
- Washington State DOT, Southwest Region - Autoscope 2003; intersection, construction

Wisconsin

- Wisconsin DOT, Milwaukee - Autoscope 2003; freeway site, loop/Autoscope comparison
- Wisconsin DOT, Waukesha - Autoscope 2003LE; intersection

MIST 2.0 BY FARRADYNE

MIST 2.0 provides a platform for all major ATMS applications, including those that control freeways, arterial streets, or both. The MIST platform supports the following operation modules: Traffic Signal Control, Traveler Information Dissemination, VMS Control, Weather Stations, Gate Control, Corridor Control, CCTV Control, Ramp Metering, Changeable Speed Limit Signs, Electronic Toll Collection, Incident Detection and Management, HAR, Maintenance Management, Traffic Count Stations, Cellular Telephone Interface.

MIST 2.0 is designed to control a broad range of devices that exist in the field such as: traffic signal devices, ramp control devices, environmental sensors, closed loop system/master controllers, count stations, VMS/congestion management systems, electronic toll and traffic management/automated vehicle identification readers, open architecture controllers, gate controllers, pagers, camera pan/tilt/zoom controllers, video switches, external clock, digital auxiliary I/O black box.

MIST 2.0 provides all of these capabilities utilizing a single user interface. In addition, MIST 2.0 offers the staff other significant capabilities, including: traffic data collection for vehicles, speed, and occupancy information, using information from conventional traffic detectors or vehicle probes; control of multiple devices from multiple vendors through a single interface; information presented through real-time graphics; scheduling of most system functions during predetermined periods; modular system architecture to streamline future expansion without significant development time and expense; and remote operator interface with customized levels of access. MIST 2.0 offers multiple communications protocols.

The system is capable of communicating with NEMA, Type 170, and 2070 controllers, many different VMS's, weather stations, cellular telephones, and ETTM equipment, plus a variety of vehicle probe systems. MIST 2.0 operates on industry standard microcomputer platforms. Typical MIST 2.0 applications operate in OS/2 or UNIX operating environments, generally on 486 or Pentium-based desktop computers in a single machine or networked configurations.

MIST 2.0 major features include:

- Graphical and Object Oriented Maps - the operator interface for MIST 2.0 allows the presen tation of a map as the basic view shown on the client area within the graphical user interface (GUI). The map includes graphics that respond to external system changes.
- Incident Detection and Management - MIST 2.0 supports an assortment of incident detection algorithms in addition to the automated procedures to facilitate incident management.
- System Reports - the design of each new report promotes use and readability.

- Remote Operator Interface - this feature allows remote users to view and control the data from workstations located at a distance from the central control. The system supports both leased-line and dial-up operations.

MIST 2.0 DEPLOYMENT SITES

Tennessee DOT - This project implements a computerized system for detecting and reporting fog conditions. The system integrates weather sensors and Dynamic Message Signs for reporting of real-time fog conditions to motorists.

Connecticut DOT - This project involves the surveillance of 52 miles of I-95 freeway in Connecticut. ITS technology is used to control Dynamic Message Signs and Count Stations.

Florida DOT - This project involves the surveillance of I-4 near orlando, Florida. ITS technology is used to control Dynamic message Signs, CCTV, Highway Advisory Radio, and Incident Detection.

Washington DOT - This project involves the installation of dynamic Message Signs, weather monitoring equipment, Dynamic Speed Limit Signs, and In-vehicle Signing Units from TrafficMaster.

TRANSCOM - This project implements an Automatic Vehicle Identification-based surveillance system that is used for measuring traffic flow and detecting incidents.

Daytona, Florida - Installation of a Traffic Management System using traffic surveillance on I-95 in Daytona.

Washington, DC Area - This project involves surveillance through cellular phone technology. Some of the features include a basic direction-finding mechanism, geolocation techniques, antenna layout, electronics for direction finding, and the data flow associated with multiple cell sites.

New Jersey DOT, MAGIC - This project developed a surveillance and route guidance system that includes interfacing Dynamic Message Signs, CCTV, Ramp Controllers, and Detector Count Stations.

ICONS BY GARDNER-ROWE SYSTEMS, INC

Icons Advanced Traffic Management System provides a single integrated platform for information management, graphical data display, and system control. Through a map-based graphics display, the operator is able to assimilate data more rapidly, improving operating and decision making efficiency. Icons provides a full-featured, object-oriented Graphical User Interface (GUI). Intersection-specific objects support centralized management and control of signalized intersections. Icons provides the ability to extend this integrated display environment to manage other ATMS/ATIS-related data.

The features and benefits of Icons include:

- 32 bit Windows-based GUI design provides improved ease of use, increased control and assimilation of data, and reduced training time.
- "Open" NTCIP communication support of field control equipment.
- Multi-user SQL networked Database Management System provides parameter storage, data archiving, and facilitates integration with other agency systems.
- Integrated user interface provides the graphical display of section, corridor, and individual intersection-related data.
- Support of standard icon objects and GUI-based tools provides the ability to uniquely config ure displays to collect, manipulate, and display data.
- Graphical icons provide easy and intuitive access to traffic control data, real-time data, parameter database and graphical image files.
- Support for multiple levels of background image maps using commercially available file formats.
- All traffic system reports, graphic displays and dialogs are accessible through the GUI.
- Ability to integrate and link files with off-the-shelf software, including Geographic Information Systems (GIS), Computer Aided Design (CAD), spreadsheet, and database products.
- Navigation of the network through multiple levels of background maps from system-wide to individual intersections.
- Display detector-based measures of effectiveness in both graphical and tabular formats.

"Open" Architecture Environment

Icons is supported across a distributed client-server architecture for improved performance and configuration flexibility. The use of standard protocols allows the system to adapt to changes in technology and increased functionality over time with a minimum impact on individual system compo-

nents. Any number of PC operator workstations may be networked with each providing complete system access and user interface functionality.

ATMS SOFTWARE SYSTEM BY IBI

IBI developed a central software system to fully integrate operation, monitoring and control of ATMS. The central system software currently resides on a VAX 4000 Model 160 but it is being converted to a high end PC environment. This software provides incident detection and freeway management capabilities through a graphic user interface and also allows for the integration with traffic signals on a parallel arterial operating under the adaptive signal control algorithm SCOOT. The ATMS software is currently operating in the Gardiner-Lake Shore corridor of downtown Toronto.

Unique Features

- Integrated corridor management system
- CTMS/SCOOT/UTC
- Traffic information display feature
- Interface to ATMS, ATIS & AVI systems
- Multilingual
- True scaled map-based
- Remote traffic information
- Interface to police CAD system
- Auto response plan generation.

Key features

- Communication to Type 170 field controllers via fiber optic network
- Traffic data collection, adjustment, validation and display
- Multiple incident and queue detection algorithms
- Travel time calculation for individual links and user defined routes
- Historical data smoothing
- Time-of-day scheduling to change parameters or get reports
- Response plan generation for multiple devices (such as fax, VMS's, etc.) with conflict detection and resolution logic

The Graphical User Interface includes: various levels of operator privilege; accommodates multiple operators, with conflict resolution; point-and -click operation; true to scale map background. The central software also includes support for a Remote Traffic Information System (RTIS). This software runs on a PC and it calls the central system via modem and graphically displays traffic data. The RTIS can display: mainline speeds; travel times; incident information; upcoming scheduled event information. The *Central Traffic Management System functions* include: traffic surveillance; automatic incident detection; response plan management; congestion detection/management; automatic travel time calculations; integrated CCTV operations; sign/display control; device status; schedule events; interface to UTCS/SCOOT/SCAT systems; multiple operator environment; system management; interface to Traffic and Road Information System (TRIS); interface to AVI systems; interface to compass ATMS. CTMS System Requirements -- VAX 3100 Model 90 or equivalent, VAXStation 4000 Model 60 or X-Terminal or PC/X Emulator, VAX/VMS 7.0, 1280 X 1024 Color Monitor.

