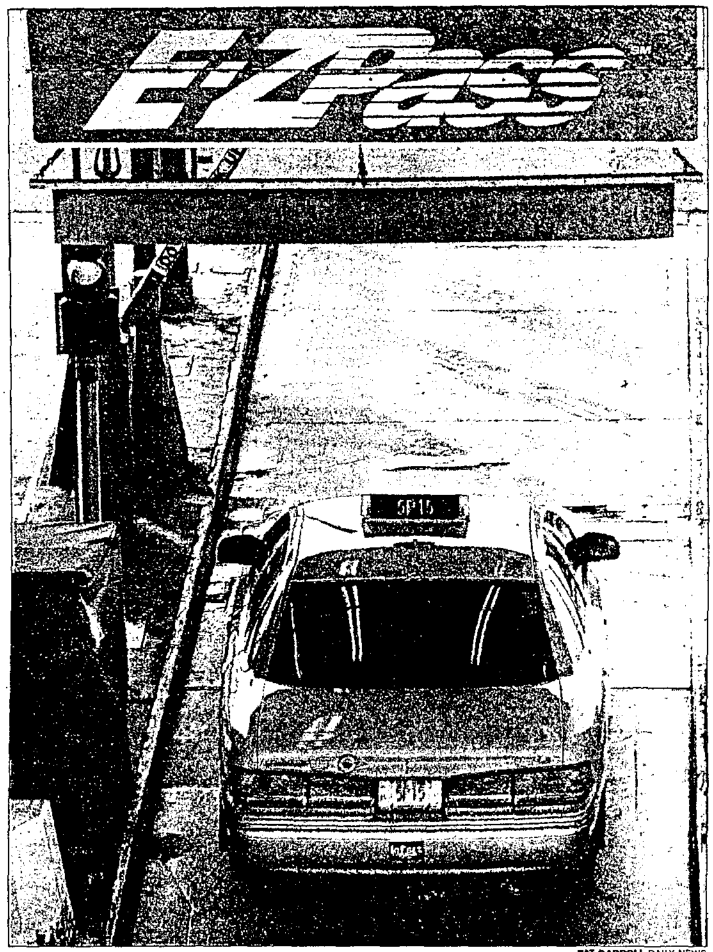
DAILY NEWS

50¢ http://www.mostnewyork.com NEW YORK'S HOMETOWN NEWSPAPER Monday, November 3, 1997

# IT'S E-Z TO SPY




PAT CARROLL DAILY NEWS

## Toll lane records used in crime cases; divorce court could be next

SEE PAGE 3

# E-ZPass slows those trafficking in wrong

PAGE 2 OF 2

By ALICE McQUILLAN and JAMES RUTENBERG
Daily News Staff Writers

Fleeing bank robbers, mobsters on the run and philandering husbands engaged in interborough trysts should think twice if they plan to use E-ZPass to make their escapes.

Law enforcement authorities are aggressively using the electronic toll system in criminal investigations, expecting records to put them in the express lane to the bad guys.

Transportation officials said so far they have provided E-ZPass records to cops and prosecutors tracking the movement of suspects in 35 criminal cases — a number that is likely to grow astronomically.

"It will become another item to be checked off in a routine investigation," said a New York Police Department investigator who spoke on condition of anonymity. "You must do it. It will be an omission not to do it."

Civil libertarians predict that others — divorce lawyers, for example — are likely to begin seeking access to the same E-ZPass information.

"When he says, 'I was at work, Honey,' now she can check the E-ZPass and prove he was at the Hot Bed Motel in Long Island," said divorce attorney Raoul Felder.

New York Civil Liberties Union attorney Norman Siegel said he feared the information could be used in political campaigns or to smear public personalities.

"Once you have the capacity to track the whereabouts of citizens," he said, "it opens a huge door for violations of privacy."

The sought-after information is gathered each time a car with an E-ZPass sensor in its front windshield goes through a toll. Tolls are automatically deducted from a pre-paid account — and a record is made of exactly where that car has been and when.

Of course, it doesn't tell who's driving. But law enforcement types said it's worth checking.

And in at least one big case, it came in handy: When police were trying to track down missing millionaire Nelson Gross, who was abducted by two teens outside his Edgewater, N.J. restaurant Sept. 17.

E-ZPass records showed his car had crossed over the George Washington Bridge twice that day and his body was found in Manhattan days later by the Hudson River near the span.

"It's significant," said Edgewater Detective Alex Hanna, who worked on the Gross case. "It can put a person in a place at a certain time; that would be important to any investigation."

The NYPD investigator said that access "to a suspect's movements often will reveal coverups or lies in their stories. And in terms of a homicide victim's movements, it will provide answers to questions only the perpetrator would know."

When the Triborough Bridge and Tunnel Authority launched E-ZPass, it brushed off questions about confidentiality with assurances that records would be tightly kept. At first, the TBTA demanded all requests for information be accompanied by a court-ordered subpoena.

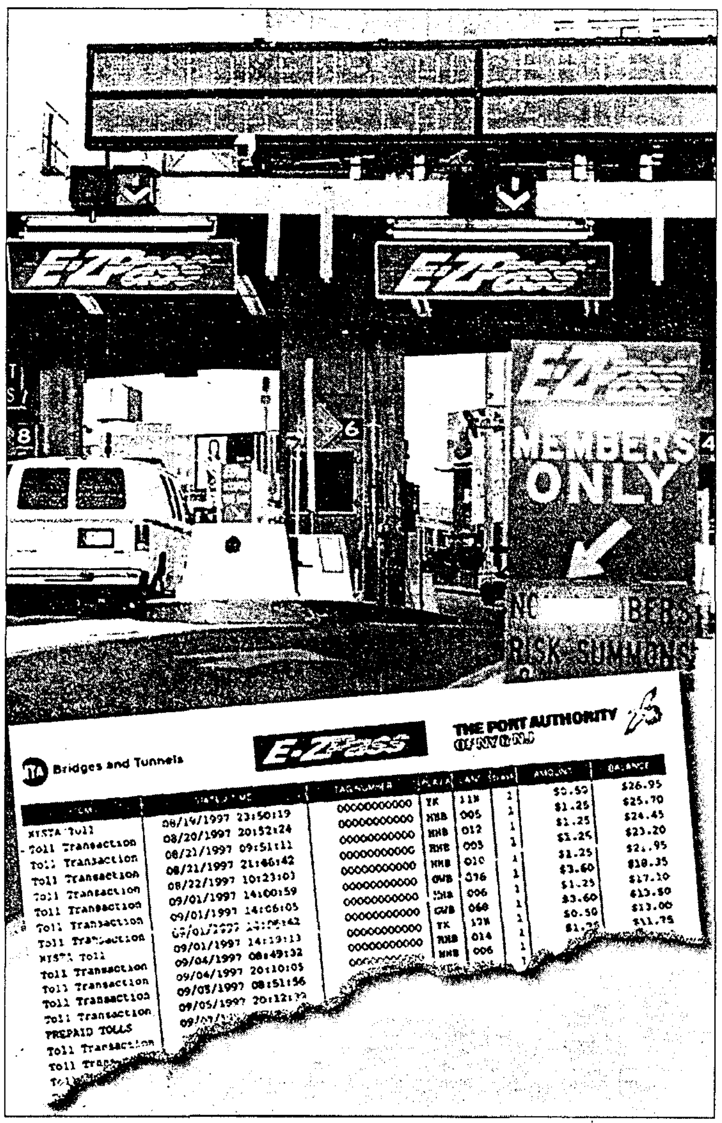
But during a Brooklyn homicide investigation last summer, the NYPD fought the TBTA's policy in court and won. A judge ruled the records could be obtained without the court order.

Since then, the TBTA has modified its policy and tells its customers that their records will be kept from law enforcement authorities except in cases involving "serious crime."

Michael Vaccari, general counsel for the Metropolitan Transportation Authority, admitted that the agency does not have a standard defining "serious crime."

"There would be a judgment call as to whether or not the

• SEE PASS PAGE 49




E-ZPASS RECORD shows tag, date, time and location of bridge or tunnel used, making it possible for authorities to track the movements of all vehicles equipped with the electronic toll system's sensors.





**PASS** FROM PAGE THREE

matter is serious," he said. He said since the Brooklyn case was a homicide, "it was pretty clear."

Using this case-by-case approach, the MTA has turned down 15 requests for E-ZPass records from law enforcement officials.

The agency does refuse all requests involving civil litigation — lawsuits, divorces and custody suits. So far, TBTA officials said, they've only received one request.

And, while civil libertarians said the summer court decision could open the records to people other than law enforcement, Vaccari said that won't happen. "There is no public interest for us, essentially a government agency, to get involved in a divorce proceeding," he said.

To make sure, he said, the agency wants legislation that would make it impossible for civil litigants to get their hands on E-ZPass info.

Others worry that no matter what the law says, the information will get out.

"If information is inside a room and the room costs 50 bucks to get a key, someone will try and do it," seasoned private investigator Joe Mullen said.

INTELLIGENT TRANSPORTATION SOCIETY OF AMERICA'S
EIGHTH ANNUAL MEETING AND EXPOSITION

# PRELIMINARY PROGRAM

ITS America

# ITS 98

INTELLIGENT TRANSPORTATION SOCIETY
OF AMERICA'S EIGHTH ANNUAL
MEETING AND EXPOSITION

## INTELLIGENT TRANSPORTATION SYSTEMS:
# TECHNOLOGY FOR TODAY

MAY 4-7, 1998
COBO HALL, DETROIT, MICHIGAN

ITS America

expanding our knowledge base, and examining various model validation approaches as ITS systems are deployed.

**Moderator**

August Burgett, Chief, Light Vehicle Dynamics & Simulation, National Highway Traffic Safety Administration, Washington, DC,

**Panelists**

- Thomas Dingus, Director, Center for Transportation Research, Virginia Tech, Blacksburg, Virginia
- Valerie Gawron, Principal Engineer, Calspan SRL Corporation, Buffalo, New York
- Eugene Farber, Manager, IVHS Safety & Regulatory Issues, Ford Motor Company, Dearborn, Michigan
- Louis Tijerina, Research Scientist, Transportation Research Center Inc., East Liberty, Ohio
- Raja Sengupta, Assistant Research Engineer, University of California, Berkeley, Richmond, California

## 7 Societal Issues: What the Intelligent Vehicle Initiative has to Learn from the Experiences of the Automated Highway System

This session will address the Societal Issues studied prior to, during, and following the Automated Highway System (AHS) Demonstration (August 7-10, in San Diego, CA). Panelists will analyze the implications associated with society as a whole resulting from the implementation of AHS. Lessons learned from the AHS Demonstration will be adapted to the new Intelligent Vehicle Initiative (IVI). Topics of discussion will include: Is there adequate coverage pf Social Issues in the new program? Should new research be performed to reflect the evolutionary development of IVI as a validation of AHS research?

**Moderator**

Michael Martin, President, Martin Enterprises & Associates, Inc., Reston, Virginia

**Panelists**

- Steven Shladover, Path Deputy Director, University of California - Berkeley, Richmond, California
- Alan Lubliner, Assistant Vice President, PB Farradyne, New York, New York
- Daniel Berler, U.S. Department of Transportation, Washington, DC

## 8 Intermodal ITS Applications - Current & Future

Modal ITS freight movement applications are emerging. Two studies will be presented on ITS for ports and rail systems. The impact of megaships will be presented, including potential ITS applications. Airports are beginning to employ ITS for both travelers and freight. Panel members will present the results of their activities and discuss how to meet the future ITS challenges.

**Moderator**

John West, Program Manager, CAL-TRANS, Sacramento, California

**Panelists**

- John G. Kaliski, Senior Associate, Cambridge Systematics, Inc., Cambridge, Massachusetts
- Robert Larsen, Manager, Transportation Systems, Raytheon E-Systems, Falls Church, Virginia
- Dres Zellweger, Embry-Riddle, Aeronautical University
- Alan Myers, VZM-Transystems, Reston, Virginia

### 1:30 - 3:00

## 9 Standards & Protocols

**Moderator**

Allan Kirson, Senior Member Tech. Staff & Director Technology ITS, Motorola, Inc., Northbrook, Illinois

**Paper Presentations**

- *U.S. Department of Transportation ITS Standards Program**
  Michael Schagrin, Program Manager, U.S. Department of Transportation, Washington, DC, Susan Scott, Member of Technical Staff, JPL, Washington, DC
- *An Adventure in Purchasing NTCIP Compliant VMS: Virginia Department of Transportation's Lessons Learned**
  Joerg Rosenbohm, Senior Transportation Engineer, Viggen Corporation, Sterling, Virginia, Craig Franklin, Senior Transportation Engineer, Viggen Corporation, Sterling, Virginia, Robb Alexander, Dave Fogg and Mike Winn, Transportation Engineers, Virginia Department of Transportation, Richmond, Virginia
- *Emerging Interoperability with National Transportation Communication for ITS Protocols (NTCIP)**
  Raman K. Patel, Vice President, PB Farradyne Inc., New York, New York, Edward J. Seymour, Research Engineer, Texas Transportation Institute, Dallas, Texas
- *Ready, Set, Standardize: Building the IEEE Data Dictionary and Message Set Template Standards**
  Valerie Shuman, Manager, Strategic Development, Navigation Technologies, Rosemont, Illinois

## 10 What You Should know about Paratransit and Demand Responsive Transit

- *SMART Operational Field Test Evaluation Employee Survey Report**
  Zakia Shaikh, Research Associate, University of Michigan, Ann Arbor, Michigan, Steven Underwood, Assistant Research Scientist, and Richard Wallace, Evaluation Project Manager, University of Michigan, Ann Arbor, Michigan
- *Effects of Automated Scheduling And Dispatch Technology on Paratransit Schedule Adherence in Southern Michigan**
  Richard Wallace, Evaluation Project Manager, University of Michigan, Ann Arbor, Michigan, Yu-Hsin Tsai, Graduate Student Research Assistant, and Steven Underwood, Assistant Research Scientist, Universtiy of Michigan, Ann Arbor, Michigan
- *Supporting Demand Responsive Transit Operations**
  Brian Smith, Senior Research Scientist, Virginia Transportation Research Council, Charlottesville, Virginia, Priya K. Durvasula, Graduate Research Assistant



* Published papers in proceedings

transportation smart card programs in the U.S. and abroad, as well as representatives from the financial community who are seeking to develop partnerships with transportation agencies for multi-use card programs. Panel members will address: the technological challenges for multi-use smart cards, evolving new partnerships and key issues in implementing large-scale smart card programs in all modes of transportation.

**Moderator**

Michael Dinning, Chief, Safety & Security Systems Division, U.S. Department of Transportation/Volpe National Transportation Systems Center, Cambridge, Massachusetts

*Panelists to be determined.*

## 27 The ATIS Deployments

There are 15 significant ATIS deployed throughtout the U.S. This conference session will consist of one representative from each of those sites to discuss and answer questions related to their particular ATIS. Topics to included: ATIS Business Plans, what are the goals and expectations (public and private goals) and; institutional and political concerns, constraints and opportunities.

