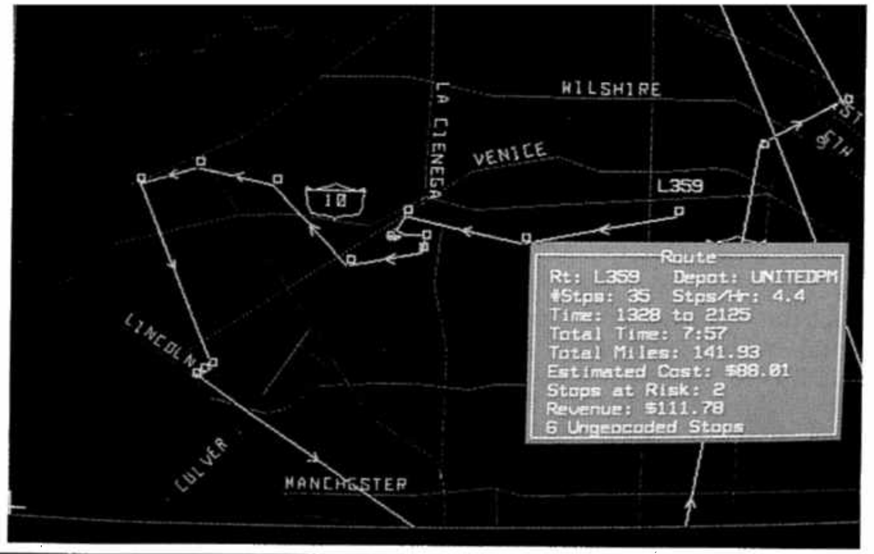
The locations and status of emergency vehicles are displayed below on a road network using Etak's dispatching system. Green arrows represent available vehicles, yellow arrows represent vehicles in transit, and red arrows represent vehicles on-site. Etak's system can also highlight for delivery vehicles the best route to follow (right).



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Computer-Aided Dispatching

Digital maps aid emergency response and fleet management

By Michael L. Sena

It's a hot, dry afternoon in midsummer, and children are playing in the field behind the old schoolhouse. Suddenly, someone spots a trail of smoke wafting through a patch of trees; within minutes, the entire field is ablaze.

As a neighbor gathers the children away from danger, another neighbor calls 9-1-1 to report the fire. Immediately, emergency personnel move into action, monitoring the fire and quickly determining which emergency vehicles to dispatch, as well as the shortest, quickest route to the scene. A mere 20 seconds after the initial call for help is made, a squadron of fire trucks and other emergency vehicles are dispatched and are on their way to fight the blaze.

In time-critical, emergency response situations, such as a fire, the ability to respond quickly and appropriately to a call for help can save people and property. And a new, map-based dispatching technology, being used by fire, police, and ambulance services, is helping to reduce response time to emergency situations from minutes to seconds, while providing vital information about the nature of the emergency to personnel dispatched to an incident.

Emergency road services are also using this technology to locate and dispatch the closest maintenance facility or available tow truck to the scene of a vehicle breakdown. While roadside vehicle breakdowns may not be life-threatening, per se, in some situations they can be very dangerous and require a quick response for service.

But emergency response isn't the only area in which the use of this dispatching technology is proliferating. For situations in which time means money, this technology—combined with delivery scheduling and vehicle routing and tracking capabilities—is helping to reduce the overall operational costs of vehicle fleet management. Delivery companies are using this technology to plan efficient routes and lower their costs per mile; telephone and utility companies are increasing the number of service calls they can handle per day; and pizza is arriving at homes hotter and faster than when delivery routes were laid out manually.

What makes these applications possible is map-based, computer-aided dispatching, a combination of technologies which reference an incident—such as a fire, a crime, a vehicle breakdown, or a delivery destination—to a geographic location. The location of the incident is then matched to the vehicle that is best able to service the incident.