SMARTSONIC BY IRD

The **SmartSonic Traffic Surveillance System (TSS-1)** is a passive acoustic sensor and automated signal and information processing system which listens (no energy is radiated by the system) for the noise generated by stationary or moving vehicles in a detection zone on the roadway. Each SmartSonic sensor is comprised of a microphone array which listens continuously to sound energy emitted from vehicles on the highway. The signals from the microphones are processed to provide sensor directivity, creating an effective detection zone within a highway lane. Only vehicle sounds coming from within a specific detection zone are retained. Sounds from locations outside the detection zone (such as an adjacent lane) are severely attenuated and are ignored. When a vehicle enters the detection zone, an increase in sound energy is detected and a vehicle presence signal is generated. When the vehicle leaves the detection zone, the sound energy level drops below the detection threshold, and the vehicle presence signal becomes inactive. The detection process for vehicle sound energy is analogous to the way the metal in vehicles is detected as they pass over a loop. The sensor portion of the system is overhead mount and limited side mount. The TSS-1 is intended to be a one for one magnetic induction loop replacement or alternative. The TSS-1 fully emulates loop output signals and thus requires no modification to existing system hardware or software. The sensor is connected to an Output Interface Card (OIC) through a cable. The OIC has the same physical configuration as a loop detector card and is compatible with Type 170 or NEMA cabinets. The sensor is capable of operating from up to 35 feet above and up to 15 feet horizontally from the detection zone in the lane being monitored. For these maximum distances, the detection zone size is less than 7 feet across the lane and 6 feet up and down lane.

The TSS-1 provides the following:

- A detection zone size of 6 to 8 feet in the direction of traffic, and one or two lane selectable zone size in the cross lane direction
- Presence type of detection, and will not tune out a vehicle in the detection zone
- Detection of moving vehicles in individual lanes (one sensor per traffic lane), and producing accurate traffic counts, headway, individual vehicle speed and occupancy for the monitored lane
- Detection of the presence of stationary vehicles
- Cuing intersection controllers of approaching traffic. In this application, SmartSonic sensors act as mid-block approach sensors, and can be used to sense vehicle presence at intersec tions
- Demonstrable detection ability (at all speeds) which compares very well with loop detector sensitivity based on significant testing results from may sites around the United States
- Vehicle presence relay on/off response of 10 ms or less

- Solid state vehicle present output relays along with an RS-232 interface for traffic flow mes sages
- A design that facilitates easy and rapid (30 minutes on average per sensor) installation, minimum training for installations, and no maintenance or cleaning
- Full compatibility with existing infrastructure
- Reliability and low life cycle costs
- Robust performance
- Single home run cable for up to four sensors
- A robust processing software that is - adaptable to all traffic conditions..free-flow to stop-and-go, weather independent..adapts to pavement conditions, occupancy calibrated, self testing

The SmartSonic TSS-1 is made up of three primary hardware components: the Sensor, interconnecting cables, and the controller. Processing functions for the TSS-1 are implemented in both the sensor (mounted over the monitored lane or from a side mount position) and the controller (typically located in the roadside cabinet). Several interfaces provide connectivity for the components which make up the TSS-1 and with systems in the roadside cabinet.

Sensor - Multiple microphones are used in a special array configuration to sense acoustic energy radiated from vehicles in each lane being monitored. The use of a microphone array makes it possible to isolate sounds coming from a specific direction (detection zone) while attenuating or rejecting sounds coming from other directions (outside the detection zone). The microphone array configuration used maximizes the spatial directivity of the sensor while minimizing the total number of microphones used. The microphone array is most directive (smaller detection zone) at high frequencies and least directive at lower frequencies in the signal band. Analog filtering and amplification is applied to the electrical signal outputs of the microphone arrays for the purpose of eliminating dominating low frequency signals, adjusting the analog signal level before digital sampling, and eliminating high frequency energy (anti-aliasing) before digital sampling. Analog to digital conversion is performed on the filtered and amplified microphone signals. These sampled signals are input to the digital signal processor. Fully programmable digital signal processing is utilized to perform processing frequency band selection, signal energy envelope generation, output signal multiplexing (with the upstream sensor output signals), and communication with the controller. Additionally, fault monitoring and localization algorithms are being executed continuously in the processor.

Controller - Sensor signal acquisition and processing for up to four sensors is handled by the TSS-1 controller. The sensor signals are time multiplexed onto the differential data lines of the sensor interconnect cables and the home run cable. The controller signal acquisition function decodes the sensor identification tag and routes the appropriate sensor data stream to each processing channel. Vehicle detection processing consists of monitoring the traffic signal environment (sensor output signal) at very fine time increments and computing adaptive detection parameters and thresholds for each detection channel (up to four channels). The detection processing is robust and can detect vehicle presence at all speeds from stop and go conditions to high speed free flow conditions with

closely spaced vehicles. The vehicle detection processing also adapts to varying pavement conditions due to pavement type and weather (i.e., wet, dry, snow, etc.). Output vehicle presence relay closure signals are generated for each vehicle detection channel in the TSS-1 controller. The relay closure signals are completely consistent and equivalent to that generated by a magnetic loop detector. The vehicle presence relay signal is compensated to account for detection zone size, which varies with installation geometry. Traffic flow measurements are computed at specified reporting intervals (i.e., 20 sec, 30 sec, 1 min, etc.) and reported via the RS-232 output channel. The traffic flow measurements computed are vehicle volume per reporting period, lane occupancy, average headway, and average speed. Average speed is computed using the measured per vehicle speed and averaging over the reporting interval. Fault monitoring functions are executed on power up, reset, and then continuously during operation to identify and report TSS-1 sensor, cable, or controller health. Upon sensing a sensor failure, the corresponding vehicle presence relay closure signal is set up to the active or vehicle presence condition. This is consistent with loop detector requirements.

The SmartSonic TSS-1 supports up to four sensors connected in a daisy-chain. The last sensor in the chain is connected to the transition module in the roadway cabinet via a single home run cable. Each sensor in the daisy-chain is given a unique identifier code. Data from each sensor is tagged with the appropriate sensor ID and multiplexed onto a single differential data line.

SMARTSONIC DEPLOYMENT SITES

San Antonio, Texas - TransGuide, 100 sensors installed

Phoenix, Arizona - 123 sensors installed on I-10

Boston, Massachusetts - 5 sensors installed on Tobin Bridge

Minnesota GuideStar

Arizona Border Crossing - 4 sensors

Virginia DOT - 10 sensors used for data collection

Virginia Tech Testing

Indiana DOT - for portable construction applications

G2 EXPERT SYSTEM BY KSD

The Expert System component of ATMS is built using the G2 Expert System shell. Custom incident response knowledge must be coded into the G2 Expert System shell to make it useful. Each Department of Transportation (DOT) district has unique requirements and specific incident responses. Capturing this operations knowledge in the Expert System knowledge base is key to building an effective incident response system.

Knowledge System Design (KSD) specializes in building G2 Expert System applications. Our services help clients identify incident response knowledge to be captured in the Expert System knowledge base. Once the incident response knowledge is identified, KSD can help code this knowledge into the G2 Expert System shell. To update the incident response knowledge DOT personnel must be trained in using the G2 Expert System shell. To meet this need KSD offers a specialized G2 training course geared towards building an incident response knowledge base. This one week hands-on training course can be provided on-site at client facilities.