**Moderator**

George Schoene, Team Coordinator, Federal Highway Administration, Washington, DC

**Panelists**

- Marion Waters, State Traffic & Safety Engineer, Georgia Department of Transportation, Atlanta, Georgia
- Gary/Chicago/Milwaukee Corridor representative
- Leon Walden, Transportation Engineer, II, Kentucky Transportation Cabinet, Frankfort, Kentucky
- Kunwar Rajendra, Engineer of Transportation Systems, Michigan Department of Transportation, Lansing, Michigan (invited)
- Gloria Stoppenhagen, Acting Manager, Metropolitan Transit Authority, Houston, Texas
- James Wright, Assistant Division Engineer - ITS, Minnesota Department of Transportation, Roseville, Minnesota
- Dan Powell, Chief Administrator, Arizona Department of Transportation, Phoenix, Arizona
- Melanie Crotty, Travinfo Project Director, Metropolitan Transportation Commission, Oakland, California
- Leslie Jacobson, Traffic Services Manager, Washington Department of Transportation, Seattle, Washington
- Pam Marston, Transportation Management Engineer, Federal Highway Administration, Baltimore, Maryland
- Jackie Erlanger, Manager, Finance and Policy, TRANSCOM, Jersey City, New Jersey (invited)

## 28 ITS Media Coverage: How to Publicize Your ITS Program

Reporters and editors from both the print and electronic media discuss what makes an ITS activity newsworthy, how best to approach the news media, and what works and doesn't work in attracting media attention to ITS projects and programs.

**Moderator**

Chalmers "Hap" Carr, Program Manager, AlliedSignal Technical Services Corp., Charlotte, North Carolina

**Panelists**

- Hank Schaller, Oakland Press (invited)
- Jeff Gerritt, Detroit Free Press
- Ed Garsten, CNN
- Murray Feldman, WJBK-TV (invited)
- Bob Giles, WXYZ-TV
- John Delle Monache, WYUR-AM
- Dave Phillips, Detroit News (invited)

## 29 Strategies to Plan for and Develop Integrated Transportation Management Systems

**Moderator**

Lawson (Joe) Stapleton, Assistant State Traffic Operations Engineer, Georgia Department of Transportation, Atlanta, Georgia

**Paper Presentations**

- *San Diego's Prototype Intermodal Transportation Management Center: A Southern California Priority Corridor SHOWCASE Project**
  Bruce W. Churchill, Senior Project Manager, National Engineering Technology Corp., La Mirada, California
- *Implementation of the Next-Generation Smart Traffic Center: A State-of the-Art TMS for Virginia Department of Transportation in Northern Virginia**
  Barry Grasso, Principal Software Engineer, Lockheed Martin SMSS, Seabrook, Maryland, Jimmy Chu, Manager TMS, Virginia Department of Transportation, Arlington, Virginia
- *Integrated Corridor Traffic Management (ICTM) Project: Minnesota DOT's Lessons Learned**
  Linda Taylor, ICTM Project Manager, Minnesota Department of Transportation, Roseville, Minnesota, Lyle Berg, Traffic Engineer, City of Bloomington, Bloomington, Minnesota, and Selvin Greene, ICTM Operations Engineer, Minnesota Department of Transportation, Roseville, Minnesota
- *Achieving Interoperability in Anaheim**
  John Thai, Prinicipal Traffic Engineer, City of Anaheim, Anaheim, California

## 30 User and Societal Acceptance of AVCSS

**Moderator**

Steven E. Shladover, Deputy Director, University of California, Berkeley, PATH Program, Richmond, California

**Paper Presentations**

- *User Acceptance of Certain Automotive Safety Devices**
  Michael A. Kemp, Vice President and Mark R. Kiefer, Senior Associate, Charles River Associates Inc., Boston, Massachusetts and Jane E. Lappin, ITS Program Manager, U.S. Department of Transportation, EG&G at the Volpe National Transportation Systems Center, Cambridge, Massachusetts
- *Greater Yellowstone Rural ITS Priority Corridor AHS Case Study**
  Russell Gomke, Associate Research Engineer, Western Transportation Institute, Bozeman, Montana, Steve Albert, Director, Western Transportation Institute, Bozeman. Montana
- *A Revealed Preference Study of Automated Vehicle and Highway Systems**
  Youngbin Yim, University of California, Berkeley, Richmond, California, Ronald Koo, Harvard Universtiy, Cambridge, Massachusetts



* Published papers in proceedings

## 31 Privacy and ITS: An Update

Panelists will provide an update of several activities related to privacy occurring within the ITS community, particularly as applied to specific ITS user services. Privacy activities related to the following will be covered: commercial vehicle operations, dedicated short-range communications, an international privacy standard and ITS America's Fair Information and Privacy Principles.

**Moderator**

Craig Roberts, Director, Policy and Partnerships, ITS America, Washington, DC

**Panelists**

- Carol Coleman, Principal, Cambridge Systematics, Boston, Massachusetts
- Peter Houser, Engineering Manager, ITS, Signal Processing Systems, San Diego, California

*Additional panelists to be determined.*

## 32 Future Possibilities for ITS/CVO (1)

The purpose of this interactive forum is to explore the issues, barriers and prospects for ITS/CVO national deployment today and for the next millennium. The various strategies and stakeholder perspectives—U.S. Department of Transportation, states, carriers, and vendors—for championing and deploying ITS/CVO will be presented and debated via a facilitated dialogue, the goal of which is to suggest and provide a basis for future CVO Committee activities and to formulate a strategic direction for deployment programs for ITS/CVO. The forum will continue in session #40.

**Moderator**

Dick Landis, President, HELP, Inc., Phoenix, Arizona

**Panelists**

- George Reagle, Associate Administrator, Office of Motor Carriers, Federal Highway Administration, Washington, DC (invited)
- Ed Logsdon, Commissioner, Kentucky Transportation Cabinet, Frankfort, Kentucky (invited)
- Ray Chamberlain, Vice President, DMV Regulation, American Trucking Associations, Inc., Alexandria, Virginia (invited)
- Norman Mineta, Senior Vice President & Managing Director, Lockheed Martin IMS, Washington, DC (invited)

### 10:00 - 11:30am

## 33 U.S. Department of Transportation's Metropolitan Area Integration Policy

This session will describe the elements of U.S. Department of Transportation's approach in assisting metropolitan areas in deploying integrated ITS to meet U.S. Department of Transportation's goal of 75 equipped areas by 2005. Top officials will detail the following key program elements: incentives, training, architecture conformance, standards, and technical guidance.

**Moderator**

Christine Johnson, Director, ITS Joint Program Office, U.S. Department of Transportation, Washington, DC

*Panelists to be determined.*

## 34 Evaluation of SMART's ITS Field Operational Test

The Suburban Mobility Authority for Regional Transportation (SMART) has installed an automatic scheduling and dispatch (ASD) system in southeastern Michigan for the expressed purposes of increasing the efficiency of their paratransit system and improving paratransit mobility in the region. This panel will present the results of several studies completed as part of the University of Michigan's evaluation of SMART's implementation of ITS. These studies explore three categories of evaluation outcomes: (1) objective measures of system performance, (2) employee reactions to the ITS implementation, and (3) public reactions to the system. Of the three, the objective measures reveal the most consistent, positive evidence of beneficial results. Results from the other two categories, however, reveal significant level of employee dissatisfaction with the system and a large gap in public knowledge of SMART's ITS program.

**Moderator**

Steven Underwood, Assistant Research Scientist, University of Michigan, Ann Arbor, Michigan

**Panelists**

- Thomas Reed, Assistant Research Scientist, University of Michigan, Ann Arbor, Michigan
- Richard Wallace, Evaluation Project Manager, University of Michigan, Ann Arbor, Michigan
- Jonathan Levine, Assistant Professor, Urban Planning, University of Michigan, Ann Arbor, Michigan
- Zakia Shaikh, Research Associate, University of Michigan, Ann Arbor, Michigan

## 35 Developing ATIS Business Models

In order to deliver Advanced Traveler Information Systems more effectively, in many cases public agencies need to work effectively and efficiently with the private sector. ATIS Business Plans are depicted as a means of understanding, clarifying and structuring such relationships among public and private firms. This session will look at the need for business plans and their constituent elements.

**Moderator**

Rick Schuman, Director, System Applications, ITS America, Washington, DC

**Paper Presentation**

- *Towards an ATIS Business Plan Framework**
  Mark Hallenbeck, Director, University of Washington - TRAC, Seattle, Washington

**Panelists**

- Larry Sweeney, Vice President & General Manager, Etak, Menlo Park, California (invited)
- Jerry Pittenger, Vice President & Deputy General Manager, Battelle, Columbus, Ohio (invited)
- Joel Markowitz, Manager, Advanced Systems, San Francisco Metropolitan Transportation Com., Oakland, California
- James L. Wright, Assistant, Division Engineer, Minnesota Department of Transportation, Roseville, Minnesota

## 36 Public Relations for MDI Cities: Lessons Learned

Those responsible for public information/outreach in the four Model Deployment Initiative projects — TRANSCOM in the New York-New Jersey-Connecticut metropolitan area, AZ Tech in Phoenix, TransGuide in San Antonio, and Smart Trek in Seattle -- discuss what has worked and not worked in the efforts to explain the benefits and operations of their projects to the news media and the community at large. A question and answer period following the briefings will bring the experience and insights of these panelists to bear on your own efforts in public relations and ITS awareness.

# Six highway segments eyed as toll roads

**By Mark Arner,** STAFF WRITER

A six-mile stretch of freeway linking Rancho Peñasquitos with Carmel Valley is one of six highway segments being eyed by county transportation planners as possible toll roads.

The proposed $72 million extension of state Route 56 is one of the most feasible freeways for collecting tolls, according to a study conducted by the San Diego Association of Governments.

SANDAG is looking for ways to raise more money for major transportation projects.

The county currently has no toll roads, but a segment of state Route 125 is proposed to be the first, from about a mile south of state Route 54 to Interstate 905. Construction would be paid for by private enterprise.

"We should eliminate the word 'freeway' from our vocabulary and start considering completing some projects with toll roads," said Art Madrid, a member of SANDAG and the mayor of La Mesa.

County Supervisor Pam Slater said the 19-member board needs to "be creative in terms of funding opportunities" to raise money for sorely needed freeway improvements.

The six freeway segments under consideration to become toll roads cover 32 miles and if built would cost an estimated $788 million. Two of the projects are already under construction.

"I believe that the public will be supportive of particular (freeway) projects that have a reasonable toll," said Slater, who also is a SANDAG member.

She made the comments during a SANDAG meeting last week in Borrego Springs that focused on the projected $9 billion funding gap in the board's recently adopted $24.8 billion plan through 2020.

Existing taxes and fees are expected to cover $15.8

*See* **TOLL ROADS** *on Page B-8*

## Future toll roads?

Six segments of proposed freeways or highways are being considered by SANDAG as possible toll roads. All would be four to six lanes. They are:

**1 State Route 76**
9.1 miles, $94 million, from the eastern border of Oceanside to Interstate 15.

**2 State Route 56**
5.9 miles, $72 million from Carmel Valley Road to Black Mountain Road.

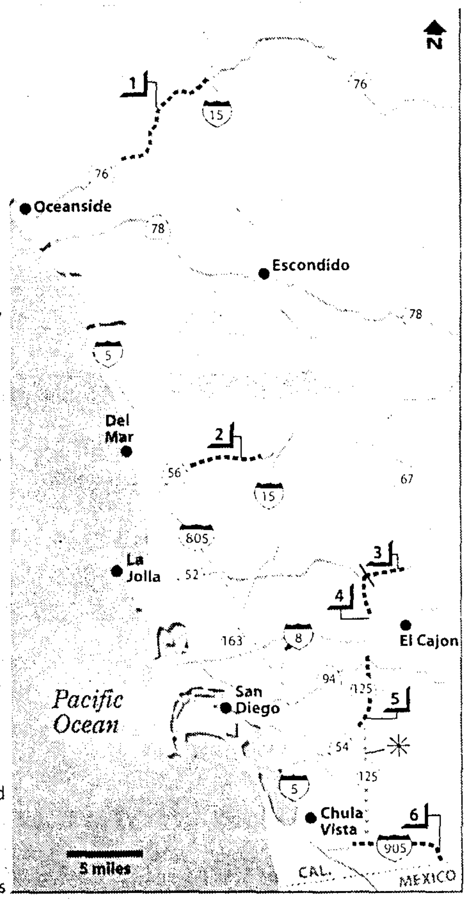
**3 State Route 52**
2.5 miles, $162 million, from Route 125 to state Route 67.

**4 State Route 125**
(Fanita segment)
3.5 miles, $50 million, from Fletcher Parkway to state Route 52.

**5 State Route 125**
(Sweetwater segment)
4.4 miles, $190 million, from state Route 54 to state Route 94.

**6 Interstate 905**
6.6 miles, $220 million, from Interstate 805 to the Mexican border.

**✳ State Route 125**
Already being planned is a privately funded toll road: state Route 125, from state Route 54 south to Interstate 905; 11 miles at a cost of $360 million.




SOURCE: SANDAG

JIM BURNETT / Union-Tribune



# Toll roads

## County planners eye six highway segments

*Continued from B-1*

billion worth of freeway, road and public transit improvements by 2020, but SANDAG has decided that more improvements are needed countywide to keep traffic flowing smoothly.

It has decided in the months and years ahead to grapple with whether to seek higher taxes or fees or to somehow stimulate the economy to produce more taxes to help bridge the gap.

Lee Hultgren, SANDAG's director of transportation, said Route 56 was considered to be one of the best bets for a toll road in a study conducted last year that analyzed roughly a half-dozen freeways countywide for such fees.

"State Route 56 is pretty feasible," Hultgren said, "because there's a lot of demand — up to 40,000 trips per day — and it's not that expensive."

Hultgren said the segment of Route 56 would probably require tolls of 50 cents to 75 cents per trip, assuming that it opened between 2000 and 2005.

Barbara Warden, another SANDAG member who represents Rancho Peñasquitos on the San Diego City Council, said after the discussion that she is open to charging a toll to help fund the extension.

"I grew up in Philadelphia, so I'm used to toll roads," Warden said. "All the turnpikes required us to throw those quarters in those little kiosks."

Warden, however, said the concept of toll roads drew a chilly reception in 1994 from many state legislators.

"It was not well-received by the majority of the legislators that I spoke with. They felt it was the people's right to have freeways (without tolls)."

Warden is spearheading a plan to connect Route 56 with four lanes of expressway-style roads for $41 million, funds already earmarked for the project. SANDAG is studying whether it could be upgraded to a six-lane freeway for $31 million more.

Financing for the initial expressway has been obtained from the city of San Diego, the county and a half-cent countywide sales tax. However, more is needed to cover the proposed freeway upgrade.

Other routes being considered for toll roads:

- State Route 52, from Route 125 to state Route 67.
- State Route 125 (Sweetwater segment), from state Route 54 to state Route 94.
- State Route 125 (Fanita segment), from Fletcher Parkway to state Route 52.
- State Route 76, from the eastern border of Oceanside at Jeffries Ranch Road to Interstate 15. The project would expand the highway from two to four lanes.
- Interstate 905, from Interstate 805 to the Mexican border.