A route—be it fastest, shortest, or least-expensive—is then selected to connect the service vehicle to the incident location. Proceeding in tandem with call-taking and dispatching are the repetitive tasks of collecting and verifying the data, keeping and updating the records, and monitoring the status of the incident as it is in progress.

A map-based, computer-aided

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dispatching system helps to automate all of these functions. Such a system typically provides support for call-takers and dispatchers in emergency response applications and routers and dispatchers in fleet management applications. Tracing the progress of the 9-1-1 call in the opening example of the fire behind the schoolhouse illustrates the components of a dispatch system designed for emergency response applications.

When a 9-1-1 call is made from any telephone, public or private, and if the area in which the call is made is part of the Enhanced 9-1-1 (E9-1-1) dialing system, the call is automatically routed through the phone company's Automatic Number Identification computer, which matches the calling phone number to billing records. The name and address of the caller's telephone is then added to the signal and routed back to the communications center (a public phone is simply given an address).

Pinpointing the Location

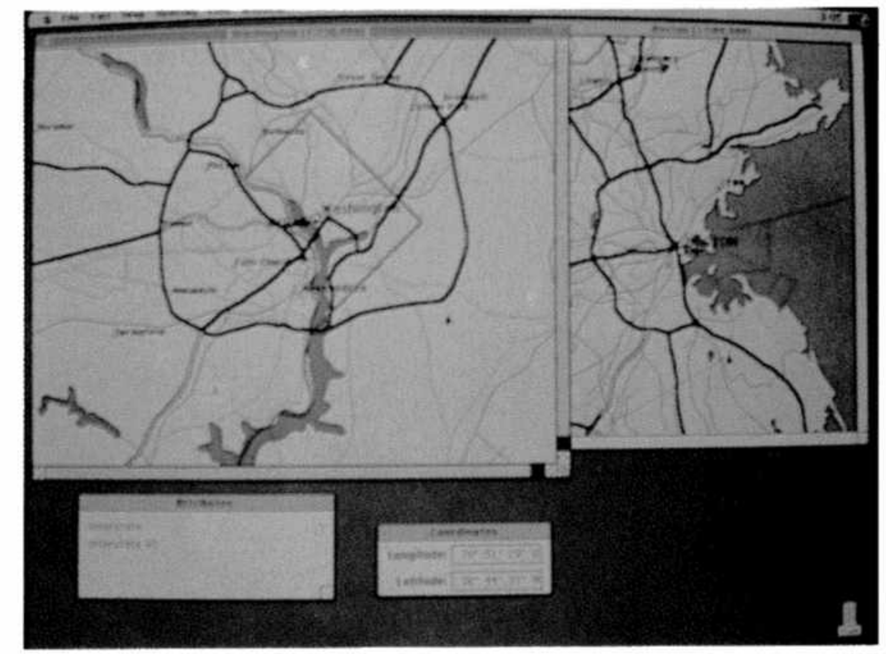
As the call-taker answers the telephone, the address is geocoded (the assignment of one or more addresses or establishments to a location and its related latitude and longitude) and located in the dispatch system's digital map database. When the call-taker begins the call, the name and address of the caller is filled in on an Incident Entry Form. In some computer-aided dispatching systems, a second screen displays a map on which the incident location is pinpointed. All of this transpires in less than two seconds.

The call-taker asks: "What is your emergency?"

The caller answers: "There's a fire behind the old schoolhouse."

With that information, the call-taker enters the incident type, confirms its location ("Is it the school on Oak Lane?"), and presses a transmit key to route the emergency to the appropriate dispatcher.

As the dispatcher receives the incident report, the dispatch system checks the fire quadrant in which the fire is located to determine which fire station is closest to the scene. It then checks on the availability of the fire-fighting equipment from data it has received via Mobile Data Terminals (MDTs) located in the vehicles. If the vehicles also have Automatic Vehicle Location devices (AVLs), the actual positions of the vehicles are plotted on the system's digital map. The system also searches its database to check for special hazardous conditions at the address, such as whether explosives or other materials are located on-site.