ASSIST BY LOCKHEED MARTIN

ASSIST (Advanced Support Systems for Integrated Surface Transportation) is a "tool box" of ITS products for building and upgrading Traffic Management Centers (TMCs) and Traveler Information Centers (TICs). These products are responsive to many critical transportation management needs such as real-time, interagency, and inter-jurisdictional coordination; control center automation; open architecture; and modular design. ASSIST is built with proven, Commercial-Off-The-Shelf (COTS) products, offering low risk and ease of installation and operation at an economical price.

While providing the basic functions of a stand alone TMC, ASSIST also offers real-time exchange of data and management information between TMCs and TICs using its Information Exchange (INEX) module. INEX employs the latest data replication technologies available in many commercial Relational Data Base Management Systems (RDBMS). Data replication and exchange are also the basis of ASSIST's Wide-Area Traffic Management (WATM) support system, which allows several TMCs in an area to exchange information and coordinate control plans to implement integrated, regional traffic management strategies.

ASSIST's Advanced Traveler Information System (ATIS) data server fuses regional traffic data from the WATM with weather data for dissemination to public or private distributors and resellers of traveler information.

ASSIST's modular design and open architecture permits straightforward integration with equipment already in place at TMCs and TICs. This "plug and play" architecture provides a simple interface to existing field equipment and software products provided by other manufacturers.

The Core Data Management

The core data management package is the keystone of ASSIST's modularity. A commercial RDBMS serves as the "clearinghouse" for all applications. This clearinghouse employs industry standard interfaces to enable connectivity between ASSIST and various ITS applications such as traffic monitoring, incident detection, adaptive signal control, and ramp metering. A TMC with an installed Core Data Management Package has all of the basic capabilities to display traffic conditions and command control devices (e.g., signals, ramp meters, DMSs). The Core Data Management Package also contains the GUI tools, which help the operators perform their functions more effectively and efficiently through easy-to-use menus and on-screen icons.

ASSIST has three key features that makes it "open" to a variety of ITS applications. First, ATMS applications "talk to" the RDBMS using industry standard SQL Application Program Interfaces (API). This ensures the incorporation of products that conform to these industry-wide standards. Second, ASSIST's Core Data Management Package contains a Data Dictionary designed to recognize all fundamental ITS elements. This dictionary is consistent with the National ITS Architecture. Third, the ASSIST data architecture is designed to optimized the performance of commercial RDBMS products. This maximizes the real-time operational efficiency of ASSIST in large metropolitan areas, where thousands of surveillance and control devices are monitored.

Wide-Area Transportation Management (WATM)

ASSIST's WATM continuously examines the data exchanged over the INEX modules from all participating TMCs, looking for symptoms of spreading congestion effects from one jurisdiction to another. When such an event occurs, WATM first informs all TMCs of the situation, and then tries to determine the causes of the congestion, based on which appropriate corrective actions are recommended. Suppose that the congestion is caused by an incident. ASSIST's Incident Management module analyzes and characterizes the incident, and automatically retrieves candidate regional incident response plans from its database, using artificial intelligence techniques. These plans are analyzed and the most feasible one recommended to the TMC operator who may accept, decline, or modify ASSIST's recommended solutions.

Once an incident management is selected for implementation, WATM transmits it to each of the TMCs. The contents of a plan clearly describe what should be done, when, and whom. The implementation of the plan's elements at the local level rests with the associated local agency, who again may accept or reject the WATM's recommendation based on the prevailing and/or emerging local traffic conditions.

ELECTRONIC TOLL COLLECTION BY MARK IV INDUSTRIES LTD.

Dedicated Short Range Communications Reader

At the heart of Mark IV's Roadcheck system is the Reader. A compact working model of the Mark IV Reader is concealed within the Patron Fare Display's enclosure. It establishes high speed, two-way communications between vehicle-mounted transponders and a Central or host Computer system. In this model, the Mark IV reader is directly connected to the Patron Fare Display's intelligent FP2001 controller via an RS-232 link.

A variety of Mark IV Reader models are currently available: Non-redundant multi-lane, Redundant multi-lane, either of which support the Inter Agency Group (IAG) lane based protocol or the ASTM E17.51 Draft 6 protocol, which is wide area Time Division Multiple Access (TDMA). Marketed under the name FUSION, a dual mode reader is capable of reading a variety of transponders used for electronic toll collection and thos currently popular for commercial vehicle operations, i.e., mainline screening and border crossing applications.

The Mark IV reader systems can be used in conjunction with overhead, in-pavement or specialty antenna types such as the patch antenna integrated into this demonstration unit. The readers are configurable to deal with transponders with a range of capabilities, from older generation read only units through Type 3 units (read-write capable plus connector to on-board computer).

A single Mark IV Reader using multiplexed antenas can interface simultaneously with uip to eight lane based antennas and is able to monitor multiple lanes of highway speed traffic accurately or perform in channelized toll lanes with with high precision lane specificity.

The system operates automatically and unattended. An extremely high level of accuracy and reliability is assured through the use of Cyclic Redundancy Checks (CRC). Additionally, the high 500 kbps data rate of the system ensures multiple handshake opportunities with all passing transponders.

Dedicated Short Range communications Transponder

The demonstrator unit is an example of an Active DSRC read-write capable transponder and was designed for mounting on the exterior of heavy vehicles. Approximately, 100,000 units of this rugged type are currently in service in the United States and Canada. The primary mounting location for DSRC transponders is on the interior surface of the vehicle's windshield. Over 1,000,000 interior Mark IV units are presently in circulation in North America. Mark IV also offers transponders with integrated driver feedback indicators.

The demonstrator unit features a 128 bit memory. The IAG version of this transponder has a 256 bit memory. The FUSION transponder released by Mark IV in 1997 has a 256 bit memory for IAG transactions, plus a 512 bit internal memory for TDMA applications.

Demonstration of Integrated Patron Fare display (PFD) and Dedicated Short Range Communcations (DSRC) Equipment

Overview of Self-working demonstration unit

The active read-write transponder is waived over the patch antenna integrated into the case of the PTD. The DSRC Reader inside the PTD case is emitting a low power trigger pulse. In response to the trigger pulse, the transponder transmits a message at 500 kbps containing a factory programmed ID code, transponder capability code, issuing agency code, etc. The reader receives this data and validates the frame after a given number of repeated handshakes. Once verified, the transaction is reported by the reader to its host, which in this case is a PTD controller. (NOte that the reader may be configured to time-out the transponder from the re-reporting until a certain length of time has passed so that if it sits in the reader's field of view for a longer than normally expected period, it will not cause multiple transaction messages to occur. For demonstration purposes, the time-out period has been significantly reduced on purpose).

The message content from the transponder invokes a particular message to be displayed on the reflective disk array. The display elements remain magnetically latched indefinitely until the display controller intentionally changes their state. The transponder is written with a date and time stamp along with other transaction related data which is held in memory until another transaction take place. Two transponders have been supplied with the unit to demonstrate different messages being displayed as the result of reading different information from the respective transponders.

The PFD unit configures as two lines of 5, 2.7-inch high characters. Other display configurations can be used to display more lines of text or both text and graphics when a continuous matrix display is incorporated. Messages can be pre-formatted and stored in the controller's non-volative memory or sent from the reader or a Lane Controlling device.