E-PASS

ORLANDO-ORANGE COUNTY EXPRESSWAY AUTHORITY
E-PASS SERVICE CENTER
762 S. GOLDENROD ROAD
ORLANDO, FL 32822

** STATEMENT **

[redacted]

STATEMENT DATE 08-MAR-95
ACCOUNT NUMBER 6290

FOR PERIOD:
01-FEB-95 TO 28-FEB-95

ACCOUNT ACTIVITY

| DATE | POSTING DATE | DESCRIPTION | LOCATION | AMOUNT |
|---|---|---|---|---|
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| 03-FEB-95 | 03-FEB-95 | CC - RETURN | EPASS SC | (50.00) |
| 03-FEB-95 | 03-FEB-95 | CREDIT OTHER | EPASS SC | 50.00 |
| | | | | $ 50.00 |

VEHICLE ACTIVITY

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| 06-FEB-95 09:33:28 | 06-FEB-95 | HOLLAND W. (M) LANE 8 | 0.75 |
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| 11-FEB-95 20:11:34 | 11-FEB-95 | UNIVERSITY (M) LANE 9 | 0.50 |
| 11-FEB-95 20:33:34 | 11-FEB-95 | BOGGY CRK (M) LANE 11 | 1.00 |
| 11-FEB-95 20:41:27 | 11-FEB-95 | JOHN YOUNG (M) LANE 12 | 1.00 |
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| 21-FEB-95 20:48:12 | 21-FEB-95 | HOLLAND E. (M) LANE 4 | 0.75 |
| 23-FEB-95 08:57:32 | 23-FEB-95 | HOLLAND W. (M) LANE 9 | 0.75 |
| 23-FEB-95 14:29:32 | 23-FEB-95 | HOLLAND W. (M) LANE 1 | 0.75 |
| 23-FEB-95 21:23:43 | 23-FEB-95 | UNIVERSITY (M) LANE 11 | 0.50 |
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| 24-FEB-95 11:06:03 | 24-FEB-95 | HOLLAND E. (M) LANE 4 | 0.75 |

DO NOT PAY

DO NOT PAY -- THIS IS NOT A BILL

THANK YOU

# Web on Wheels: Toward Internet-Enabled Cars

**An open system that conforms to standard Internet protocols for communication to and from automobiles could greatly enhance driving. Existing Internet resources can be leveraged to integrate a car into the Internet. Service providers will subsequently produce innovative services for drivers and passengers that will improve safety and security as well as provide infotainment.**

*Akhtar Jameel*
*Matthias Stuempfle*
*Daniel Jiang*
*Axel Fuchs*
Daimler-Benz Research and Technology, North America

The services provided to customers through the Internet can be extended to the automobile. Early versions of Internet-enabled cars might hit the road in five years or less. Portions of the technology could be available to customers in as little as two years as an after-sales solution. Indeed, such integration could become essential, given the constant access to information our just-in-time world seems to require. Integration could also be two-way: Your car might also provide information to the Internet for the purposes of remote diagnostics, among other things. Unlike the portable method of accessing the Internet with a laptop computer, an Internet-integrated vehicle is truly mobile. Mobility serves as both a challenge and a distinguishing factor in the design of our communication and service architecture.

With the advancement of the Global Positioning System (GPS) and other position-tracking technologies, *location awareness* emerges as a distinctive characteristic of combining mobile computing and automobiles. This knowledge will be used to build communication and service architectures. For example, a service could provide information about the nearest gas station or restaurant.

A safe and easy-to-use human interface for drivers and passengers must be designed to bring Internet-based services to moving vehicles. For example, an e-mail service must not require that drivers take their eyes off the road. We employ various alternatives, such as speech-based technologies, to address safety concerns.

## SCENARIOS

Our overall goal is to provide "telematik" (telecommunications and computer science) services to drivers and passengers. What types of services are interesting to our customers and how we serve them are open questions. The Internet appears to be the most appropriate infrastructure through which to conduct car-based services.

Services range from the obvious to the innovative, and include the following:

- Integration of personal data to the car using personal devices such as smart cards and handheld personal computers.
- Interactive audio and video games for passengers.
- Personalized services on demand, for example, personalized commuting information.
- Location-based information on demand, for example, the nearest Chinese restaurant.
- Seamless access to office or home computers.
- Roadside assistance and remote diagnostics.

These services can be grouped as generic and location based. Generic services, for example, real-time stock quotes, are not directly car-related but are of interest to drivers and passengers. In general, the infrastructure for such services can be supported in the same way as a desktop environment.

Location-based services directly relate to the car-driving experience. Because the car moves, its location changes and thus brings new demands for services: Where is the nearest gas station? Location-based services are possible because a car's position can be known at all times with current GPS technology.

An Internet car is similar to any other node on the Internet. Although highly mobile, an Internet car can use the standard transmission-control protocol/Internet protocol (TCP/IP) to communicate with other nodes on the Internet. The Internet car can be a client and a server, and in essence becomes an open platform for services to be delivered over the Internet.

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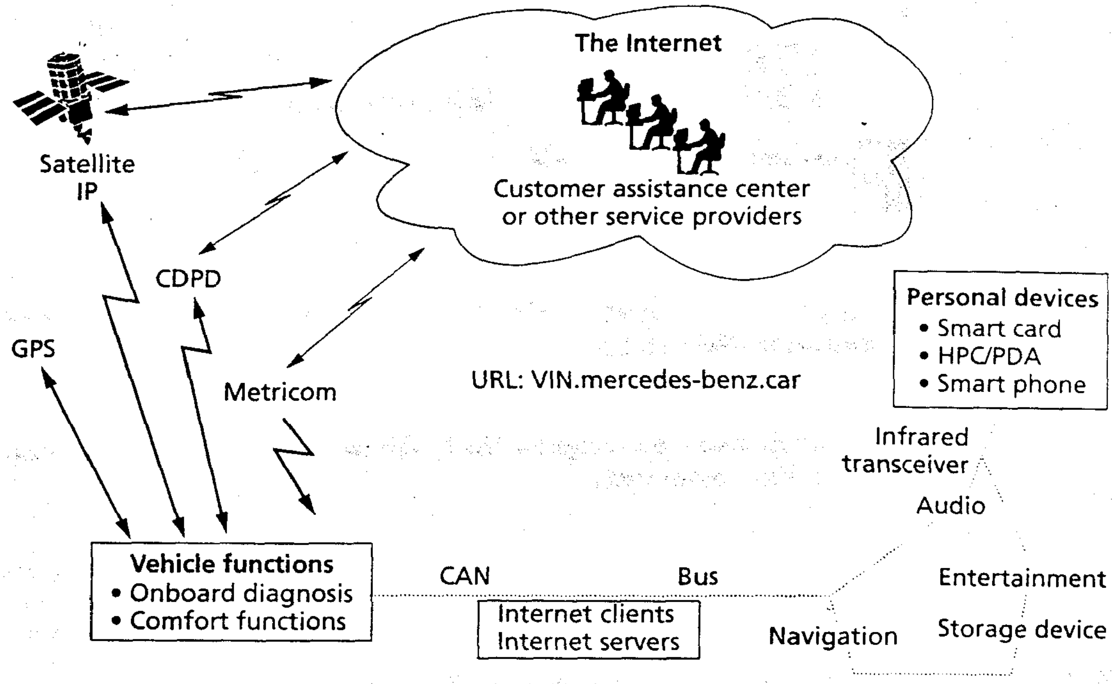


*Figure 1. The Internet-on-wheels concept car integrates a mobile vehicle with services available on the Internet.*

## CHALLENGES

The design of Internet access for automobiles involves three major issues: mobile wireless communications, system architecture, and user interface design.

### Mobile wireless communications

Networking requires a variety of wireless technologies.

In a local area, infrared (IR) and radio frequency (RF) technologies generally provide high-speed wireless access of several megabits per second at relatively small or no cost.

At the metropolitan level, technologies such as Metricom's Ricochet network are capable of access speeds of tens of kilobits per second with a flat monthly fee.

For a wide area, cellular digital packet data (CDPD) and emerging standards, such as the General Packet Radio System (GPRS), achieve speeds of about 10 kilobits per second at a higher cost. Furthermore, a plethora of new satellite-based systems are proposed. When realized, these satellite systems will deliver globally from a few kilobits per second up to one megabit per second at a premium. Of course, when all else fails, the wireless modem over the Advanced Mobile Phone System (AMPS) cellular system is still available.

These technologies provide the basic infrastructure for maintaining access to and from a vehicle. The main challenge lies in selecting the appropriate technology according to such factors as cost, performance, and availability.

### System architecture

In connecting cars to the Internet, a system architecture must provide a flexible distribution of computing power and communication between the automobile and the infrastructure. Basically, a car could be treated as either a thin or thick client. Cars with only input/output devices and a modem to request and receive information are thin clients; cars with state-of-the-art computing power and onboard storage media to receive raw data and to process it are thick clients. The key factor influencing this overall architectural choice is the cost of wireless communication.

The form of the final architecture will be determined by technologies and business models. In any case, the integrity, security, reliability, and speed of communication must be maintained. The software architecture should also allow for the development of new services and benefits that adapt easily to new and evolving Internet technologies.

### User interface

Introducing multimedia information in a moving vehicle creates a potential hazard. A human interface both safe and convenient while mobile at vehicular speeds significantly challenges the utility of services to be delivered over the Internet to drivers. The requirements for a safe human interface also have a drastic impact on the design of services for vehicles.

## SYSTEM DESIGN

The initial intent of the project was to design a system to meet the challenges of wireless communication and the issues relating to a user interface in a car. At the same time, the growth of the Internet and the Web brought to the fore a new way of network computing. The design that emerged from these factors led to the concept of total integration of vehicle functions, personal data, position awareness, seamless access, and Internet-based services. Figure 1 shows this concept, which we call Internet-on-wheels.

Our system design has three major components: the communication layer, the service infrastructure, and the user interface. The reliability, security, performance, and scalability of the system are also essential aspects of our design but are beyond the scope of our discussion here.

### Communication layer

The communication layer must be both open and convenient:

- *Openness.* In today's networking world, TCP/IP is the de facto standard for communication. Most applications use TCP/IP for communication, and many resources and services available on networks are accessible through TCP/IP, including the Web. It therefore must be used in any open networking solution. TCP/IP enables the use of many of today's existing applications, provides access to numerous resources, and encourages new service development. Furthermore, it does not make sense to require the current servers on the Internet to change their software or hardware.
- *Convenience.* Many wireless data communication technologies exist and more are coming. We need to support these technologies without additional burden. First, we need to work with the availability of a technology in a particular geographical region. Second, customers should not have to change the technology they currently use. For example, a user might be a Global Standard for Mobile Communications (GSM) subscriber, in which case the GSM handset should plug into the user's car to enable communication through the GSM network. To provide connectivity anywhere and to account for the coverage of different technologies, one wireless network should be able to hand off to another. We cannot expect a customer to have the technical understanding to manage the handoff, nor can we expect a driver to have the time or attention to deal with such details. Furthermore, a constant identity needs to be maintained. Therefore, the necessary handoff among various wireless networks must be seamless and transparent.

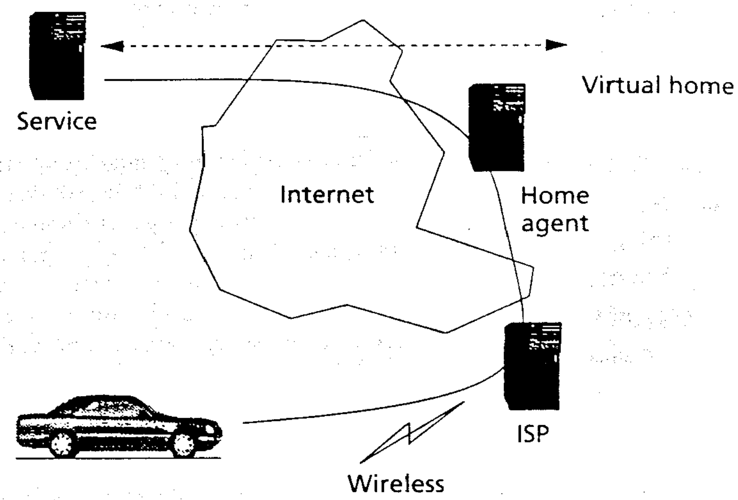


*Figure 2. A typical Mobile IP communication network has a virtual home address.*

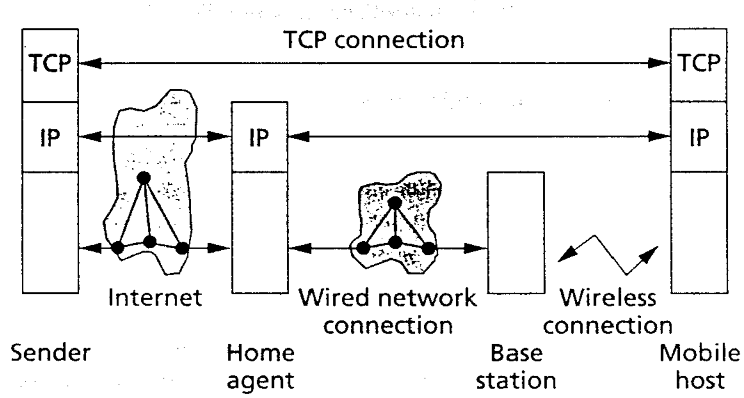


*Figure 3. The basic Mobile IP architecture seamlessly hands off among interfaces.*

We omit performance as a basic requirement of the communication layer. Although we want as much networking performance as possible, our ability to provide this in the communication layer is limited by available technologies and wireless service providers. So we try to provide an architecture that supports as many existing or emerging wireless technologies as possible, but we cannot dictate the performance of those wireless channels directly. Therefore, the application design should adapt to the communication layer's capabilities rather than the other way around. Of course, we will try to improve the networking performance as much as possible in our capacity.

**Basic communication architecture.** With augmented handoff support, the Mobile IP's capability of maintaining the same identity over various network access points provides a natural solution.[1,2] Mobile IP supports

**Services for an Internet car are bidirectional. In the more common services, the car acts as a client and the service infrastructure supports such services.**

a seamless handoff among multiple wireless interfaces in a manner that is transparent to the higher layers.

Figures 2 and 3 show the workings of the proposed Mobile IP. As Figure 2 shows, the vehicle has a virtual home IP address. Any service provider or corresponding host would always see the vehicle at that IP address, which is connected to the Internet at large via a home agent.

The vehicle connects through a particular wireless network and an Internet service provider (ISP) and uses an IP address issued by the ISP. The vehicle registers its current address with a stationary host known as its *home agent*. In communicating with a service provider, the incoming IP traffic from the service provider would be intercepted by the home agent and forwarded to the current address of the vehicle. Likewise, all traffic to the service provider would be sent to the home agent before being forwarded to the service provider.

In the event of a handoff from one wireless network or ISP to another, the actual IP address of the vehicle changes. Such a change would be reported to the home agent, and all subsequent IP traffic would be routed to the vehicle at the new address. None of these activities is visible from the applications that use the communication layer.

**Communication performance.** Two issues affect performance in this environment: TCP performance over wireless links and the handoff from one wireless network provider to another.

TCP[3] was designed to work for the wire-line-based Internet, which rarely creates errors in the transmission of IP packets. In such an environment, TCP assumes that failure to receive a packet results from congestion. In the event of a packet loss, TCP slows and sends fewer packets to lessen the congestion. Such an algorithm works well in the wire-line network, but not so well over the wireless link. However, when a TCP connection includes a wireless link, packet loss is far more likely to be caused by errors in a wireless channel. Consequently, TCP data should be sent faster, not slower.

The networking research community has done much to improve performance over lossy wireless links. In general, the proposed solutions fall into three groups:

- An end-to-end connection is intended to improve TCP performance relative to that of wireless communication.
- A split TCP connection divides a TCP connection into two end-to-end parts.
- The reliable link layer has some knowledge of the TCP.[4]

The end-to-end and link-layer solutions work comparatively well. However, any end-to-end solution requires changes at the TCP layers of both the sender and the receiver. All servers on the Internet that our customers might contact cannot be expected to upgrade their TCP software, leaving the link-layer solution as the most feasible measure for improving TCP performance.

One link-layer solution employs a *snooping agent*.[5] A snooping-agent observes and caches the TCP packets going out to the mobile host on the wireless link. When the agent senses that some packets are lost (by monitoring the acknowledgment packets coming back from the mobile host), it retransmits the cached TCP packets. In this way, the snooping agent effectively prevents the effect of packet loss on the wireless link from being propagated to the TCP sender and triggering a TCP slowdown.