A dispatcher using Spatial Data Sciences' MapStation system can simultaneously display latitude and longitude on several windows.

The dispatcher then alerts the station or the vehicles by printing the incident location and any special instructions on the MDT screen. While the vehicles are en route to the scene, they are given additional information on the status of the blaze, as well as routing instructions to avoid traffic delays.

Rapid identification of the location of an incident is the key to rapid response. Therefore, a digital map, which is geographically referenced to latitude and longitude and which contains associated street addresses and major landmarks, is the heart of a computer-aided dispatch system. Some vendors of turnkey systems, such as Etak (Menlo Park, CA), deliver the system with their own map database (Etak's is from its MapBase library). Other vendors, such as Intergraph (Huntsville, AL), can use digital maps prepared by others, including the client's own data.

This map data must be topologically structured. That is, the points and lines on the map that define streets, landmarks, and boundaries must be logically related to each other so that actual street names and addresses can be referenced accurately to a geographic location. As such, US Census Bureau GBF/DIME (Geographic Base Files/Dual Independent Map Encoding) files are a common source of address data for dispatching applications. These files contain information describing the street network and other map features in records representing the segments of the features. Each record contains the segment name, address range, and ZIP code. Node numbers for intersections are referenced to *x,y* coordinate data that is, in turn, referenced to latitude and longitude.

For vehicle tracking applications using AVL devices or vehicle routing techniques, road geometry must be accurate *and* positionally precise—within 15 to 30 feet of ground truth. Two technologies are used for vehicle tracking: autonomous and signal-dependent. Autonomous devices, such as Etak's Navigator, reside in the vehicle and use wheel sensors to gauge distance travelled, a compass for direction, and an on-board database for map-to-ground matching.

Signal-dependent systems generally use Loran C technology. Loran C uses positional information transmitted from land-based radio towers. The vehicle's AVL device receives the transmissions and triangulates (calculates latitude and longitude) its own position.

Map-based, computer-aided dispatching systems are being used by numerous public service and fleet management companies nationwide. For instance, PRC Public Management Service, a wholly owned subsidiary of Planning Research Corp. (McLean, VA), has installed over 80 computer-aided dispatching systems for police, fire, and emergency medical services. PRC is a turnkey vendor and systems integrator. Each PRC system is tailor-made for the client, combining hardware and software, dispatching terminals, radio equipment, MDTs, and AVLs. PRC dispatch software runs on Digital Equipment Corp. (Maynard, MA) minicomputers and workstations.