MARK IV DEPLOYMENT SITES

New York - "Inform" System

New York - La Guardia Airport

Maryland - Ft. McHenry tunnel

Maryland - Baltimore/Washington Airport

Maryland - Ft. McHenry/Approach

Maryland - Woodrow wilson Bridge

Maryland - Beltway

Maryland - I270/I495

Virginia - Virginia Beach

Virginia - Northern Virginia FTMS

Virginia - Dulles "Greenway"

Virginia - Coleman Bridge

Washington - FTMS Exapnsion Project

Washington - FTMS Sign Upgrade

Ontario - "Commpass" sign Upgrade

Ontario - Pearson Airport

Florida - "E-Pass" toll (Orlando)

Florida - Osceola Parkway

Tennessee - Chattanooga Fog Detection System

Pennsylvania - Altoona Weather Advisory System

North Carolina - Charlotte FTMS

North Carolina - Roanoke

North Carolina - Haywood County

Wisonsin - Milwaukee FTMS

Kentucky - "ARTIMIS" Project

Texas - "Transguide"

Texas - PHARR

Texas - Beaumont

Utah - Statewide Contract

Idaho - Weigh-in-Motion System

New Brunswick/PEI (Canada) - Confederation Bridge

California - San Diego FTMS

New Hampshire - Franconia Notch Upgrade

Colorado - Weight-in-Motion System

Oregon - Weight-in-Motion System

Maine - Maine Turnpike

DYNAMIC MESSAGE SIGNS BY MCCAIN TRAFFIC SUPPLY, INC.

MTS participates in virtually every aspect of the traffic control products industry offering a full line of products including NEMA, 170 and 2070 controller assemblies; traffic signals; pedestrian signals; lane control signals; and fixed, changeable, and variable message signs utilizing LED, fiber optic, lamp matrix, flip disc, drum, neon and incandescent lamp technologies.

The recently formed Transportation Concepts Group, located at McCain Traffic upply Canada, Ltd. in Ottawa, is complimenting our existing full line of traffic control products with design and development of new products. This Group is primarily responsible for overseeing all Intelligent Transportation Systems (ITS) projects, from inception to completion. Their suite of specialty products include Transit Management Systems; Advanced Traffic Management Systems (ATMS); Emergency Vehicle Preemption Systems (RESPONSE); and Traffic Signal ontroller Software. The Canadian office also focuses on ITS design/build jobs.

The SVMS100 LED sign is McCain's newest sign product and is featured as McCain's submission to the FHWA Project No. 105 "Advanced Traffic Management Technologies" trailer. The SVMS100 is a micro-processor based, distributed intelligence, 12" character LED display modular sign. It's modular design allows construction of a uniform display matrix comprised of multiple modules grouped together. The grouped modules will allow the user to create single and multiple line matrix signs, as well as large full graphics matrix signs. The McCain Traffic Supply SVMS100 LED sign also incorporates the following features:

Low power consumption

Operates from 170ES and 2070 traffic controllers Serial communications to eliminate massive cabling Communications with central computer via modem 8 dim levels for ambient light conditions Vandal/graffiti resistant module lens. Each pixel and module is universally addressable to eliminate stocking of specific matrix and driver boards for replacement.

MCCAIN DMS DEPLOYMENT SITES

City of South San Francisco at Cow Palace

San Diego Qualcomm Stadium - 2 DMSs to direct traffic from east and west direction

NAVTECH DATABASE BY NAVIGATION TECHNOLOGIES

The NavTech database is a highly accurate and complete representation of roadway network characteristics used for a variety of demanding applications, including the calculation of efficient, accurate driving directions and the generation of accurate, attractive geographic displays. What's on the ground is what's in the database. In addition to over one-half million points of interest in 40+ categories such as restaurants, hotels and gas/petro stations, NavTech also offers up to 150 attributes per road including:

- Primary and alternate Street Names
- Block-by-Block Addressing
- Dividers
- Highway Signage
- Landmarks
- One-Way Streets
- Overpasses and Underpasses
- Roadway Classification
- Street Geometry
- Time-of-Day and Day-of-Week Restrictions
- Turn Restrictions
- Vehicle-Type Restrictions

The NavTech database has a navigable map database with a written warranty of 97% accuracy and completeness against ground truth. NavTech's commitment to accuracy enables system manufacturers and solution providers to build superior vehicle routing, scheduling and tracking applications.

NavTech has more than 65 field offices throughout North America and Europe that continuously check and update the database. Their field staff drives over one million miles in North America and over 1.3 million kilometers in Europe each year performing extensive verification and validation of additions and changes to the road network. This ensures that changes, whether due to road closings, construction or traffic flow management, are in the database.

The NavTech database is a leader for In-Vehicle Route Guidance products. NavTech's superior addressing capabilities offer Fleet Management System providers a crucial advantage for optimizing routing, scheduling, and vehicle utilization. Personal Navigation & On-Line Service providers bring the NavTech database in leading-edge applications to users at home, at work, and on the road around the world. Geographic Information System customers use the NavTech database to support

demographic analysis, site selection, sales territory analysis, customized printed map making, and facilities records keeping.

NAVTECH DATABASE DEPLOYMENT SITES

Federal Model Deployment Projects

- San Antonio TransGuide
- New York TransCom

Federal Operational Tests

- San Francisco Bay Area TravInfo
- Washington Beltway Traveler Information System
- Atlanta Traveler Information Showcase
- California/Nevada Transcal
- Gary-Chicago-Milwaukee ITS Corridor Project
- I-95 Corridor Coalition
- Boston Wireless Advanced Traveler Information System

Vehicle Navigation Systems

Every in-vehicle navigation system in North America that offers turn-by-turn route guidance uses the NavTech map database. Navigation systems featuring the NavTech database are available today on these cars:

- Acura RL 3.5
- BMW 5 and 7 series
- Oldsmobile 88, LSS and Bravada
- Toyota Avalon, Camry and 4Runner

Aftermarket Systems

- Alpine's Voice Guidance Navigation System
- Amerigon's Interactive Voice Systems sold through Clarion, Eclipse, Kenwood and Pioneer
- Rockwell's Pathmaster

Rental Cars

- Hertz
- Avis

Internet and Personal Navigation Products and Services

- AAA-Travel/Entertainment Information Services
- CompuServe - WayToGo
- Frommer's Travel Guides - PC Products
- MapQuest - www.mapquest.com
- Retki Metroguide - Laptop and Palmtop Products
- Zip2 - www.zip2.com

Fleet Management

The NavTech map database is used to plan efficient routes for the following:

- Citibank
- The Daily News (New York)
- Dow Jones (Wall Street Journal)
- Federal Express
- New York Times
- Whirlpool
- United States Delivery Service

ATMS BY NET

Freeway congestion is a real problem for Orange County's 2.4 million residents. As obtaining rights of way and building new freeways has become increasingly difficult and expensive, it has become clear that we can no longer build our way out of traffic congestion. The California Department of Transportation (Caltrans), District 12 was inspired to search for more innovative ways of moving people and goods along Orange County's congested freeways. Caltrans' vision calls for the development of new transportation technologies which enhance the safety and mobility of goods and services in the region, resulting in increased productivity and financial growth.

The new Orange County Advanced Transportation Management Center (TMC) is a major step toward realizing that vision. A culmination of years of collaboration, the new TMC is Caltrans' nerve center for the collection of all transportation information in Orange County. From the TMC, a state-of-the-art Advanced Transportation Management System (ATMS) is operated to help manage Orange County freeways.