The snooping-agent method works well in a wireless local area network (LAN), in which the snooping agent sits in the wireless base station. For wireless wide area networks (WANs), the snooping agent must be placed a little further away from the wireless link. The logical location would be that of the home agent through which all traffic goes. Our research will focus on the snooping agent's impact on performance relative to its distance from the vehicle.

The issues concerning handoffs and their effect on communication performance are twofold. First, handoffs exist among cells in a wireless network infrastructure. Although transparent to the mobile host, the handoff's impact on the communication layer performance is unclear. Second, the handoff from one wireless network provider to another has a much larger effect. During the change of an actual IP address, the registering of the change to the home agent, and finally the rerouting of traffic to reflect the change, some IP packets might be lost.

The impact of such a handoff could be lessened by holding onto the existing wireless connection and simultaneously routing the same packets to the new address as well as the existing one. With the new connection fully operational, the previous connection closes. The vehicle has the advantage of knowing where it is and where it is going to be and at what time.

Combining such information with the knowledge of where the coverage of a wireless network begins and ends, a new connection can be preestablished before the current connection runs out of coverage. Such information might be cached by the vehicle through the experience of driving in a familiar region, for example, a daily commute from home to work, or it could be provided by service providers that measure and collect the coverage of various wireless data networks.

**In-car network.** Most of the automotive industry supports some types of bus architectures for control

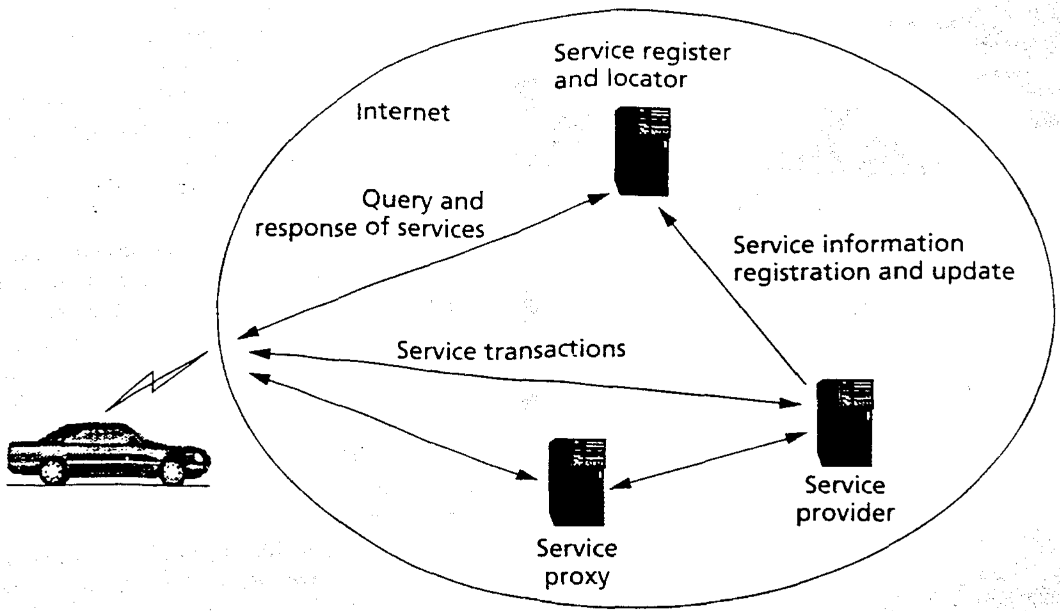


*Figure 4. The service architecture design contains these high-level components.*

and data transmission. A bus system with bandwidth large enough to support multiple video and audio channels is needed to support the Internet-based multimedia information in the car. The Universal Serial Bus (USB), the IEEE 1394 standard Firewire, or the Intelligent Transportation System Data Bus (IDB-I and IDB-II) could be considered for such a task.

Multiple inputs and outputs—such as screens, control units, and audio channels—must be available for use by all occupants in a car without any interference with each other. This flexibility is relatively easily achieved for screens and control units, but it is harder to separate audio sources without using headphones.

Merging the in-car network with Internet communication services will provide an integrated internal and external environment for the occupants. A multimedia infrastructure in a vehicular environment challenges the design. The storage media is an essential component of an Internet information-based multimedia environment in a car. At a basic level, the media might be just a cache or simply a readable media such as the minidisc or digital video disc, but the ultimate solution will be a hard-disk-like unit for storing large amounts of data that can be dynamically changed.

Docking of personal devices has wide acceptance in the personal computing arena. People will likely use devices such as smart phones, smart cards, and personal digital assistants (PDAs) to integrate with the car's multimedia system. These devices might also be a means through which to exchange personal information between the occupants and the car for seat adjustment, climate, and computer interface.

### Service infrastructure

Services for an Internet car are bidirectional. In the more common services, the car acts as a client and the service infrastructure supports such services.

**Service infrastructure functions.** The service infrastructure has four main functions: It must search for service providers, manage the user profile, deliver the service, and use the service. Here we will not discuss issues like billing and so on.

A location-indexed database is necessary if the car occupants are to easily search geographical location-based services. The database must contain things like service providers, Web pages, and other information, indexed by the relevant geographical area. The vehicle's location determines the scope of the search.

A service profile specifies what and how services will be delivered to the customers in an Internet car. The service infrastructure provides storage and management of a customer's service profile.

After selecting a service provider, the communication layer offers data transport functions. However, the ability of the devices in the car to use the service content must be determined. For example, large images of a Web page cannot be displayed on a tiny PDA screen. Service delivery also needs to adapt to wireless link capabilities. A service proxy works well in such a situation.[6] By doing data transformation at the well-connected side of the Internet, the data load can be reduced and something easy to present can be created. By symmetry, a car-side proxy for the vehicle must act as a server in certain applications like remote diagnostics.[7]

The need to support ad hoc service types and service providers means that we need to support automated downloading, installation, and update of client software for future, unknown services.

**Service architecture design.** Figure 4 diagrams the high-level components in the service architecture.[8] The service register and locator is essentially the location-indexed database. This database accepts and responds to queries from the vehicle for services and service providers. Once a customer finds a service provider, services can be requested and transactions begun. Such service transactions might go through a proxy.

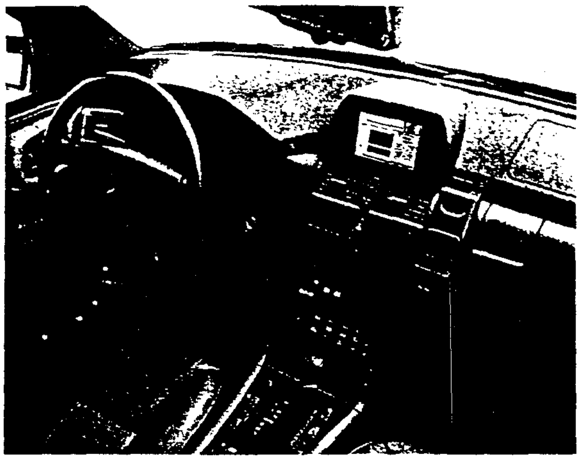

*Figure 5. The front multimedia zone of the Internet car is accessible to both the driver and the navigator.*

*Figure 6. The rear passengers have access to multimedia units that contain screens, channel selectors for games, a computer, navigation tools, infrared transceivers, and audio outlets.*

Placement of the user profile and determination of the component responsible for the profile management must be determined. This is essentially the issue of how to distribute the intelligence in the system.

### User interface design

There is no precedent for the user interface of a Web car. Obviously, there are safety issues involved in the placement of screens, hand control units, hands-free phones, and buttons.

User interfaces can range from a simple one-touch operation to a fully interactive audio and video experience. Clearly, the driver, navigator, and passengers have differing circumstances when the vehicle is parked or in motion. A taxonomy of the driver, navigator, and passengers with different human interface needs is a good starting point to understand the basic differences in the design of interfaces for these positions.[9]

Drivers might find a primarily speech-driven interface most suitable, whereas passengers and navigators can use a richer and more interactive interface. We expect that a conversational, dialogue-based speech system will be used in the future.

Large speech-recognition systems, especially those that support natural-language processing, are expensive and difficult to support in cars. Therefore, a network-based solution makes sense. Such a solution is well suited to a dynamic, on-the-fly vocabulary, and conversational natural-language processing approach, and it is cheaper to maintain and upgrade. A hybrid between in-car recognition for the car controls and a network-based approach for external information-based services would be ideal.

The type of user interface chosen will be closely tied with the nature and type of services that can be delivered to drivers and passengers. Mobility is no longer only driving the car but incorporates also the states of being at home, in the garage, on the road, and at the destination. A driver's *safety* depends on the state of *mobility*, the *time* available, and the driver's *goals*. We intend to define a metric on the basis of the relationship between these four human factors and the services that can be delivered to car drivers and passengers.[9] This metric will be used to define user interfaces that are safe and match the measures used by Mercedes-Benz, the Society of Automotive Engineers, or similar established safety standards. See Figures 5 and 6.

The presentation and user interface architecture shown in Figure 7 assumes that content providers supply the data and the semantics to describe the architecture's structure. The presenter uses this information along with the user input and status information (vehicle speed, user being the driver or passenger) to render and deliver content to appropriate output devices.

## CONCEPT DEMONSTRATION

In the first implementation of the Internet-on-wheels concept car,[10] we designed multimedia units for two different zones (*drivers* and *passengers*) with the user interfaces as shown in Figures 5 and 6. Each of these has a color screen, channel select buttons, an infrared transceiver to support handheld devices, and an audio outlet.

Access to applications differs in these two zones. The driver and the navigator have access to a single multimedia unit in the front (Figure 5), and the passengers in the back seat have access to individual multimedia units (Figure 6). The demonstrative applications in the front zone access information related to traffic and navigation. In the rear zone, access expands to include navigation tools, office applications, interactive games, and infotainment.

*Drivers* can access voice-mail, e-mail, and travel-related information such as restaurant guides and movie theater locations. By integrating the GPS and mapping technologies, the Internet car becomes location-aware, which allows for a new class of services that go well beyond classical navigation. The driver will have access to these services in a hands-free, eyes-free manner through voice commands and speech technology. In addition, the armrest in the driver's zone has a slot for a personal device to enable the driver to bring in personal preferences.

*Passengers* can access richer interactive applications such as onboard or Internet games, audio-on-demand, and the Web. They can access information about cities

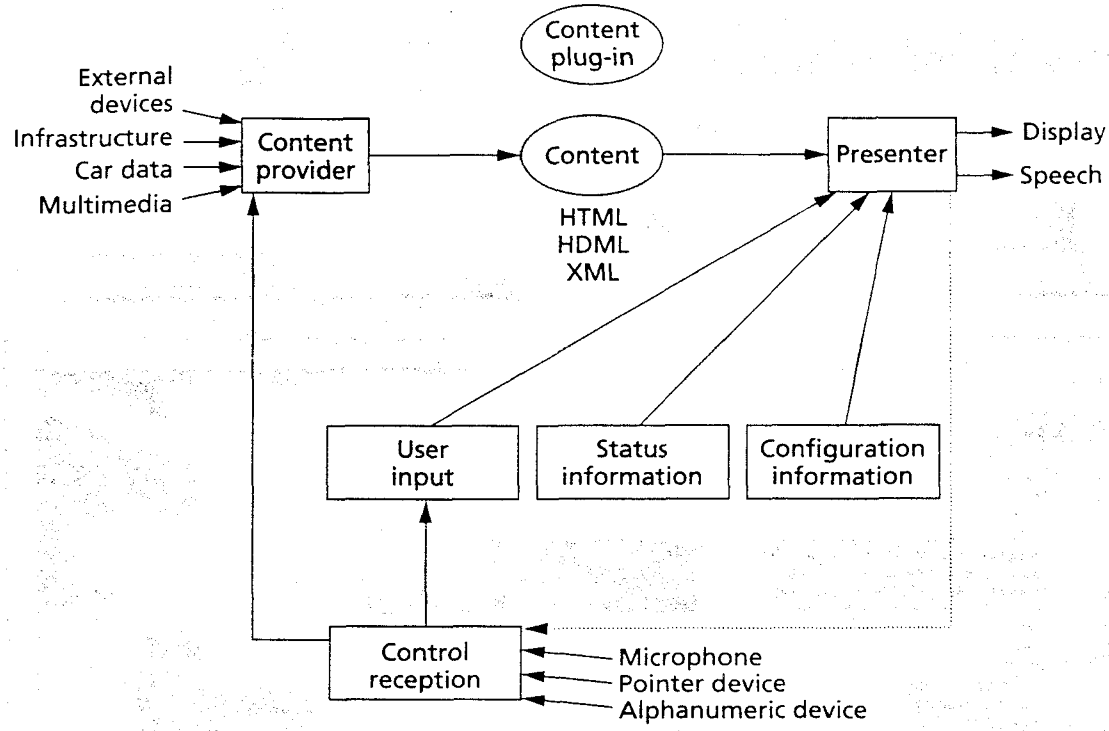


*Figure 7. Content providers define the data and semantics for the presentation and user interface architecture.*

and historical places during a drive as they pass them. Passengers can also enjoy an enhanced multimedia environment for navigation, stereo, or streaming audio and video. The built-in infrared transceivers will allow PDAs, handheld PCs (HPCs), and smart phones to interact with the systems in the car and the Internet. For these new services, user interfaces will allow easy and safe handling of the interactive media.

For the customer assistance centers that currently rely on telephony-based service, the Internet car provides an expanded datacentric multimedia environment to deliver new services, including operator's help manuals, intelligent roadside travel assistance, and remote diagnostics.

The intelligent transportation systems community intends to stimulate research and industry to build an infrastructure that will lead to better traffic and transit resource management and enhanced safety. From the perspectives of cost and reusability, a single infrastructure must provide most of the functionality as opposed to a separate infrastructure for each service. The Internet has the potential to be such an infrastructure. The car acts essentially as a probe in this model, collecting and sending data to service centers, which in future navigation systems will be used to build dynamic real-time traffic models for on-demand route guidance for individual vehicles.

The spectrum of service possibilities ranges from a highly integrated, PC-like environment to a fully autonomous network computer-like system. A safe and convenient human interface design will leverage the vast pool of potential services from the Internet for drivers and passengers.

Our research aims to investigate and prototype future Internet-based services for cars. By grounding the concept and architecture of information technology for a car around the Internet and open standards, the Internet car can take full advantage of the tidal wave of Internet-based services, technologies, and devices for many years to come. ❖


### Acknowledgments

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LOCAL NEWS / WEATHER / EDITORIAL PAGES

METRO

SECTION B

MONDAY

FEBRUARY 20, 1995 CCt

Los Angeles Times

STREET SMART RICHARD SIMON

# Camera Gains More Exposure as a Device for Traffic Control

*"When it's least expected,*
*You're elected,*
*You're the star today,*
*Smile . . . you're on 'Candid Camera!'"*

They're everywhere. On freeways. On city streets. At train crossings. In the subway. And maybe soon on buses.

Indeed, in Southern California's transportation network, cameras are becoming as common as freeway call boxes.

The freeway cameras may be used one day to monitor what the state Office of Traffic Safety says is a "growing problem with commuters eating, reading, changing clothes, brushing their teeth and generally paying less than full attention to the road."

But don't worry. They're not used for that—yet.

New York City is using cameras to catch drivers running red lights, and other cities are using them to nab speeders. But in Southern California, where officials are wary of a public backlash to Big Brother government, the cameras have largely been used to help identify the cause of traffic jams.