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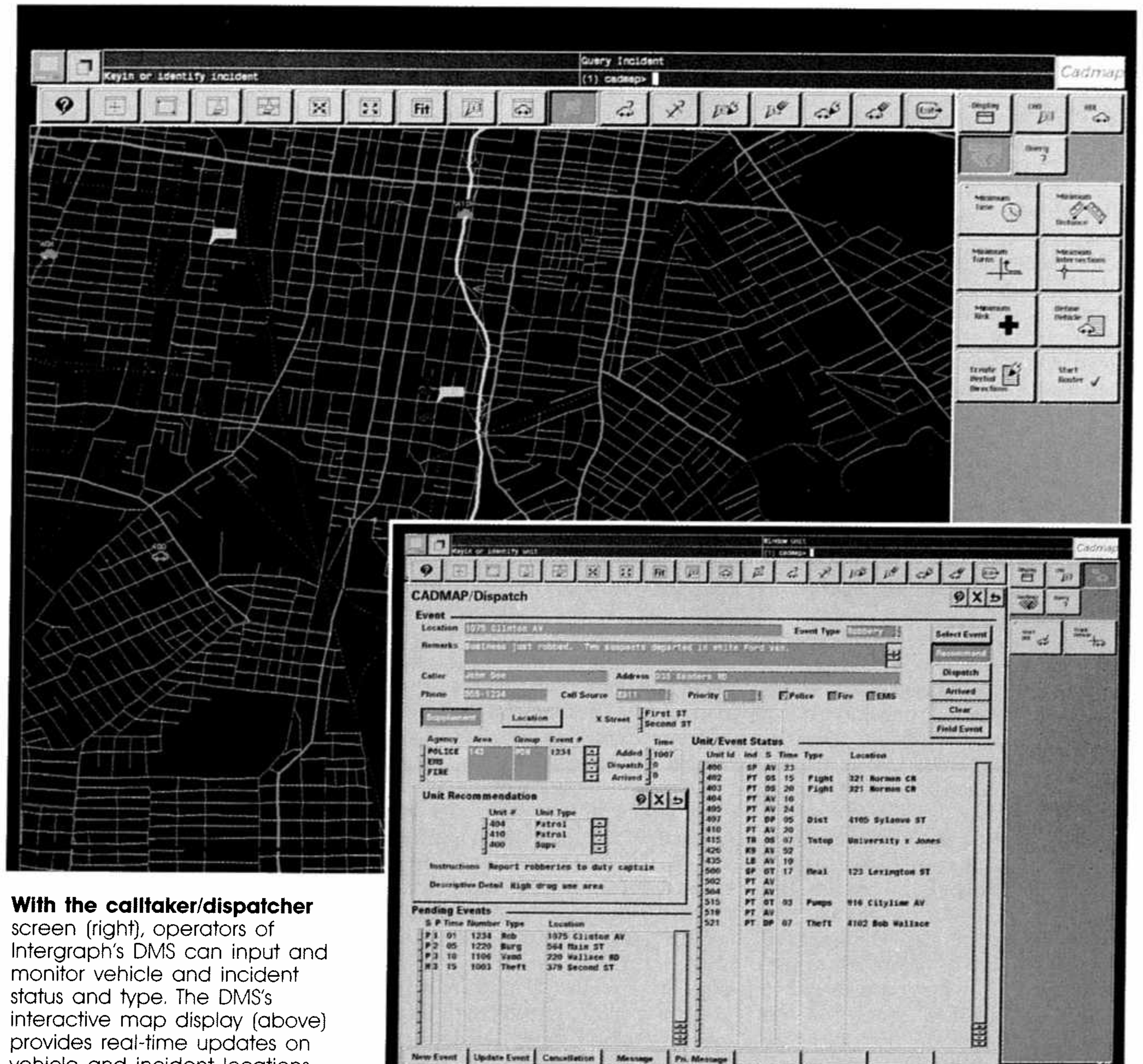
One of PRC's installations is the Fairfax County, Virginia Public Safety Communications Center. PSCC's $11.5 million emergency response system includes 12 call-taker, 12 dispatcher, and two supervisor applications running on two VAX785 and two PDP 11/44 minicomputers. Six hundred MDTs reside in police, fire, and rescue vehicles. E9-1-1 lines alone handle over 600 calls per day.

Each call-taker's station has two terminals—one for data entry and another for map display. After a caller's address is validated, the map system displays the incident location at an appropriate scale to see surrounding streets. The call-taker uses that map display to verify the location of the incident. (Fairfax hasn't installed AVLs in its vehicles, so its system can't display vehicle location.)

Albuquerque Ambulance (AA) in New Mexico is another user of a map-based, computer-aided dispatching system. When faced with the problem of increasing capacity and improving response time for its Emergency Medical Services without increasing staff size or adding new equipment, AA decided that the only way it could save time is at the start of a call.



With the calltaker/dispatcher screen (right), operators of Intergraph's DMS can input and monitor vehicle and incident status and type. The DMS's interactive map display (above) provides real-time updates on vehicle and incident locations.

Recommended routes to an incident using DMS are based on such factors as minimum distance and number of turns (above). Information in the DMS is integrated from many databases, so dispatchers can make decisions quickly (right).