The recently implemented ATMS covers the entire Orange County freeway network (by the end of 1997, though, similar ATMSs in Los Angeles and San Bernardino will manage freeways in those counties as well) and incorporates a variety of technologies for the detection, confirmation and management of incidents. Traffic operations system elements that are key components of ATMS functions include: a Closed Circuit Television subsystem (CCTV), a Vehicle Detection Station subsystem (VDS), a Changeable Message Sign subsystem (CMS) and electronic bulletin and message boards. Future features currently in development include a system-wide adaptive Ramp Metering System and an intertie to a local city for coordinated traffic management in a specified corridor. Operational Units which are integral to successful transportation management activities include California Highway Patrol (CHP), Freeway Service Patrol (FSP), and the Caltrans Traffic Management Team (TMT).

The ATMS is a sophisticated system that easily provides surveillance, incident detection and response, and information dissemination capabilities to the Caltrans operational staff.

Key features of the system include:

- User friendly graphical user interface
- Geographical map display, with various display filter options
- Real-time color-coded traffic data
- Icon-based field element control and data access capabilities
- Automatic incident detection
- Automatic response plan generation

- Expert system component for complex response plan generation
- Report and analysis capabilities
- User friendly system configuration capability

Through the Orange County Advanced Transportation Management System and coordinated activities in the TMC, Caltrans and its partners are committed to the goal of enhancing Orange County's vitality and quality of life. Caltrans District 12 continues its leadership role in meeting the future needs of the community, with the end result being a smoother commute for everyone.

MATS BY PEEK TRAFFIC

MATS is a software program design to bridge the gap between smaller closed loop systems (distributed control) and larger central systems (central control). MATS is Peek's answer to the hybrid system control, providing the best features of both systems.

System Requirements:

Unlike earlier central systems, MATS does not require a large central computer system and the expenses associated with such a system. MATS in its simplest form requires only a PC-type computer. The typical installation will utilize a network-based PC system. This network includes a server computer connected to a number of workstations. In addition to workstations, an additional computer is utilized to handle all communications with equipment installed in the field.

System Operation:

The system has two basic modes of operations, 1) Central, and 2) Local or Closed Loop.

Central Control

When the system is operating in the central control mode, a workstation is collecting data from the communication unit. This workstation then processes the data and directs each intersection to run the proper pattern. Each workstation can control 8 communications units and each communications unit can communicate with up to 30 intersections. The network can have up to 8 controlling workstations. This provides the system with the ability to control up to 1920 intersections.

Central control mode of operation allows the control area of operation to include intersections which are not physically connected to the communication units. In this manor, it is possible to establish wide area, logical, control zones that include multiple communication units. By establishing logical control zones, it is possible to provide coordination which is not limited by physical connections to masters as in a closed loop system.

Closed Loop

In the second mode of operation, the system functions very much as a closed loop system, the communication units act as closed loop masters. The masters have the ability to collect and process data, then direct each intersection as to the proper pattern. This operation is the first level of backup in the event of communications breakdown to the central computer. This ability provides a major benefit over most central systems. The typical central system reverts the local intersections to free operation or time-based, time-of-day, depending on controller capabilities. If communications is lost between the master and the local intersection, then the controller equipment will revert to time-based coordination operation.

Graphical User Interface:

Operator interface is provided by an easy to use Windows-based program. Easy to understand terminology in conjunction with a well thought out menu system allows an inexperienced user to learn

to operate the system. Each area of the software is grouped to minimize unnecessary operator action. The software makes extensive use of the computer's mouse, thereby reducing operator's errors. In addition, there is a comprehensive error-checking routine for operator data entry.

MATS provides a large number of graphical data displays, including a real-time, time-space diagram, intersection operation display, sections of intersection operations display, as well as controller front panel display. Such displays as these and the numerous others are designed to provide an easy to operate and maintain system.

Sensor Data Collection

Each communications unit has the ability to collect data from 128 system sensors. This data is then transferred to the central to be analyzed and stored. The system offers 3 computation channels to select the proper Cycle, Offset, and Split. Twelve sensors may be assigned to each channel with various weighting. Each sensor is compared to historical data to determine if that sensor data is valid. Sensors are automatically removed or reinstated based on a continuous checking process.

Events and Alarms

The system will record a number of system events, such as pattern changes, intersections out of step, and user-defined alarms. Each event is entered into a log with the time and date of the occurance. There are in excess of 30 such events that can be logged.

If the event is an alarm, the time and date of resumption to normal operation is also reported. Some alarms may be programmed to be reported immediately to the operations personnel. These alarms will be shown to the operator so that proper action may be taken. The system provides a method for documenting the operator responses. In addition to notifying an operator at the central site, the system incorporates an interface to a personnel pager. The system will send a message to the numeric pager identifying the system, the intersection, and nature of the alarm. Two different pagers may be programmed with either the same parameters or different parameters.

Intersection Data Storage and Transfer

The system will store the controller and master databases for review and modification. In addition, the system provides full download of the data to the field units or uploading data from the field units. The system provides the technician with the ability to request a download of data from the central without central operator aid. This feature will allow service personnel the ability to change controllers in the field and have the system provide and load the correct data. This feature will greatly reduce the chances of data entry errors while reducing the service time at the intersection.

Reports

The system provides a number of reports. The report generation is via database for MATS. The system reports may be tailored based on the operators needs. Reports may include all system-generated activities and databases that are stored as part of the system, including inventory and maintenance records. All data is stored in SQL format to be interchangeable between database managers.

Event Scheduling

Most operator actions may be scheduled to occur at a designated time. The scheduler has a number of options which will allow events to be programed to occur one time or numerous times.

MATS DEPLOYMENT SITES

- Boca Raton, Florida - with Radio and fiber optic interconnect; Central Business District and 15 arterials; 81 intersections; scheduled to be completed in June 1997.
- NJDOT (Route 24) - 28 intersections.
- NJDOT (Route 73) - 32 intersections.
- NJDOT (Route 9) - 32 intersections.
- NJDOT (Route 37) - 22 intersections.
- NJDOT (Routes 1 & 9) - 47 intersections
- NJDOT (Routes 1 & 18) - 38 intersections; scheduled to be completed in January 1999.
- Twin Falls, Idaho - 28 intersections; scheduled to be completed in July 1997.
- Orem, Utah - 40 intersections; scheduled to be completed in July 1997.
- Cuyahoga Falls, Ohio - 23 intersections, 3 arterials; scheduled to be completed in August 1997
- Burlington County, New Jersey - 19 intersections, 1 arterial with radio interconnect; sched uled to be completed in November 1997.
- Union County, New Jersey - 10 intersections, 1 arterial, radio interconnect; Scheduled to be completed in July 1997.

VIDEOTRACK-900 BY PEEK TRAFFIC

Peek Vision Systems VideoTrak-900 provides for the first time to the traffic industry, true wide area racking and detection capability. VideoTrak-900 is engineered to be the solution to in-ground detection problems, and offers true "wide area" detection via full scene tracking of vehicles, bicycles and pedestrians. The VideoTrak-900 provides complete intersection detection, automatic incident detection, freeway detection and management, freeway ramp metering and control, vehicle counting and classification, traffic data colleciton, turning movement analysis, wrong way detection, enforcement, queue length analysis, and s-y coordinates of critical incidents in real-time.

VideoTrak-900 is the result of integration of field-proven video image processing technology, developed and tested by David Sarnoff Research Center, into an open architecture VME platform which promotes interface with advanced traffic management systems. Sarnoff is recognized as a world leader in the development of color television, digital video, video compression and infrared imaging. Sarnoff's patented Pyramid processor analyzes the maximum amount of real-time video information on changing traffic conditions and the environment which may affect visibility and proper camera operation. Fail-safe video loop diagnostics and tracking-based algorithms aliminate missed vehicle detecitons and false detector actuations common in previous generation "trip-line" video vehcile detection systems. Remote or on-site video display of the traffic scene provides visual verification of detection accuracy. VideoTrak-900 offers affordable, robust, and user-friendly video vehicle tracking for a variety of traffic management applications, designed to meet the needs of the global traffic engineer.