"Privacy is the biggest issue in our way of spreading this program across the nation," said Wayne Porter of Electronic Data Systems, which set up the surveillance system in New York.

Local transit officials, however, are gearing up to expand use of cameras along the Blue Line route between Los Angeles and Long Beach to catch drivers who pull around lowered gates to cross the tracks. Photos will be taken of the drivers and their license plates. Violators

Please see CAMERAS, B3

BOB CAREY / Los Angeles Times

Al Romero adjusts freeway cameras from Caltrans headquarters Downtown.

# CAMERAS: Traffic

Continued from B1

will receive tickets in the mail.

The Metropolitan Transportation Authority is prepared for negative public reaction: The cameras are in bulletproof containers.

Transit officials also are exploring placing cameras on buses to deter crime. And Pasadena (which once posted a sign reading "Smile, you're on photo radar") is trying to revive the use of cameras to shoot—figuratively, of course—speeding motorists.

Caltrans has about two dozen closed-circuit cameras on Los Angeles freeways but plans to triple the number within a few months and eventually install 400.

The pictures are sent to a control center in Downtown Los Angeles, where workers seated in front of a bank of screens can quickly spot an overturned big-rig or spilled load of oranges, dispatch a cleanup crew or tow truck and pass on warnings to traffic reporters.

The cameras can zoom in on cars, but close-up shots produce a fuzzy picture. "You can't see inside the cars," said Joseph Brahm, a senior transportation engineer for Caltrans, offering assurances that the cameras are used only for traffic control.

Albert Romero, a Caltrans employee who works in the traffic control center, said he once spotted a motorist stranded in the middle of the freeway and alerted the CHP. The driver turned out to be a carjacker.

But most of the time, sitting in front of the monitors is like watching one rerun after another. Nothing but cars and more cars, interrupted by an occasional jackknifed truck or car chase.

Sometimes, Romero relies on commercial TV for the best view of freeway trouble. When O.J. Simpson led police on his famous freeway chase, Romero said, "I was home, fortunately." Telecopters provided a better view of the action, anyway, because Caltrans doesn't have enough cameras on freeways.

The city of Los Angeles has cameras at about 70 major intersections and plans to install up to 150 within the next few years.

The city cameras work much the same way as the freeway cameras.

Sensors in the ground signal to an electronic map in the city's traffic control center when a street is congested. The cameras let traffic engineers know why.

The MTA is planning to install cameras along the entire Blue Line route. Cameras were installed on a test basis at several locations in 1993 after 22 motorists and pedestrians were killed trying to beat trains across the tracks.

During a six-week trial, the MTA sent out 520 tickets—and that was just to motorists caught crossing tracks illegally at one location, Washington Boulevard and Los Angeles Street in Downtown Los Angeles.

MTA officials say the cameras have greatly reduced collisions between cars and pedestrians. In addition to an average $250 fine, violators can be ordered to attend traffic school and watch a film on rail safety.

But one problem during the trial run was that about one-fourth of the violators got away because they didn't have front license plates to photograph.

The transit agency also uses more than 100 cameras to monitor behavior at Blue Line and subway stations.

Three workers are assigned full-time to watch the screens. When they observe somebody disobeying the rules, such as standing too close to the edge of the track, they can bark out orders over an intercom.

A few years ago, Pasadena used a single camera around town to catch speeders. But the program was discontinued when it ran into funding problems and other difficulties.

The camera would photograph a speeding vehicle's license plate and the driver.

The city has looked at seeking state legislation that would make a photo-radar speeding ticket like a parking ticket. Parking tickets are deemed the responsibility of the owner of the car, not the driver.

That is what is done in New York where cameras were installed in December, 1993, at 18 intersections to catch cars running red lights. Photos of the vehicle's license plate, the traffic light and the street name are sent to the car's registered owner.

New York City officials consider the program a success.

The first year, the cameras were responsible for 182,731 tickets.

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# Smart Surveillance Gadgetry Redefines Policing, Lifestyles

By Leslie Alan Horvitz

**Law-enforcement authorities are singing the praises of increasingly sophisticated surveillance equipment, while civil libertarians are bemoaning the fact that Big Brother is expanding his field of vision.**

This summer's Olympics in Atlanta will sport one of the most intensive surveillance efforts ever mounted in the United States. "The most high-tech feature is a sensor ID," says Louis Chiera, a marketing director for Sensormatic Electronics Inc. of Deerfield Beach, Fla., which designed the system. Every person accredited to the games — about 200,000, including 15,000 athletes and coaches — will carry a badge containing a computer chip "that holds all the information about that person and what venues they're allowed into." The badge, read automatically by electronic scanners at entrances to various venues, includes a map of the individual's hand to verify his or her identity.

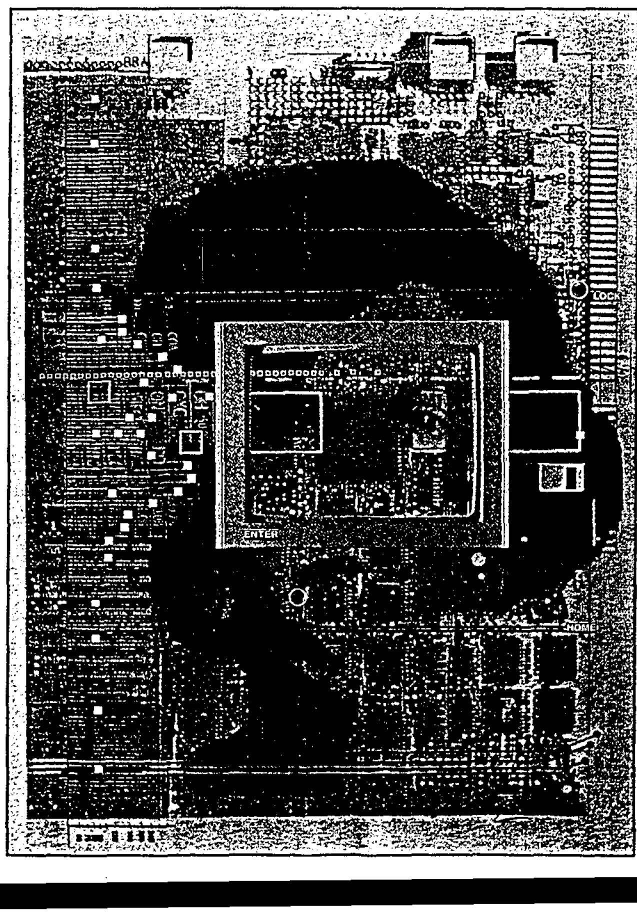
Not all of this equipment will be removed once the games end in August. "We hope that people who will take control over these venues will want to have this technology," says Chiera. Predictably, some observers find this phenomenon disturbing. "You can assume that the dividing line between overt and covert surveillance will disappear," says Simon Davies, director-general of Privacy International, a London-based surveillance watchdog group. "Because the authorities have successfully argued that there is no private right in a public space ... you should assume that at any point you could be surveilled."

Already, closed-circuit TV, known at law-enforcement agencies and private security companies by its acronym CCTV, has found its way into phone booths, buses, trains, taxis, elevators and automated teller machines. In Britain, its use is widespread: CCTVs equipped with powerful zoom lenses have been installed in more than 100 town centers. Originally intended to curb assaults, car-jackings and burglaries, CCTV is helping police arrest people for underage smoking, littering, parking-meter evasion and public urination.

U.S. law-enforcement agencies have not adopted CCTV to any great extent, but private companies are using it — even installing cameras inside ordinary office equipment. "That's right," runs an advertisement for one system, "you can install the MicroSwitcher PLUS system in the receptionist's computer, the CEO's office, the shipping department or anywhere else a PC is located."

CCTVs, together with microwave and electronic sensors, also are used on U.S. freeways as part of the Intelligent Transportation System, or ITS, which the federal government hopes to deploy in 75 metropolitan areas by 2005. ITS is intended to smooth the flow of traffic, cut down on pollution and facilitate emergency response. Unlike British towns, ITS uses low-resolution cameras; while such instruments can identify an accident or traffic jam, they are incapable of reading license plates.

But the future of surveillance is unlikely to be dominated by closed-circuit TV. Security systems are expected to rely increasingly upon biometrics — computerized measurement of physical characteristics. Fingerprinting is a familiar type of biometrics, only now it can be conducted with scanners instead of ink. New technologies exploit unique patterns found on the retina or iris of an individual's eye, as well as variations in voice, handwriting and even typing. And, of course, there's the genetic blueprint of DNA.



THE STOCK ILLUSTRATION SOURCE

Machines now can read facial thermograms — computer images created from the heat radiating from a person's face — and compare them with those stored in its memory. Not to be outdone, two researchers at Tufts University outside Boston are developing a sensing system based on body odor. All these technologies seek to eliminate the need for ID cards, passwords and personal-identification numbers, which can be lost, stolen or compromised.

The uses for this technology seem unlimited. Although politicians speak in hushed tones about the prospect of introducing national identity cards, the government already eagerly consumes biometrics systems. The U.S. Immigration and Naturalization Service, for instance, recently introduced a program called INSPASS to make it easier for 70,000 selected frequent fliers to clear customs. Rather than wait in a long line, the lucky passengers simply enter a kiosk where a scanner records the contours of their hands and compares them to a template encoded on a smart card in their possession. If the passenger's identity is confirmed, he or she can pass through customs in less than 40 seconds.

State governments are acquiring biometrics systems to combat welfare fraud. One company would identify Connecticut welfare recipients by iris image. (It is hoped this method will seem less intrusive than fingerprinting.) Another has proposed a biometric index in which welfare recipients would be grouped by gender, eye color, approximate age, height and weight. Clients would collect benefits along with people of similar characteristics (heavyset men over 45 of average height with brown eyes) in an effort to prevent double-dipping. So far, the index has no takers.

Exactly what technologies will prove popular is unclear. "Most of our customers — primarily law-enforcement agencies — are still naïve about the technology," says Peter Yeich of Primtrack, a California company that produces sophisticated fingerprinting scanners that cost as much as $70,000. "When they are comfortable with how technology works for their application, then the industry will expand."

But civil libertarians and privacy experts are concerned not only about the scope of such technology but also about the secondary uses of surveillance-related data. According to Roger Clarke, an independent consultant and visiting fellow in information systems at Australian National University, "multiple organizations may get together and pass information among themselves and coordinate the way in which they deal with individuals."

Such fears, while legitimate, may be exaggerated, says Phil Agre, professor of communication at the University of California, San Diego. "It's unlikely that all this data will be stored in one database system," notes Agre. "The organizations that use data on individuals are too various in their purposes, in their technical means and in the vocabulary they use to define their data in the first place." He acknowledges that it will become easier to merge data from different sources. "Credit-reporting agencies such as TRW and Equifax clearly seem to want to expand their business to store other kinds of data besides credit reports," he says. "If we're looking for some candidate for centralized dossiers on individuals, it would probably be credit-reporting agencies."

Agre points out that the United States is the weakest of the industrialized nations in terms of privacy protection. "We have a patchwork of special-purpose laws that are restricted in scope and that usually do not provide a great degree of protection," he says. "The Privacy Act, for instance, only pertains to the government and normally not to private industry, and even then it's routinely flouted by the government."

ITS America, the Washington-based coordinating body of the intelligent transportation system, maintains that the data it collects will not be used by law-enforcement agencies or for marketing purposes. According to Jay Bockish, a senior engineer for advanced traffic management, ITS won't store data as telephone companies do phone records. But he admits that critics have justifiable concerns. "When information is gathered on an aggregate basis [such as 300 cars an hour going through a particular toll booth], there's no problem," he says. "But when we say Bob Jones went through at quarter of two in the afternoon, there's potentially a problem." He also points out that if someone wishes to remain anonymous, the person simply can opt to pay cash rather than rely on electronic tags or identity cards. Moreover, most intelligent highway networks are being funded by taxpayer dollars. Says Bockish, "If the public doesn't see the benefit, this stuff won't get funded."

Just how does the public see the issue? Recent surveys suggest that Americans are ambivalent about privacy and surveillance. While most seem to want their privacy protected, they also expect benefits that require their privacy to be compromised. Respondents, for instance, posed no objection to companies issuing them credit cards based upon their bill-payment records. A 1991 Harris-Equifax Survey found that a solid majority of respondents, whom they labeled "privacy pragmatists," recognized that they stood to benefit when public agencies and private firms have access to certain personal information.

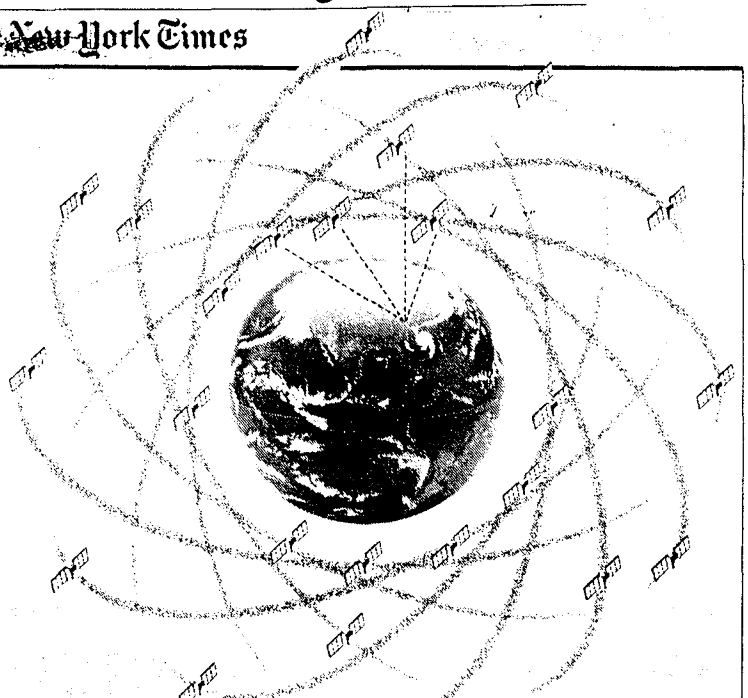
Maybe so, Agre says, but when he looks at the results he sees a different story: "The polls suggest that people have a high degree of concern but a low degree of awareness about threats to privacy. They know a lot of information is obtained about them but they don't know what happens to it or what their legal rights are." •

Business Day TUESDAY, MARCH 5, 1996 z C1

The New York Times

## Where On Earth

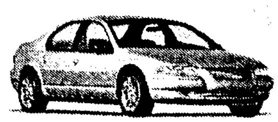
The Air Force's Global Positioning System consists of 24 satellites, equally divided among 6 orbits. Each satellite, which is 11,000 miles out in space, continuously emits a radio signal that can be received by portable computing devices on land, on sea or in the air. By picking up the signal from four or more satellites, the computer can determine the user's location within 20 to 300 yards of the exact position, depending on how finely the unit is calibrated.



The New York Times
Source: Trimble Navigation

## How on Earth

Although the Global Positioning System was designed in the 1970's for military purposes, in recent years the system has become more widely used for civilian navigation of various types, including these:



- Truck-fleet management
- Police, fire and ambulance dispatch
- Car dashboard navigation systems

- Air-traffic control
- Airplane navigation
- Location of downed aircraft

- Hiking and mountain climbing
- Wilderness search and rescue
- Relocating a favorite fishing hole

- Harbor traffic control
- Off shore oil searches
- Pleasure-boat navigation

# Finding Profit in Aiding the Lost

## A Civilian Industry Is Built on the Military's Locator Technology

By JOHN MARKOFF

It is a navigational system designed in the 1970's to guide troops and missiles, but in the 1990's it has come to be used far more often for helping truckers, boaters and hikers find their way.