"You can't drive to make up time," says John Tibbetts, AA system status manager. "If you can save 3 to 4 minutes at the beginning of every call by automatically locating and assigning an emergency crew, you not only improve overall response time, you save lives. In a cardiac arrest case, those 3 to 4 minutes are the difference between saving a life and losing one."

Three years ago, AA installed Etak's Emergency Response System CAD, including workstations, the Navigator on-board vehicle location device, and an EtakMap of the city. Eleven ambulances are fitted with the Navigator; a map display system with the Navigator screen also functions as an MDT, displaying and transmitting messages from and to the dispatching center.

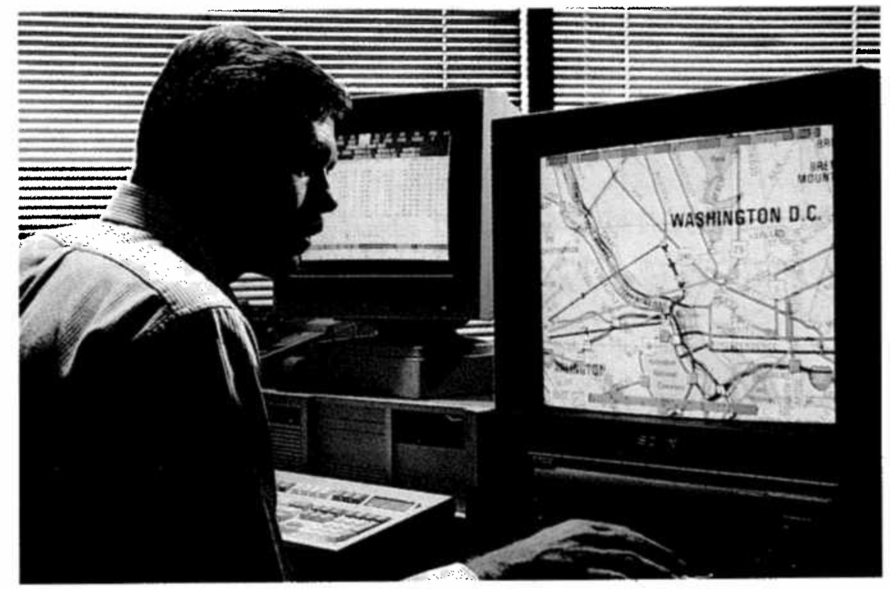
Albuquerque's dispatching center houses two Etak Dispatch workstations, each consisting of a Compaq 386 computer with dual monitors—one that displays a map and shows all emergency service vehicles with their number and color-coded status (en route; at scene; departed scene; at hospital) and another that is used for textual data, including summaries of a vehicle's status, incidents in progress, and call-taker menus. When a call comes in, the incident location is automatically geocoded and displayed on the graphics terminal, and a menu appears on the text screen. The dispatcher determines if the call must be answered immediately, or whether it can be scheduled for a later pick-up. In an emergency, the dispatcher sees which vehicle is closest to the incident and dispatches the call to the selected vehicle.

All communication between the vehicle and dispatch center is digital. Every 3/10 of a mile or 15 minutes, the location of each vehicle is sent to the center via a UHF radio frequency; another frequency is used to send messages to the vehicles. When an emergency is dispatched to an ambulance, the incident location is flashed on the Navigator screen. The driver sees its location in the middle of the screen and uses the map as a visual guide to drive to the emergency.

Tibbetts says that since the Etak system was installed, Albuquerque Ambulance has been able to handle 20 percent more call volume without adding a new crew. The key to this success, he says, is automatic geocoding and Etak's two-way AVL capability. "Emergency medical service is a complex business," he says. "It's difficult to find good paramedics. It's even more difficult to find crews who have an expert knowledge of all the streets in a city the size of Albuquerque. We estimate that our computer-aided dispatch system paid for itself in [under] a year."