PVS VideoTrak-900 Functionality

The video tracking system will accommodate up to 8 standard monochrome or color CCD cameras, in RS-170, NTSC, CCIR, PAL, M-PAL, N-PAL, SECAM, or MESECAM video formats. Accurate vehicle tracking and presence detection during such environmental conditions as darkness, rain, reflections, snow, fog, blowing dust, lightning and wind are overcome by VideoTrak-900 through specilized shadow removal, image stabilization, automatic gain compensation and field of view realignment algorithms. The system will permit the assignment of 32 zones of detection per camera, up to 8 cameras. Detection zones may be placed anywhere on the computer screen, which displays the camera field of view, and zones may be any size.

Detection Zone Statistics

These traffic statistics are typically stored in 5-minute intervals for up to 2 days. Other user selectable data collection intervals are 1, 10, 15, 30 or 60 minutes. Selection of the 60-minute logging interval will permit the storage of traffic data for up to 10 days. Real-time per vehicle records are available when connected to the setup computer either at a remote location or on-site. Vehicle classification by length is available in 5 user-selectable classifications bins.

- Vehicle volume/counts (# of vehicles)
- Lane occupancy (% of time the traffic lane is occupied
- Speed (avg. speed in mph/kph)
- Density (avg. density=volume/speed)
- Headway (avg. headway in seconds)
- Length (avg. vehicle length in feet/meters)
- Delay (avg. delay in seconds)

Incident Detection Statistics

In addition to the detection zone statistics, any of the camera's 32 zones (up to 256 zone maximum), can be configured for automatic incident detection and ouput. The following incidents can be monitored.

- Vehicle presence for 'n' seconds or minutes
- Vehicle speed (under/over selected speed)
- Wrong way detection
- Queue length exceeded
- Red traffic signal runners
- Monitoring of lane changes

Configuration Requirements

VideoTrak-900 is quickly and easily configured for complete intersection or roadway detection and can replace existing detection devices. Small CCD monochrome or color video cameras may be positioned at an intersection on a signal pole, or mounted on a traffic signal mast arm or other existing structure. Only power and video connsections are required for each camera, and wireless video transmission to/from remote locations is available via low-power microwave. Standard notebook/laptop computers may be used for detection zone setup and viewing of detector actuations within the traffic scene. Separate "supervisor computers" and special RGB video monitors are <u>not required</u> with the VideoTrak-900 system. (Both compressed video and full-motion analog video are available with this system).

TRAFFICAM BY ROCKWELL INTERNATIONAL CORPORATION

Rockwell's TraffiCam is a cost-effective vehicle detection sensor. It uses machine vision technology in a weather-proof housing to provide real-time traffic flow data, such as vehicluar presence, speed and volume. Rockwell's TraffiCam provides an alternative to high-cost, high-maintenance inductive loops buried in the roadway.

One TraffiCam unit can view up to four lanes of traffic simultaneously. Users can display real-time images of the sensor's field-of-view remotely via telephone modem. And TraffiCam lets the user specify, and later change, the zones for traffic detection within the field-of-view. This means that lane re-striping or temporary construction is easlyt accommodated by simply updating the deteciton zones without stopping traffic.

There are many streets, roads and highways out there—and they aren't all the same. That's why TraffiCam also features several user-defined options. Users can configure detection zone locations, measures of effectiveness and periods of data collection using a personal computer and user-friendly installation software.

TraffiCam is unusually durable and reliable in all kinds of situations...no matter what season of the year it is.

Each unit is enclosed by a weatherproof injections-molded housing. It has a weather-tight seal on the external cover, a weather-tight connector, and a heater on the inside of each unit for all-weather performance.

TraffiCam has performed well in all kinds of extreme weather conditions at sites around the United States, such as Utah, Georgia, Michigan and California. TraffiCam provides counting accuracies comparable to loop or manual counts, and it has provided data leading to the identification of intermittent loop failures!

Once you select the TraffiCam system, it's as easy as 1, 2, 3. Mount is, aim it, run the Windows based installation software, and begin gathering the information you need. No pavement cutting is required, and the need for lane closures is minimized.

TraffiCam can be mounted on existing structures with little effort. And once mounted—it's ready for detection.

Maintenance of TraffiCam is virtually nonexistent. No periodic calibration is required. In most mounting configurations, cleaning of the face place will not be required for several years. With a robust design and no moving parts, TraffiCam will provide years of reliable performance—minimizing year life cycle costs.

ROAD WEATHER INFORMATION SYSTEM BY SURFACE SYSTEMS, INC.

Road/Runway Weather Information System

The RWIS (Road/Runway Information System) consists of on-site temperature and atmospheric sensors, data processing units, telecommunication capabilities,a nd workstation displays.

Surface (Pavement) Sensors. Pavement temperatures are obtained from solid-state electronic devices installed in the roadway or runway. Surface sensors can be either active or passive, but passive sensors have gained more wide-spread acceptance with well over 2000 installed in the U.S., Canada, the UK, Europe, and Iceland.

The thermally passive surface devices are usually fabricated of materials with thermal characteristics similar to thos communly used for pavement contractions. The sensor, 13 cm dia., is installed in a 14 cm dia. hole flush with the pavement surface and color matched ot the surrounding pavement so that both respond to incident light energy at the same rate.

The sensor contains a capacitor with two elements mounted underneath; these measure the dielectric effect of moisture in both liquid and solid-state forms. The dielectric constant of air differs from that of ice and snow. The sensor's output signal therefore is designed to reflect the condition on top of the device, which closely approximates conditions on the surrounding pavement surface;

- Dry
- Wet (above 0 degrees C)
- Wet (not frozen but at or below 0 degrees C)
- Snow/ice alert (at or below 0 degrees C)
- Dew
- Frost
- Absorption

Other measurements include a chemical concentration factor (a relative indicator of the deicing or anti-icing chemical present in the moisture on the sensor surface). Performance of the snesor is not degraded by climatic conditions, traffic, or ice-control chemicals. the (thermally passive) sensor has a stable operating range from -30 degrees C to 50 degrees C.

Subsurface Temperature Sensors. Probes are installed directly below the surface sensor at a depth of 40 cm. These provide heat flux information primarily for computer models designed to predict pavement temperatures. Frost depth data are also used by highway agencies to regulate truck routing on the basis of the frost level beneath the road surface.

Atmospheric Sensors. Air temperature is measured over a range of -62 degrees C to 70 degrees C, RH measurements over a range of 10-100%. Dew point is calculated from tmperature and RH readings. Precipitation is detected by sensing interruptions in an IR optical beam. Wind direction and speed detectors have an operating range of 360 degrees and can record speeds up to 215 km/hr.

Data Processing Units. All data collected by the sensors are transmitted to a remote processing unit (RPU), which in turn converts the analog signal into a digital format and relays the information to the central processing unit (CPU). the RPU receives data from up to four surface sensors, four sub-surface sensors, and the atmospheric sensors. Atmospheric sensor measurements are sued in the system logic processed by one or several RPUs.

Agencies configure RPUs in various ways. Airports, e.g., typically have 2-15 RPUs; there are 178 in the highways surrounding Columbus, Ohio; and 32 are in service in the Wisonsin statewide road weather information system.

The CPU analyzes, stores, and arranges the data it receives from up to 100 RPUs for information display on the workstation (see Photo 3). The workstation displays the location of each RPU and surface sensor, the surface status of each sensor, atmospheric sensor data, and the current date and time. The system updates all this information as frequently as every 15 s.