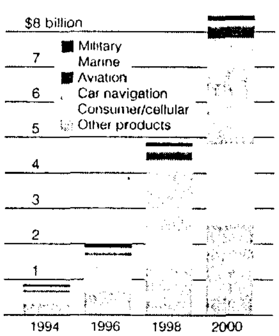
So in an example of beating swords into sextants, the White House is about to announce a policy for insuring continued civilian use of the Air Force's Global Positioning System — a 24-satellite network that enables users with small portable radio receivers to determine their precise location anywhere on land, sea or in the air.

The White House policy statement would for the first time detail the rights of use for the commercial G.P.S. industry, thus removing the longstanding implicit threat that military priorities could disrupt the civilian navigational system at any time. By bringing a new measure of certainty to a business that has so far developed ad hoc, analysts and executives in the industry say the market for the receiving equipment and services could quadruple to $8.4 billion a year by the end of the decade.

"The fact is that there has been silence from the Government while G.P.S. applications have jumped ahead of policy," said Scott Pace, an author of a recent Rand Corporation study that was commissioned by the White House. The study recommended that national security concerns not interfere with the vast commercial opportunities available with the satellite system.

### The Sky's the Limit

Estimated sales of American-made products for use with the Global Positioning System.




Source: United States Global Positioning System Industry Council

The New York Times

"A stable and clear policy needs to be presented to help with both public and private decision making about G.P.S. systems," Mr. Pace said.

Industry executives are enthusiastic about the policy statement, which White House officials say is being prepared by the Office of Science and Technology Policy and is expected to be released by President Clinton within a few weeks. The document will commit the United States to continuing to finance the positioning system for the foreseeable future and make it available for use internationally without the imposition of user fees or other commercial restrictions.

"The commercial industry is poised to explode," said Randy Hoffman, president of the Magellan Systems Corporation in San Dimas, Calif., a leading maker of commercial navigation equipment. "The Presidential policy will bring stability to the market."

A crucial part of the new policy is expected to be the eventual phasing out of a national security proviso known as selective availability — a crucial restriction that has limited the use of the technology for some civilian applications requiring a high degree of precision, like all-weather airplane landings.

When the military uses the system, as it did in troop positioning in the desert during the Persian Gulf war, the communications with the satellites are done via scrambled radio signals that are useless to anyone not privy to the code. These signals allow almost pinpoint accuracy, so that a tank on the ground or a fighter jet aloft can determine its position within feet. But the commercially available satellite signals, which are not scrambled, are modified to allow accuracy only within several hundred feet — to keep potential foreign enemies from employing the signal to precisely

Continued on Page C3

# Finding Profit in Helping the Lost, Using Military Technology

*Continued From First Business Page*

aim their own weapons.

The "selective availability" policy has, in effect, deliberately blurred the vision of the civilian G.P.S. frequencies. And it has also given the United States the option of interfering with even the unscrambled signals at any time, if deemed necessary by mililtary strategists. But that limitation and the uncertainty of the situtation will eventually be removed.

Longstanding Pentagon opposition to the combined military and civilian use of the technology has subsided as the Defense Department has concluded that selective availability is not the only, or even the best, way to deny hostile military forces the advantages of the location system.

"My feeling is that in the future the U.S. Government will design military G.P.S. receivers so they are able to operate in a radio jamming environment," said Michael Swiek, executive secretary of the United States G.P.S. Industry Council, an industry group devoted to commercial development of the technology.

As part of the White House policy statement, officials say, the Government will announce that it will work with foreign governments to devise a series of regional agreements aimed at developing standard ways to enhance the accuracy of the positioning signals and to insure that the signals cannot be used by hostile forces.

The move will clear the way for the Federal Aviation Administration to proceed with its recent decision to adopt the technology as a supplemental means of navigation domestically and as the primary means of navigation over oceans. The agency is also developing an enhanced system known as the Wide-Area Augmentation System, that will sharply increase airline navigational accuracy over the one- third of the globe centered on the United States. The system will allow commercial airliners to fly more direct routes to their destinations beginning in 1998 and by the year 2001 will permit instruments-only approaches to as many as 8,000 airports — up from fewer than 1,000 today.

*Commerce overtakes the Pentagon in using satellites as navigation aids.*

The new White House policy is an attempt to overcome reservations by European and Asian governments about supporting commercial development of an industry that would rely on what has until now been seen as primarily an American military system. And yet, the policy is intended to maintain the technological leadership of the United States in this area and discourage foreign attempts to develop competing systems.

Already, a Russian network of 24 satellites, known as Glonass, is in operation, with no artificially introduced limits on accuracy, but as yet there are no low-cost receivers being sold for use with Glonass.

Although the Air Force's complete 24-satellite system did not go into full operation until last year, the first civilian uses began more than a decade ago. In 1983, after a Korean Airlines jet that strayed into Soviet air space was shot down by the Soviet Air Force, President Ronald Reagan announced that the United States would make the fledgling system available for civilian aviation. He established the Department of Transportation as the civilian agency that would share management responsibility for the system with the Pentagon.

By the late 1980's, trucking companies and ship fleets had begun to use the satellite-based navigational systems, even though the receiving gear cost tens of thousands of dollars. But by the time of the gulf war in 1991, consumer models of hand-held receivers cost $1,000 or less. That meant that while military commanders were using the sophistiated scrambled-signal systems for strategic and tactical planning, American troops were using inexpensive receivers simply to find their way around the sands of Kuwait and Iraq.

As the expense of such systems has plummeted in recent years — aided by the falling cost of micro-electronic components — dozens of new applications have begun to emerge. It is now possible to buy a hand-held receiver in a sporting goods store for back-country hiking for less than $200, and the price is expected to continue to decline. Designers are now focusing on a range of innovative applications that include embedding G.P.S. receivers in hand-held cellular telephones and portable personal computers.

Car makers and car-rental companies have made dashboard navigation systems available for several years. One system now under design would link a G.P.S. receiver to both the car's airbag and its cellular phone. That would permit the automobile to instantly and automatically signal its location in the event of an accident.

Today the market is split into different segments. The **Magellan Systems** Corporation is the dominant player in the hand-held and recreational market, while **Trimble Navigation** Ltd. is perceived as the overall technology leader in industrial and business markets ranging from mapping systems to vehicle navigation. **Motorola** Inc. is also a major player in the vehicle navigation market, while the **Rockwell International** Corporation is the leader in military sales and also in vehicle navigation. **Honeywell** Inc. is a leader in aviation systems. Smaller companies like **Ashtech** Inc. based in Sunnyvale, Calif., have focused on such specialized markets as surveying and seismic monitoring where high accuracy is required.

Japanese electronics companies are also active in the market, including the **Sony** Corporation, which has focused on car navigation, and the **Matsushita Electric Industrial** Company, which is active in the recreational market with products bearing the Panasonic brand.

On the horizon are applications for the handicapped and elderly. For example, one system now being developed would act as an electronic guide, using synthetic speech to allow a blind person to navigate independently.

Other uses include emergency location systems for Alzheimer's patients and systems that permit tracking of vehicles like ambulances and vans that transport the elderly.

Other, less serious applications appear to be limited only by the designer's imagination. For example, golf carts available at 30 courses around the country are equipped to provide precise data on how far a ball is away from the hole, using a system developed by Proshot Golf of Newport Beach, Calif. Call it the G.P.S. caddy: the system, using software that relies on recommendations from pros, advises the techno-duffer on which club to use for the next shot.

SUNDAY RECORD
HACKENSACK, NJ
SUNDAY 246,000
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BURRELLE'S

# It's so E-Z

*The computerized E-ZPass toll system not only helps speed traffic, it's aiding law enforcement as well. But are E-ZPass databases encroaching on motorists' privacy?*

By ROBERT GEBELOFF

IN THE HOURS AFTER Saddle River millionaire Nelson Gross was abducted, investigators turned to a new kind of informant: E-ZPass.

The automatic toll system's database showed police that Gross had crossed the George Washington Bridge twice on Sept. 17, a tip that eventually enabled investigators to recover his abandoned BMW on an Upper Manhattan side street.

Police now consult E-ZPass records frequently in their pursuit of bad guys — at least 35 times in the last few months, according to transportation officials. The temptation to resort to such computer-aided detective work is likely to increase with the wider use of automated toll and navigation systems that create a record of where people go in their cars.

These transportation technologies provide convenience for motorists and a new investigative tool for police, but they also raise unprecedented privacy issues. Just who can peer into the E-ZPass database, and for what purpose, has become a hot topic among privacy activists and civil libertarians.

Today, it might be a police detective tracking down a suspected murderer.

But tomorrow, it could be a private eye documenting liaisons between a philandering husband and his paramour. Or a teenage hacker who breaks into the system for kicks and posts the travelogs of his junior high school teachers on the Internet.

"Right now, there might be just one database somewhere keeping track of bridge crossings and that doesn't look like a giant threat to civil liberties," says Phil Agre, a leading authority on technology and privacy issues at the University of California-San Diego. "The real problem is in the pattern that is emerging."

Government officials who keep E-ZPass records insist they will guard the data's confidentiality. But they've already had to backtrack on one promise — that they would only release E-ZPass data if ordered by a judge.

As a result of a July court ruling in New York, police need only demonstrate that they are investigating a "serious" crime. And some critics believe official promises to withhold the information from others, including private detectives and marketing companies, will not be honored.

This belief is based partly on a Murphy's Law-type philosophy adopted by privacy experts over the years, that almost all databases will wind up being used for purposes other than the one for which they were originally intended.

"When you have any record system or database that is created for one purpose, the privacy analyst always asks, 'Will it be used for any other purpose?'" says Alan F. Westin, a Columbia University professor who has studied privacy for 40 years and publishes the Privacy & American Business newsletter in Hackensack.

Westin says a 1995 poll he commissioned found that 80 percent of the public believes that consumers "have lost all control over how personal information about them is collected and used by companies."

**Tracking shopping, reading habits**

The volume of consumer data being gathered is already extraordinarily extensive. Anyone who uses a discount card at a supermarket is creating a detailed archive of personal purchasing habits that marketers use to refine the sales pitches people receive every day in their mailboxes.

The magic of Madison Avenue has become quite sophisticated. New parents are likely to receive offers for products related to infant care just days after the baby comes home. A subscriber to a computer magazine is guaranteed a steady supply of trial software from online companies.

With transportation systems collecting information, a shopping center might try to get a list of people who drive past it to and from work. Or a store might want a list of people who pull into a competitor's parking lot so they could be targeted with a new round of junk mail.

In this environment, the existence of almost any database can be like "honey to the bees," Westin says, adding that government must make privacy more of a priority, and not an afterthought, to regain the public trust.

"These systems should not be up and running until there is a statute on the books that sets the boundaries and makes it clear that these are not public records," says Westin.

Ideally, he said, there should be a federal law that makes privacy of transportation records uniform across state boundaries.

**Records may be resold**

Most E-ZPass customers probably assume that the data on their travels will be used only to track billing, not them. But there are good reasons to fear that the records will be used for another purpose.

"I've talked to transportation officials who've been quite frank about the inevitability of the information later being resold," Agre said. "They'll say, 'We in government are always under pressure for revenue, and we can get millions, so it's inevitable and there's nothing we can do about it.'"

In New York, the Metropolitan Transportation Authority, which administers E-ZPass, vows it will release records only to law enforcement, and even then, only if a serious crime is involved.

"If somebody wants records because they're on a fishing expedition, the answer they get is 'No,'" said MTA spokesman Frank Pascual.

But some point to the decision by Manhattan state Supreme Court Justice Collen McMahon over the summer as proof that the agency's policy is tenuous at best. In that case, police sought to establish that a murder suspect had crossed the Verrazano Narrows Bridge to commit the crime. They demanded E-ZPass records, but did not get a judicial subpoena, as the MTA had required.

After the judge ruled that an administrative subpoena — essentially, a note from police brass approving the request — was sufficient to compel the MTA to turn the information over, the agency was forced to revise its policy.

But what really caught the eye of privacy experts was the judge's rationale. McMahon noted that "a reasonable person holds no expectation of confidentiality" when using E-ZPass on public roadways.

**Legislation on privacy**

In New Jersey, the Legislature included a privacy provision in the law it passed authorizing the use of E-ZPass on the New Jersey Turnpike and Garden State Parkway starting next year.

In the case of scofflaws, security cameras positioned near the E-ZPass lanes will photograph the violator's license plate, but the law prohibits taking pictures of the driver or passengers. Cars that have a valid E-ZPass tag on their windshield are not photographed.

As for who may obtain records from the E-ZPass archive showing who traveled when and where, the law is silent.

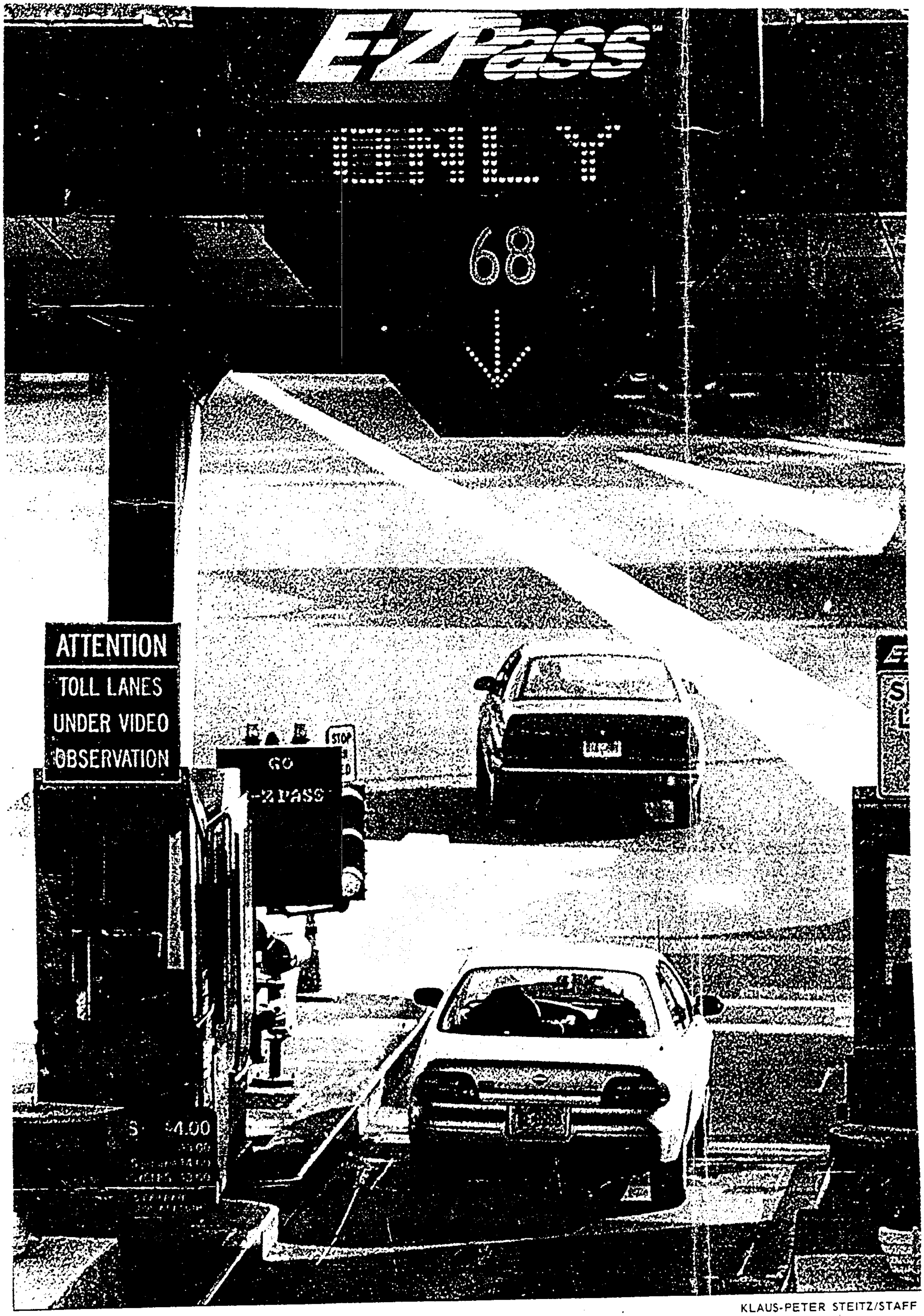
Edward Gross, executive director of the New Jersey Turnpike Authority, said the agency will likely adopt a policy similar to the one in place at the MTA. He pledges that the authority has the public's interest in mind, and won't allow the E-ZPass records to be abused.