Intergraph is a new vendor in the computer-aided dispatch systems market. Its Dispatch Management System, announced last August, includes graphics tools and RIS, Intergraph's relational interface system. RIS offers access to databases, records, and AVLs and MDTs.

The DMS consists of five software modules: I/Dispatcher, I/Calltaker, I/Tracker, I/Informer, and I/Messenger. I/Dispatcher monitors vehicle and incident status and type and provides automatic dispatch recommendations based on incident and vehicle location, type and availability, and other pertinent factors. I/Calltaker provides capabilities for entering information about an active incident. I/Tracker and I/Messenger provide communication support capabilities to several third-party MDTs and AVLs. And I/Informer allows access to data stored on other computers in different data formats.

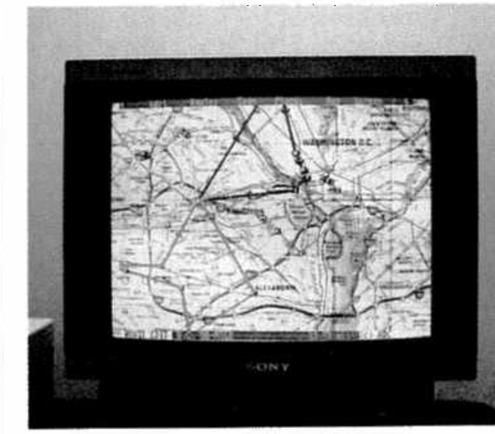


The interactive editing features of RTSI's Roadshow routing and scheduling system allow dispatchers to meet customer service windows, react to changing road and traffic conditions, determine dependable arrival times, and handle last-minute changes.

The American Automobile Assoc. has a strong interest in computer-aided dispatching. AAA has 31 million members in the US and Canada; for an annual fee, a member receives free emergency road service (ERS) in case of a vehicle breakdown. Last year, AAA clubs responded to over 22 million ERS calls through AAA's network of 15,000 contracted service facilities with over 31,000 service vehicles.

Jeff Mischke, director of Club Information Systems, says that AAA is constantly looking for ways to improve services to members while keeping the cost of those services—and therefore, membership fees—as low as possible. By enhancing its current ERS systems with computer-aided dispatch capabilities, Mischke believes that AAA can achieve both objectives.

"Reducing the response time from when a call is made by a member to when an ERS vehicle arrives on the scene not only minimizes the member's inconvenience, but also takes the member out of a potentially dangerous situation," says Mischke. He cites an example from the British Columbia Automobile Assoc. (BCAA). With a rudimentary computer-aided dispatch system that allows a dispatcher to match a caller's location to contractors' service quadrants and digitally signal a driver's MDT, BCAA was able to respond to 16 percent more light service calls (flat tire, fuel delivery) and 8 percent more tow service calls without adding equipment to the fleet.



Routes displayed on RTSI's Roadshow VideoMaps. While this example shows only straight lines between points, the "path" function displays actual streets travelled.

Mischke believes that the seconds saved in using computer-aided dispatch technology result in productivity improvements over time. A group of AAA clubs will soon install computer-aided dispatch systems in their ERS dispatch centers and MDTs in their contractors' vehicles. Initially, there will be neither a visible map display nor AVLs. But Mischke sees their inclusion as a desirable feature in future AAA dispatch systems.

The major difference between ERS dispatch systems and fleet management dispatch systems is the latter's incorporation of a routing and scheduling component. Routing applications require a much more robust digital map than do vehicle tracking applications. Each link in a topologically structured network must contain data on time to travel or special restrictions that must be enforced, such as height, weight, or speed limits and time-of-day prohibitions. A simple routing calculation for one vehicle attempting to move from one point to another, although not computationally trivial, is easily managed by simple routing software. A complex routing characteristic of fleet management consists of multiple available vehicles, multiple vehicle types, variable driver starting times, preferred and maximum route duration, time window requirements, and load characteristics. Unscheduled stops may have to be inserted on even a pre-planned route.