Communcations. Several telemetry options are available for system configureation, including dial-up and leased telephone lines, radio, microwave, fiber optics, satellite, and value-added networks.

Workstation Formats and Displays. In addition to displaying the information in tabulated test formats, the system provides customer-specified individualized color graphics. Critical pavement conditions are color coded for instant recognition of situations that may require proactive decisions.

Custom-Tailored Weather Information

Pavement-Specific Weather Forecasting. The most important elements in making proactive ice and snow control decisions are current and projected (for the next 12-24 hr) pavement *surface* temperatures. It is important to note that the difference between air temperatire and pavement temperature can easily exceed 7 degrees C. Ice prevention, or anti-icing, requires 30-75% less chemical treatment than does deicing , and is therefore much more cost effective in snow and ice control. Knowing both current and predicted pavement temperatures *and* the amount of chemical concentraion on the pavement permits improved timing for chemical applications.

The pavement temperature at any given time represents a blaance between heat energy added to or lost by the pavement. Most heat transfers are weather related. To accurately project pavement temperature requires an accurate forecast of weather parameters, a stable numerical energy balance model, the initial surface (pavement) temperature, and the sub-surface temperature 40 cm down. Pavement prediction models require site-specific surface and sub-surface data for initialization.

System Use and Benefits

The remote roadway/runway weather sensing system is not the total solution for cost-effective and efficient ice and snow control maintenance program. It has, however, proved very successful in reducing the amount of standby/availability wages paid out, as well as increasing savings in materials through proactive rather than reactive treatment of pavements. Three documented case histories support this observation:

- Indianapolis Department of Transportation saved $23,050 on one storm, based on the correct decision not to call out crews, using observed and forecast pavement terperature. In two seasons, $486,375 was saved on manpower, equipment, and chemicals .
- Wisconsin Department of Transportation saved $75,000 and 2500 tons of salt per storm.
- New Jersey Department of Transportation was able to delay chemical-spreading for three hours, saving $54,170 on each statewide salt spread.

SSI'S SCAN DEPLOYMENT SITES

- San Bernadino, California
- Durango, Colorado
- Colorado Springs, Colorado
- Greeley, Colorado
- Groton, Connecticut
- New London, Connecticut
- Middletown, Connecticut
- East Hartford, Connecticut
- Newark, Delaware
- Washington, DC
- Twin Falls, Idaho
- Springfield (Capital Airport), Illinois
- Fort Wayne Airport, Indiana
- Algona, Iowa

- Avoca, Iowa
- Carroll, Iowa
- Jefferson, Iowa
- Sigourney, Iowa
- New Hampton, Iowa
- Sidney, Iowa
- Williams, Iowa
- Frankfort, Kentucky
- Louisville, Kentucky
- Covington, Kentucky
- N. Corbin, Kentucky
- Baltimore, Maryland
- Baltimore County, Maryland
- Hartford County, Maryland
- Greenbelt, Maryland
- St. Louis (Lambert Airport), Missouri
- Missoula, Montana
- Billings, Montana
- Butte, Montana
- Lewistown, Montana
- Wolf Point, Montana
- Great Falls Glendive, Montana
- Miles City, Montana
- Cherry Hill, New Jersey

- Albuquerque (Albuquerque International Airport), New Mexico
- Rochester, New York
- Buffalo, New York
- Bayonne Bridge, New York
- Columbus, Ohio
- Fairfield (Cincinnati International Airport), Ohio
- Akron Canton Regional Airport, Ohio
- Dalles, Oregon
- LaGrande, Oregon
- Medford, Oregon
- Salem, Oregon
- Philadelphia, Pennsylvania
- Providence, Rhode Island
- Nashville, Tennessee

SMARTTRACK SYSTEM BY TRANSPORTATION MANAGEMENT TECHNOLOGIES

The SmartTrack Computer Aided Dispatch and Automatic Vehicle Location workstation that is set-up in the trailer is typically installed at an operations control center (dispatch operations) for public transit applications. For ITS applications, the subsystem complements an existing or new communications system and can be integrated with a region's ATMS.

The SmartTrack CAD/AVL fleet management system automates and integrates all of the traditional dispatch functions of communications, incident management, and fleet control. Additionally, the system allows the dispatcher to track vehicles continuously and to detect schedule and route deviations. Bus operators are automatically informed of schedule deviations via a digital message. The fleet management system helps to maintain and improve on-time schedule performance.

The dispatchers know where the vehicles in the transit provider's fleet are, and can pro-actively manage the fleet by allocating valuable resources where they are needed most and can be most efficiently utilized. Known vehicle location, whether for buses, supervisor vehicles or maintenance vehicles, allows dispatchers to respond to incidents, either routine or emergency within seconds of being notified. Required emergency resources or needed maintenance assistance can be dispatched to the site of an incident promptly and with a high degree of confidence that the assistance providers will meet the disabled vehicle in the location that is was dispatched.

Route and schedule adherence of fixed route buses is also facilitated and successfully made possible using the Global Positioning System. Another benefit of a fleet management system is the ability for the transit properties to improve customer service by improving the fleet's on-time performance. If buses consistently arrive to and depart from bus stops at their advertised schedule times, riders will place confidence in the service provider and thereby feel comfortable riding public transit to get to where he needs to go - work, shopping, appointment, or business meeting. The location information (latitude and longitude positions) of specific vehicles that are equipped with a GPS receiver is extracted from the Global Positioning System. These lat./long data points are then translated to specific name places (that the average person can associate with) after being processed through sophisticated algorithms. Now the vehicle's location, buses in this case, are depicted by icons on a map, on a computer screen. This algorithm processing occurs within milliseconds.

The determination whether a bus is ahead or behind schedule or off route can be made by comparing a bus's actual position based on the GPS location information with a pre-determined schedule and route. When a variance is detected between the published schedule and route and the actual bus location, an incident will be sent to the dispatcher. If a bus is not where it is supposed to be (on route, but late for example), a dispatcher may be able to assist the driver so as to make up time or have another vehicle added to the route to accomplish the work. (Depending on the situation, obviously there are many possible scenarios and appropriate actions the dispatcher can take.)

Communication is also facilitated by the CAD/AVL system. Not only is the location information transmitted but so are large amounts of data messages, such as , text and status messages. Communication is via two-way radio, cellular or satellite communications systems to an operations center, where it is processed into useful information. This becomes more important as the entire fleet is

equipped with AVL devices and integration into other ITS projects become a reality. The SmartTrack system collects the real-time status of the bus fleet. This information is not only used by the Transit Operations Manager to manage the fleet as efficiently as possible, but this information can be shared with the riding public through devices such as kiosks, passenger information displays, on-line computer services, sign boards, TV-type monitors and variable message signs.

TMS'S SMARTTRACK DEPLOYMENT SITES

Atlanta, Georgia - MARTA has contracted Transportation Management Solutions to install an integrated computer-aided dispatch and automatic vehicle location information system. The GPS-based system also includes in-vehicle voice annunciators and signs, automatic passenger counters, and 15 passenger information devices displaying up-to-date bus status. Currently, 250 buses are deployed with the CAD/AVL equipment.

Maryland MTA - TMS provides computer-aided dispatch and AVL information systems. Over 245 buses and 35 light rail vehicle pairs are deployed with the CAD/AVL equipment.

Broward County, Florida - TMS installed a SmartTrack integrated computer aided dispatch and an AVL information system on 196 buses.

County of Lackawanna, Pennsylvania - The County of Lackawanna Transit System (COLTS) AVL system includes the Fleetservice Control Center and 32 GEO-Trac vehicle tracking units which are installed on fixed route buses. The system monitors buses on-time schedule adherence and vehicle status.