With more than 1 million customers already, and more sure to join on when EZ-Pass comes to the Lincoln and Holland Tunnels later this year, and the Turnpike next year, there's little evidence that privacy concerns are making people balk at the system — particularly since there is plenty of evidence that EZ-Pass makes commuting more convenient.

"I have not received a single call from any of our members who are concerned about this," says William Visser, a spokesman for AAA North Jersey. "Anything can be abused. There are dishonest people all over. But you have to lay out the benefits too."

Still, you won't catch privacy advocates like David Rocah using an automated toll system any time soon.

"I don't use it, and it's not because I have something to hide," he says. "I just don't like the idea of that database being there."




KLAUS-PETER STEITZ/STAFF

Motorists taking advantage of E-ZPass lanes on the George Washington Bridge.

# Computers Let Japan's Drivers Play in Traffic

By ANDREW POLLACK

TOKYO — Kaoru Hinata's car navigation system can plot a course and guide him to his destination, telling him when to turn left or right. If he's hungry or low on fuel, it can show him the location of the nearest fast-food joint or gasoline station. And it even can receive the latest traffic information and tell Mr. Hinata which roads are congested and which parking lots still have space available.

Given all these whiz-bang features, how does the 32-year-old produce-market worker use his $3,000 car navigator? One way is to watch television on the navigator's screen, helping to while away the time stuck in traffic jams.

The car navigation system, in which a computerized map showing the car's location is displayed on a dashboard-mounted screen, is usually advertised as a tool to help drivers find their way, saving time and fuel.

But in Japan, where such systems are in more widespread use than anywhere in the world, the navigator is also becoming the hub of car information and entertainment, delivering television, data, video games, and other comforts of home to one's home on wheels. The information highway meets the asphalt highway.

The experience in Japan could be a prelude to what will happen in the United States, where car navigation systems are starting to be offered to consumers and

Continued on Page 5



# In Japan, a New Way to Play in Traffic

Continued From First Business Page

provided in rental cars.

In gadget-happy Japan, about 780,000 systems were shipped last year, an increase of 51.5 percent from 1995. In the first half of this year, sales were up 9.4 percent, according to the Electronic Industries Association of Japan.

Car navigators, most of which sell for about $2,000, are essentially computers with a small liquid crystal display screen and a player for the CD-ROM's that contain the digital maps and a data base of addresses. The car's location — determined mainly using Global Positioning System satellites developed by the Pentagon — is displayed on the map and is adjusted accordingly as the car moves.

But having a screen, and with the addition of a television tuner and two small antennas on the roof of the car, the navigator can serve as a television. The navigators can also be used to play music compact disks and, in some cases, to sing karaoke or play games.

So now, there is a rush in Japan toward what is being called car multimedia. Already dozens of software titles, sold on CD-ROM's, have been developed for car navigators. Golf programs provide tips on the game and guide a driver to the course of his choice. A program called "Places where Girls Choose to Feel Romantic" offers information about and directions to dating spots and hotels. Some disks offer quiz games.

But the newest effort is in transmitting information to the car navigators for display on the screen.

The Vehicle Information and Communication System, or VICS, the first system of its kind in the world, transmits information on the latest traffic conditions to navigators by radio waves and light beacons. Congested roads show up on the screen colored in red. Navigators can then automatically plot a course to avoid the worst congestion.

VICS, supported by Japan's Government and numerous companies, is available in the Tokyo, Osaka and Nagoya regions and has about 250,000 users. The ability to receive VICS information adds about $500 to the cost of a navigator but there is no charge for the traffic information.

Coming next are two-way systems, allowing users to request more customized information. Starting this fall, the Mercedes-Benz unit of **Daimler-Benz** is equipping all its S-class cars sold in Japan with a navigator that will use a cellular phone to automatically dial an information service every five minutes, retrieving not only the latest traffic updates for the area the driver wants, but also weather, fishing reports, airline flight information and schedules of events.

The system will be able to estimate the driver's time of arrival based on the latest traffic congestion information.

## Digital maps help drivers navigate. Karaoke software helps them relax.

Similar systems will be introduced in Germany in 1998 and in the United States probably about 1999, said Hermann Gaus, senior vice president of Daimler-Benz.

The **Toyota Motor** Corporation established a company in July that also aims to use cellular phones and car navigators to provide drivers with information on traffic, news, weather, gas stations, restaurants and parking.

**Honda Motor** has just announced a navigator, available as an option on the Japanese version of its new Accord, that will allow drivers to tap into the Internet, a step toward transforming the car into an office on wheels.

Toshiba, with 12 other companies, is looking at developing a satellite broadcasting service aimed at cars and other mobile users. Instead of the big dish-shaped antennas needed to receive existing satellite broadcasting services like DirecTV, the Toshiba system would be designed to be received by a pencil-shaped antenna only four to six inches long.

Whether drivers will pay for such information, some of which is available free on the radio, remains to be seen. The Mercedes service in Japan will cost more than $40 to become a member, plus a subscription fee of about $25 a month as well as cellular telephone charges.

An even bigger potential problem is that drivers could be distracted, causing accidents.

"It's more difficult to remember the operation of this machine than it is to learn to drive," said Kiichiro Yoshimoto, a freelance photographer, who nonetheless was very adept at operating the navigator's remote control with one hand while steering with the other.

"It's dangerous to drive when you're looking at the screen," he said. "And if you are operating this and you get a cellular phone call, then you panic."

It is not illegal in Japan for a driver to watch television while the car is in motion. Under voluntary guidelines issued by the Japan Automobile Manufacturers Association, the parking brake must be on for the television set to work or for navigator users to be able to perform tasks more complicated than just looking at the map and zooming in or out — tasks such as plotting a destination or making choices from a menu. But systems installed by car stereo shops often don't have these safeguards or drivers figure out how to circumvent them.

Yoshimi Tanaka, deputy director of the traffic regulation division at the National Police Agency, said safety had not been a big problem. In the last six months of 1996, navigators were responsible for 62 accidents injuring 84 people, he said. That pales beside the 1,140 accidents, causing 1,627 injuries and 9 deaths, linked to cellular phone use.

Still, Mr. Gaus of Daimler-Benz said that in Germany car navigators did not use screens because of safety concerns, but guided drivers by voice alone. Toyota Media Station's service will also provide information only by voice when the vehicle is moving. Since the navigation systems already have electronic speech synthesis to tell drivers when to turn right or left, they can be readily adapted to read data or E-mail aloud, engineers say.

## One program gives golf tips, another gives directions to romantic spots.

Takeshi Imai, chief engineer for navigation systems at Honda, contends that navigators actually enhance safety because a driver who is lost can be distracted. Navigators can also pinpoint the car's location in an accident, allowing help to arrive sooner.

Honda just introduced a navigation system that emits a sound to waken a driver who is dozing off. The navigator can detect an erratic driving pattern that could indicate drowsiness.

American companies, including the **Microsoft** Corporation, are working on car computer systems. But whether navigation systems catch on in the United States remains to be seen.

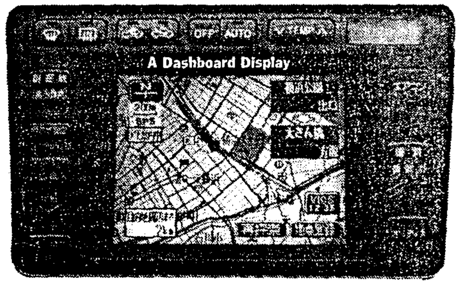
In Japan, it is much harder to find one's way than in the United States because most streets do not have names. There could be more restrictions on screens visible to drivers in the United States.

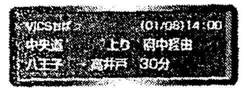
Then there is the peculiar relationship between the Japanese and their cars. With Japanese homes cramped and walls thin, the Japanese tend to treat their cars like sanctuaries, a place to get a little peace and quiet or, conversely, to blast the stereo without annoying the neighbors

Even though many urban Japanese barely use their cars, they keep them spotless and fill them with gadgets. Some people take their shoes off in their cars as they do in their homes. "The car is sort of a room for us," Mr. Hinata said.

## A Computer in Every Dashboard

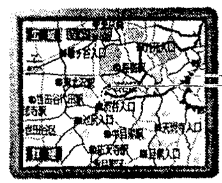
Car navigation systems, which locate one's vehicle on a map, are now becoming communications tools as well. The Vehicle Information and Communication System (VICS) transmits, via radio waves and light beacons, information on the latest traffic conditions. That information is then displayed on the navigator screen in one of three ways.

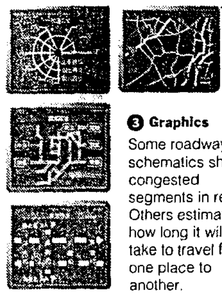



**2 Text**
Textual information on the estimated travel time between two points is sent by VICS.

**1 Maps**
Congested roads in the area are highlighted in red on a map showing the location of the car.



**3 Graphics**
Some roadway schematics show congested segments in red. Others estimate how long it will take to travel from one place to another.

Source. Vehicle Information and Communication System Center

The New York Times

CHICAGO, IL
THURSDAY 664,584
NOV 20 1997
BURRELLE'S

# I-PASS technology getting up to speed

By Rogers Worthington
TRIBUNE STAFF WRITER

There's something both cheery and eerie about the changes to the I-PASS electronic toll-collection system now being built into mainline plazas of the Illinois tollway.

The cheery part is that if you have one of the system's transponders on your windshield and an I-PASS account, you will soon be able to zip through some toll plazas at highway speeds.

In a recent test at the Illinois Toll Highway Authority's I-PASS proving grounds, cars swooped beneath the trussed gantry at up to 70 m.p.h. Each time, the window-mounted I-PASS transponder emitted a confirming beep, indicating that the toll had been paid electronically.

The eerie part is that the system appears to work so well here and in other states that it could usher in a proliferation of toll roads nationwide. And why not, with human labor, a major cost in toll collecting, largely eliminated?

When and if everyone gets the I-PASS religion, gone will be the clanky coin baskets that carry toll money down a tube to a vault tray, where it is removed and trucked off to the tollway's subterranean counting room in Downers Grove.

The all-electronic I-PASS system could do for traditional toll gathering what automated teller machines have done for personal banking and what the Internet may do to reference librarians and, perhaps, the printed page.

"With electronic toll collection, it is possible to imagine toll roads being pervasive," said Philip Agre, a communications professor at the University of California at San Diego. He has expressed concerns that such technology could invade motorists' privacy if their commuting patterns were publicly disclosed. Already, many states sell driver's license information.

The history of electronic toll collection in Illinois has been marked by delay and intrigue. Nearly five years after tollway officials started experimenting with it, fewer than 40,000 cars have I-PASS transponders.

As a car rolls through a toll plaza equipped with I-PASS lanes, the transponder sends an electronic signal to a receiver, and the motorist is automatically billed. Drivers pre-pay the tollway when they put down $38 to lease a transponder.

To ensure safety, the new I-PASS express lanes that let motorists drive through at highway speeds are wider and separated from other lanes by long concrete barriers. Also, the traditional tollgate is replaced by a video camera that records the license plates of any cars that pass through without I-PASS transponders.

Though fewer than 40,000 of the 1.2 million motorists who use the tollway daily have signed up for I-PASS, tollway officials predict that up to 600,000 eventually will become electronic payers. Officials have an ambitious goal of signing up 260,000 more by the end of next year.

Part of the impetus for such a dramatic increase, officials hope, will be the new express I-PASS equipment. It is first being installed at the Boughton Road toll plaza on the North-South Tollway, and the new Pfingsten Road plaza on the Tri-State Tollway. But only three other plazas on the 50-plaza system are scheduled to get the express lanes by the year 2000.

All but four of the system's plazas, however, are set to get at least some form of I-PASS by the end of 1998.

Glitches have largely been worked out in other states. New York City's system counted the shadows of cars as vehicles. It also added axles to other cars, thus billing them at the higher truck rate. In the South, where anti-glare windshield accessories are common, transponder signals initially were thwarted altogether.

Some have wondered whether toll-jumpers will speed past the video security monitors, and others have questioned what would happen to out-of-state cars that use an I-PASS lane—inadvertently or otherwise.

"People from remote states will get a free ride. They're not going to pursue someone from Idaho," said Peter Samuel, editor of the Toll Roads newsletter, who nonetheless considers electronic toll collecting "a raging success."

No one doubts that the system is cheaper. The Federal Highway Administration reported recently that the Oklahoma Turnpike Authority's electronic toll-collection lanes yielded a 90 percent savings in operating costs compared with manned lanes.

The federal analysts also found that toll collection capacity even at stop-and-go electronic lanes increased by at least 250 percent, fuel consumption decreased by up to 12 percent, and emissions decreased up to 83 percent.

Transportation analysts see still another potential bonus in electronic toll collection: Because it can instantly change toll rates, it has enormous potential for ushering in "congestion pricing," in which motorists are charged more when they drive in rush hour.

But then there's the eerie part.

With the lower costs of electronic toll collection, states may be tempted to follow through on an invitation in the Clinton administration's transportation bill to collect tolls on interstate highways to pay for maintenance.

Some also have expressed privacy concerns. With electronic toll collection, a fairly comprehensive picture of people's driving habits can be developed.

In at least two states, law enforcement officials have used electronic toll data to prove the whereabouts of subjects in criminal cases.

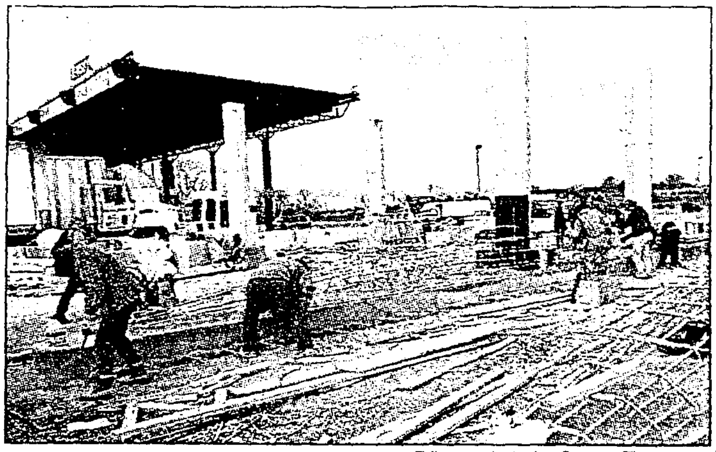
If toll authorities want to avoid such suspicions, they could sell debit cards that would work much like the telephone calling cards for sale in vending machines, said Marc Rotenberg, director of the Electronic Privacy Information Center in Washington, D.C. The card could be bought at varying values and inserted into the transponder until that value was exhausted.