Roadnet Technologies (Hunt Valley, MD), a United Parcel Services (UPS) Company, offers its Roadnet system for fleet management applications. Roadnet is a stand-alone, PC-based, decision-support tool designed to help a router select the most efficient way to load and route delivery vehicles.

Roadnet created a street-level base maps for its system by digitizing from US Geological Survey (USGS) 1:24,000 scale topographic series maps. GBF/DIME files have been combined with the digitized street data to merge address data and code intersections with latitude and longitude locations. The digitizing process is now complete for 50 of the largest metropolitan areas in the US and Canada, including all of the primary state and interstate highway networks. Roadnet doesn't sell its digital database independently of its system.

System set-up includes contracting Roadnet Technologies to geocode all customer locations and associated data, such as standard delivery items, delivery time windows, and hours of service. Every customer has a unique identification number. When the system is put into use, daily orders are either keyed into the system or downloaded from a central database. Proprietary algorithms are used to calculate clusters of deliv-

eries and stop order sequences.

According to David Carp, Roadnet's national sales manager, automated fleet management offers the added benefit of driver accountability. "With manual routing and scheduling, a driver goes out with a day's orders and comes back, but there is no control over the driver movements," he says. "With automated fleet management, the driver is given a sequence with estimated times between stops and completion times. Dispatchers know approximately where a driver should be at all times."

UPS is using a special version of Roadnet, and one Roadnet division works only on the UPS applica-

METS purchases maps for its clients from other companies, including Geographic Data Technology (GDT, Lyme, NH).

Routing Technology Software Inc. (RTSI, Vienna, VA) is another vendor specializing in the development of routing and scheduling dispatch systems. RTSI's Roadshow system is designed to find the most cost-effective routes for clients' vehicles, enabling them to reduce distribution costs. This is accomplished through a program that processes the delivery order and evaluates such factors as actual mileage, road speed, rush-hour or weather slowdowns, vehicle capacity and operating costs, and driver wages. These routes are then displayed on a proprietary video system that includes street maps and data screens. RTSI's ar-

"With automated fleet management ... dispatchers know approximately where their drivers should be at all times."

tion. Around the time UPS purchased Roadnet, it acquired II-Morrow (Salem, OR), manufacturers of an AVL system. Roadnet and II-Morrow, along with UPS, are building the next generation of fleet management systems for UPS.

Mobile Electronic Tracking Systems (METS, Indianapolis) is another vendor of fleet management systems. The METS system includes a proprietary in-vehicle computer unit, called Tracker, which contains an AVL device and input/output ports for MDTs and other peripherals. Tracker's AVL uses Loran C to position the vehicle in geographic space and relays the position back to the central dispatching system. METS does not sell its own computer-aided dispatch system, but provides an interface capability to other systems.

METS adds a Vehicle Management System module to a computer-aided dispatch system so that a display is available to monitor fleet activity. Its RoadRunner module performs routing, scheduling, and dispatching. Point-to-point route maps are displayed as an overlay to a street-level map.

rangements with map publishers ensure that Roadshow's maps are up to date and accurate.

Whether a map is displayed or used only for processing a match between a vehicle and an incident, computer-aided dispatching is not possible without a geographically accurate and precise map database. Companies such as Etak, GDT, Navigation Technologies (Sunnyvale, CA), MapInfo (Troy, NY), and Spatial Data Sciences (McLean, VA) are creating street-level map databases which are highly detailed and geographically precise. Their job, and that of other database producers, is being made easier by a wealth of new data coming from the public sector and from the introduction of more powerful computer mapping tools for data conversion.

Digital map data, vehicle tracking and communications systems, and functional software—the components of computer-aided dispatch—are now available. The benefits of this technology in fleet management and emergency response applications are demonstrated. Expansive growth in computer-aided dispatching appears inevitable. *CGW*