Denver, Colorado - This system manages a fleet of 1000 vehicles, including buses, light rail, and street supervisor cars.

Detroit, Michigan - TMS provides the SmartTrack system including radio communications. If all options are exercised, TMS will equip over 400 vehicles with an integrated demand response paratransit, fixed-route bus, and support-vehicle fleet.

Des Moines, Iowa - TMS provides Auto-Trac AVL systems on 20 of the Des Moines METRO transit buses.

Harris County, Texas - TMS provides an Advanced Radio Communications and Computer-Aided Dispatch System (ARCS). The project will equip over 1600 vehicles, including revenue buses, paratransit buses, police vehicles, and administration and support vehicles.

Los Angeles County, California - TMS provides a GPS-based AVL system on 153 Freeway Service Patrol Vehicles.

Milwaukee County, Wisconsin - TMS provides radio and AVL, GPS-based equipment on 582 buses, 68 non-revenue vehicles, as well as the communications system and control center integration.

Minnesota Travlink - The TMS CAD/AVL system monitors and tracks 80 vehicles on a major transit corridor using GPS technology.

OVERHEIGHT VEHICLE DETECTION SYSTEM BY TRIGG INDUSTRIES, INC.

This is a system that is used to detect and warn overheight vehicles and incorporates the following five basic parts:

- Advance warning signs of the height restriction
- A device to detect overheight vehicles
- Audible alarm bells that are activated when an overheight vehicle is detected
- Overheight warning signs with flashing yellow beacons that are activated when an overheight vehicle is detected
- Regulatory sign(s) with instructions for drivers of overheight vehicles

The detection device consists of a transmitter and a receiver. The transmitter emits two infrared beams, which allow the system to distinguish the direction of travel. A measure of safety is also provided by the use of two beams, in that id one of the beams goes out, the other will still be able to activate the warning device. The use of two infrared LEDs doubles the transmitter power and insures reliable operation at distances to 125 feet.

The receiver has two eyes with silicon phototransistors and solid state amplifiers. The phototransistors are spectrally matched to the infrared transmitter LEDs for maximum signal detection. Since the left and right channels are identical, the left channel only will be discussed. The pulsed infrared signal from the transmitter is detected by the eye and amplified by solid state operational amplifiers. These amplified pulses are then applied to a missing pulse detector circuit. The missing pulse detector is designed to output a high voltage as long as incoming pulses are present. If the transmitted infrared beam is blocked for any reason, the output of the missing pulse detector circuit switches to alow voltage. Thus, a fast moving truck with a small diameter obstruction that momentarily interrupts the transmitted signal will cause a pulse at the output of the missing pulse detector. A slow moving truck (with a large obstruction) that stops and blocks the transmitted signal will cause a continuous low voltage at the output of the missing pulse detector. The level detector circuits are designed to act as a sun shield if the eye is momentarily saturated by sunlight or other strong infrared source. Infrared bandpass filters and optical baffles are installed to assist in reducing the effects of spurious interference.

LED indicators (green) are provided on the receiver control panel to indicate normal operation of the level detector and missing pulse detector circuits.

The transmitter and receiver units are mounted on poles on opposite sides of the road. The receiver unit contains an adjustable timer to control the duration of the flashing beacons and the alarm bells. As a result, the alarm bells and beacons do not need to be reset after activation. The receiver unit also contains other controls, such as the on/off switch.

TRIGG'S OVERHEIGHT VEHICLE DETECTION DEPLOYMENT SITES

Las Vegas, Navada - Tropicana Avenue Uprr Railroad Overpass, 2 double eye

San Angelo, Texas - Loop 306 & Knickerbocker Road, 1 double eye

Town of Stratford, Connecticut - Intersection of Route 110 and Route 1, 1 double eye

Lafitte County, Oxford, MS - 2 double eye

Boston, Massachusetts - Boston Tunnel, 12 units

Great Falls, MT - Smelter Overpass - 1 mile North of Sissouri River on Highway 87

Big Timber, MT - 1 on each side of Train Underpass - 1 mile North of Big Timber on Highway 191

Montana - Culbertson Rest Area/Weigh Station - 1/2 mile East of Culbertson on Highway 2

New York - World Trade Center

Lakewood, CO - Hanging lanes Tunnel

Coeur D'Alene, Idaho - Interstate 90, mile post - 13 West Bound

Poolsville, Maryland - JFK Highway, Poolsville Toll Facility - 7 units

Punta Gorda, Florida - Weigh Station - 2 units

Wilmington, North Carolina - Sixth Street

VULTRON DYNAMIC MESSAGE SIGNS DEPLOYMENT SITES

- Port Authority of New York and New Jersey, New York City area - (81) Lane Mode Signs. Curtain display with EZ Pass logos and 7x64 amber LED DMSs installed on toll canopies; (81) Driver Feedback Signs. Nine lines of amber or green LED display. All signs cetnrally controlled from World trade Center

- St. Ignace, Michigan - Vultron has provided roadside amber LED DMSs to the Machinac Bridge Authority, providing motorists traveling between the Upper and Lower Peninsulas of Michigan of driving conditions on the bridge.

- Washington, DC - 262 sets of bus signs for WMATA

- Michigan DOT, Wayne County, Detroit - 14 DMSs, 3-line matrix, 18" high characters, 20 characters per line, walk in cabinets. (12) Reflective Dot, (1) 3-color LED, (1) Fiber Optic.

- Detroit Michigan - Vultron, as part of the MDOT Freeway Management System, is providing 43 fiber Dot DMSs, 3 lines, 18" characters, 7x160 per line matrix, walk in cabinets.

- Puerto Rico - 85 sets of bus signs

- Dayton, Ohio - Vultron is installing signs that work with DATAGUIDE units to inform the seeing and hearing impaired of bus stop locations. To accomplish this, automatic annuncia tors and internal destination signs have been incorporated into bus information systems. The Vultron signs display the bus route/destinations in conjunction with the announcements.

- Texas DOT, Houston - (5) Reflective Disk DMSs with ground-mounted controllers, (4) 3-line, 20 characters per line, 18" high characters, (1) 3-line, 20 characters per line, 11.5"high characters.

- Florida DOT, Orlando, Florida - (4) LED Dot DMSs with ground-mounted controllers, 3-line, 7x90 line matrix, 18" high characters; (12) 24x96 Full Matrix LED-Dot DMSs, 18" high characters; (2) LED-Dot DMSs, 3-line matrix, 7x88 per line, 18" characters, walk-in cabinet.

- San Francisco International Airport - (2) Overhead Signs, 7x155 reflective Dot matrix, 18" high characters.

- Minnesota DOT, St. Paul, Minnesota - (2) reflective Dot SMSs, 3-line, 10 characters per line, 28" high characters.

- Maryland DOT, Baltimore, Maryland - (10) reflective Dot DMSs, 21x65 full matrix

- Lynchburg Department of Public Works, Lynchburg, Virginia - (4) Reflective Dot DMSs, 3-line, 8 characters per line, 18" high characters.

- City of Cleveland, Ohio - (12) 3-line, 8x64 line matrix, amber LED w/central controller; (9) 2-line, line matrix, Reflective Disk DMSs

- New York State Thruway Authority, Buffalo, New York - (4) Red LED DMSs, 3-line, 14x240 per line, line matrix.
- New York DOT, Onondaga County, Albany, New York - (1) Aber LED DMS, 56x160 full matrix.
- Delaware River & Bay Authority, New Castle, Delaware - (3) Red LED DMSs, 56x384 full matrix, walk-ine cabinets, 48" length spans 4 lanes of traffic.

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