I-PASS spokesman Donald O'Toole says Illinois tollway officials will not make membership lists commercially available, and names, addresses and phone numbers would be deleted if the lists were obtained under a Freedom of Information Act request.

According to Rick Schuman, of the Intelligent Transportation Society of America, a technology trade group, the new systems are being designed to protect privacy.

Schuman is more excited about the possibilities of the new systems. He sees the transponders used in electronic toll collection as the first step in developing a wireless communication device in cars that could have national applications.

"This transponder will ultimately come as part of the car, and evolve into the equivalent of a wireless ATM or credit card," he said.



Tribune photo by George Thompson

The Boughton Road toll plaza on the North-South Tollway will allow I-PASS users to breeze through at highway speed.

# Toll system's I-PASS moves into the fast lane

## With a transponder on the windshield, a driver will soon be able to move through some toll plazas at highway speed in specially equipped lanes.

### I-PASS: Making a move to alleviate tollway plaza congestion

By the end of 1998, the Illinois Toll Highway Authority hopes that 300,000 users of the Illinois tollway system will tuck loose change back in their pockets and use upgraded, pager-like transponders to pay tolls on its 274-mile system of roads. About 40,000 drivers now use I-PASS and pay for tolls using a pre-paid debit account. In October 1998, the Boughton Road Toll Plaza on the North-South Tollway will allow I-PASS drivers to use express lanes to pay for tolls while driving at a normal highway speed.

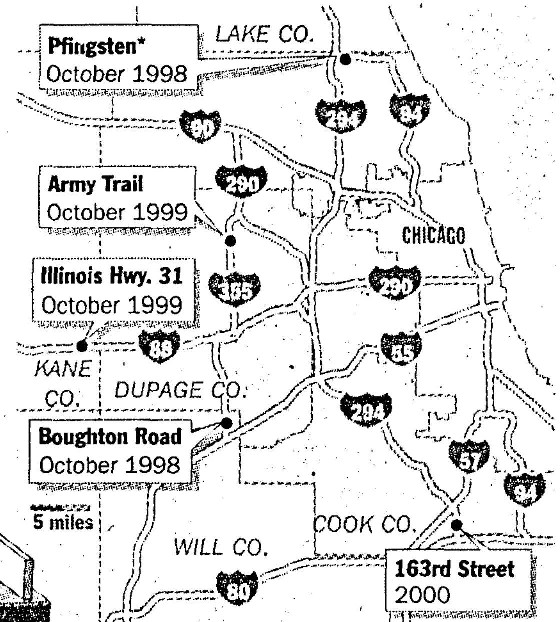
### Boughton Road Toll Plaza: How I-PASS express lanes work

For a car equipped with I-PASS, a toll transaction is virtually instantaneous when a driver passes through an express lane equipped with an electronic toll collection system.

pg.3 / I-PASS technology getting up to speed

## Implementing I-PASS express lanes

During the next several years, the tollway plans to construct express lanes at five toll plazas. In the future, as toll plazas are rebuilt, more express lanes will be added. By the end of 1998, virtually all the tollway plazas will accept I-PASS.

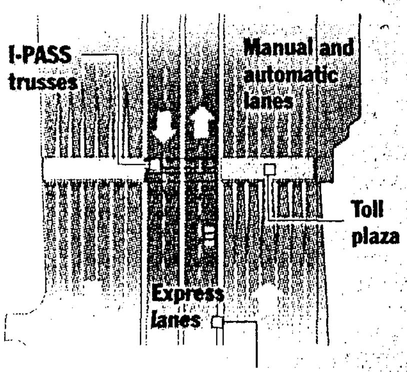



*Under construction

Source: Illinois Toll Highway Authority

**1** As the I-PASS-equipped car approaches the toll plaza, the driver enters an express lane while non I-PASS users enter manual or automatic toll payment lanes at a decreased rate of speed.

**The future Boughton Road toll plaza**

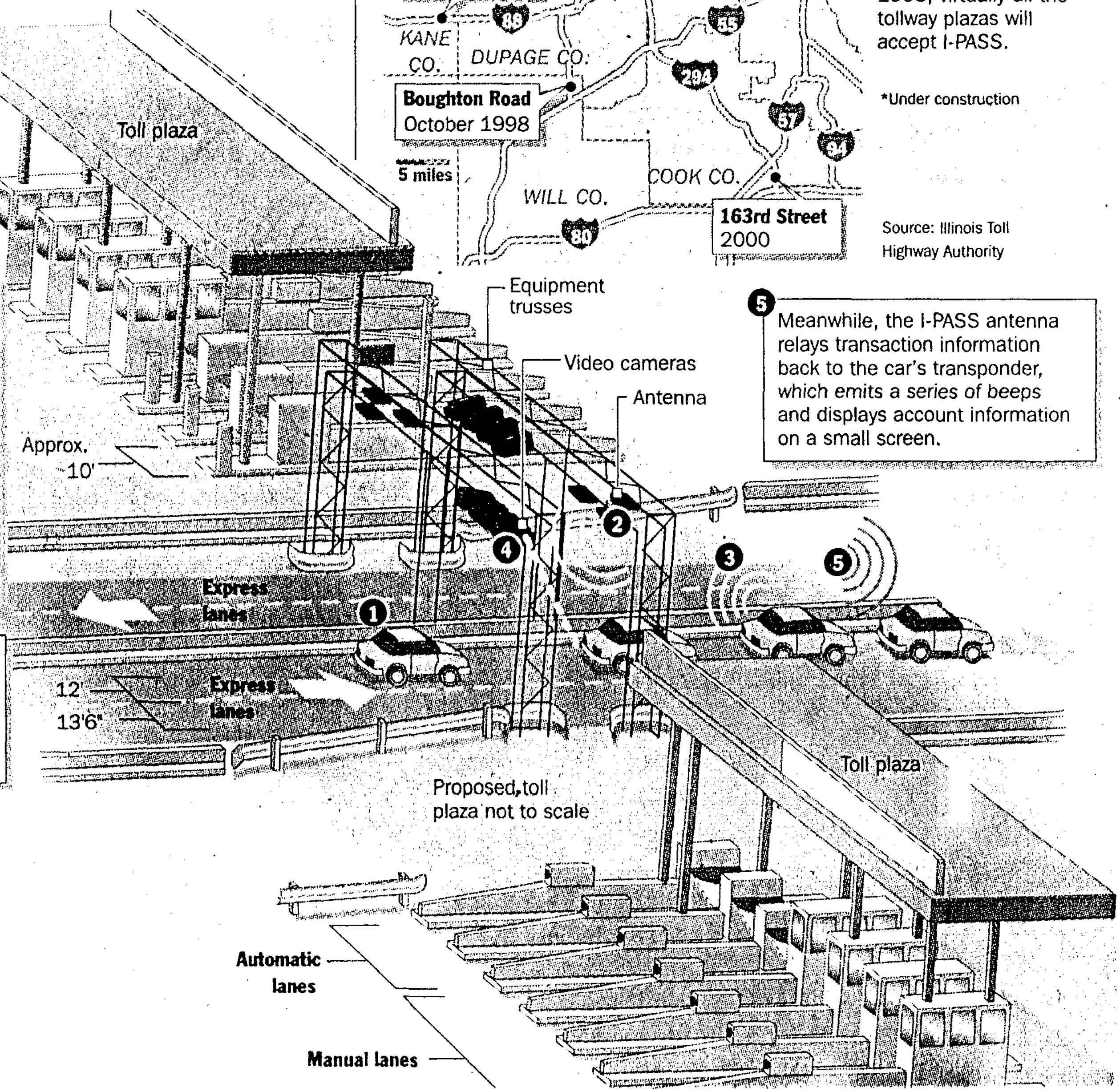



Concrete barriers begin approximately 1,700 feet from toll plaza

**2** As the car passes under the I-PASS trusses, an antenna broadcasts a radio frequency over the road area.

**3** The pager-like transponder, located on the windshield of the car, transmits the identification number of the I-PASS user back to the antenna. A computer at the tollway headquarters processes the information and the user's transaction is relayed back to the toll plaza area.

**4** Video cameras film the car and its license plate for accountability after it passes under the trusses.




**5** Meanwhile, the I-PASS antenna relays transaction information back to the car's transponder, which emits a series of beeps and displays account information on a small screen.

# Could L.A. Be Heading Toward Toll Roads?

By RICHARD SIMON
TIMES STAFF WRITER

Eventually, even the unthinkable gets thought—including the possibility of toll lanes in Los Angeles, birthplace of the freeway.

Under a proposal picking up speed in government offices, solo commuters would pay a toll for the privilege of blowing past slow-moving traffic on Los Angeles freeways, while carpoolers could use the lanes for free.

A task force of business, environmental and labor leaders and transportation planners is considering Los Angeles County routes suitable for a toll lane experiment. The Antelope Valley Freeway is the front-runner. The lanes would be similar to those in operation on the Riverside Freeway in Orange County and Interstate 15 in San Diego County.

Those lanes were constructed as toll roads; the Los Angeles experiment would use existing carpool lanes. However, the change would face financial, political and environmental hurdles.

Planners also are considering toll lanes on Interstate 15 in Riverside County.

Planners say that introducing toll lanes to Los Angeles County will be politically more difficult, but potentially more significant because of the region's fabled gridlock and its reputation as a testing grounds for new transportation ideas.

But don't dig into your pocket yet.

The 70-member task force, known as REACH for Reduce Emissions and Congestion on Highways, is aware that tinkering with the sacred freeway system is politically risky, especially if it promotes something called "Lexus lanes" by critics.

"I know what names you get called when you try to do something new," said Judy Wright, a former Claremont city councilwoman and past task force chair-

Please see TOLL, A58



# TOLL: Task Force Considers Routes

Continued from A1

woman.

(Separately, the Southern California Assn. of Governments has proposed using tolls on new truck lanes on the Golden State and Santa Ana freeways in Los Angeles County and on the Long Beach and Pomona freeways. Truckers would pay only if they wanted to get out of congested free lanes. But the president-elect of the California Trucking Assn. said he would oppose a toll. "We pay enough in highway taxes," he said. The proposals call for moving the carpool lanes to an aerial structure, freeing up space on the roadway for truck lanes.)

And before freeways can become feeways, the state Legislature must give its approval. That's no easy task, with Senate President Pro Tem Bill Lockyer calling toll roads a "polite form of highway robbery."

Federal approval is required for tolls on interstates. But President Clinton this year suggested giving states permission to charge tolls on interstates and use the revenue to improve their transportation systems.

With the government facing environmental, financial and political obstacles to building new highways, "we see pricing as a way of improving the efficiency of the system," said John Berg, team leader for highway revenue and pricing for the Federal Highway Administration.

"We use pricing in so many sectors of the economy to allocate scarce space," Berg said. "Hotels charge more in peak season than in off peak. Phone calls cost you more during the middle of the day than if you call on the weekends."

The REACH task force has been studying "congestion pricing" for nearly three years with $1.4 million in federal grants. The group has been working closely with the Southern California Assn. of Governments, the South Coast Air Quality Management District and the California Department of Transportation.

But local planners are moving cautiously, remembering the public revolt over the Santa Monica Freeway diamond lane in 1975. That experiment, abandoned after five months, involved taking away a lane open to all drivers and restricting it to carpools.

This time, planners will probably recommend adding a lane that would be open for free to carpoolers and for a yet to be specified fee to solo commuters. They also are exploring opening any new carpool lanes as toll lanes.

Other cities are watching Los Angeles.

"They know you have huge traffic, and the attitude is, 'If it can be made to work in L.A., it can work anywhere,' " said Peter Samuel, editor of Toll Roads newsletter.

Nightmare images of Los Angeles' traffic have become a staple of other cities' political campaigns. In Denver, lawn signs in support of a recent light-rail measure known as 4A read: "4A or L.A." In Portland, Ore., TV ads in support of a mass transit proposition offered the option: "Light rail or Los Angeles."

Although the idea of introducing a toll—even if voluntary—in Los Angeles would appear to be a long shot, proponents believe that they can steer clear of political gridlock. They point to focus groups and polls showing public support for the concept.

To critics who call the lanes elitist, they say toll revenues could be used for mass transit and other traffic improvements that would benefit everybody. They also contend that the Riverside Freeway toll lanes carry just as many Hondas as Lexuses.

Planners see "high occupancy/toll" or HOT lanes, as they are called, as a way to head off catastrophic gridlock.

"We see growing interest in HOT lanes around the country," said Kenneth Orski, chairman of the high occupancy/toll lane task force of the Institute of Transportation Engineers in Washington.

With the era of building freeways in the Los Angeles region virtually at an end, transportation planners are now focused on finding ways to better manage what they have, such as using high-tech devices such as sensors in the pavement to alert authorities and motorists to trouble spots sooner.

Adding toll lanes to some of the most congested freeways—the Santa Monica, Hollywood, Santa Ana near downtown Los Angeles and Ventura through the San Fernando Valley—would be environmentally, financially and politically more difficult.

There is no space to add lanes without spending hundreds of millions of dollars to buy land or build elevated roadways like the one on the Harbor Freeway.

Caltrans officials said the state agency first wants to complete its long-promised network of carpool lanes on the freeway system. But they said the agency would consider adding toll lanes if space is available to accommodate them.

The toll lanes are considered a politically safer way to go—at least initially—than some of the other "congestion pricing" ideas under consideration, such as charging motorists a fee—perhaps 5 to 10 cents per mile—based on how far they drive during rush hour or an emissions fee based on how much their car pollutes. The REACH task force is still studying the ideas for the future, if needed.

"Freeways weren't named freeways because they don't cost money," Wright said. "They were named freeways because they had no stop signals."

A number of issues still must be resolved: Will opening up carpool lanes to solo-paying commuters clog those lanes and discourage carpooling? How should toll revenues be spent? And perhaps most important, is it fair to let those who can afford a toll speed by those who can't?

Some think the idea of tolls in Freeway City will end up like proposals for subterranean freeways or opening the Los Angeles River to traffic during the dry season.

But proponents say circumstances have changed:

A recent study by the Texas Transportation Institute named Los Angeles the most congested city in the nation for the 10th year in a row, though some transit experts dispute the findings, saying Los Angeles' traffic is no worse than other big cities. Traffic delays are projected to grow three times worse by 2020. The average round-trip commute—now about 45 minutes—could easily be an hour and a half longer early in the next century, planners say. And the percentage of drive-alone commuters—more than 70% of all commuters—continues to grow, despite efforts to promote carpooling.

Toll collection is now fully automated; no need to stop any more at tollbooths, the image that East Coast transplants remember. Transponders installed on cars signal devices on the roadway and automatically debit drivers' accounts. Cameras photograph cars without transponders, and tickets are mailed to car owners.

In Orange County, 29,000 cars each day use the Riverside Freeway toll lanes, which opened in December 1995. Drivers pay from 60 cents to $2.95 to shave an average 20 minutes off a 10-mile commute, officials say. The price varies depending on time of day and congestion level.

In San Diego County, 900 solo commuters pay $70 a month to drive in an eight-mile carpool/toll lane on I-15 under a federal demonstration project begun in December 1996.

But the more ethnically and politically diverse Los Angeles County could be a tougher place to establish toll lanes.

State Sen. Richard G. Polanco (D-Los Angeles) said, "We should use our limited right-of-way space for bus express lanes and high-occupancy vehicle lanes, not high-income vehicle lanes."

Assembly Transportation Committee Chairman Kevin Murray (D-Los Angeles) said, "I don't think transportation should be based upon whether or not [people] can afford it."

But Senate Transportation Committee Chairman Quentin L. Kopp (I-San Francisco) said he would support a toll lane experiment in Los Angeles County and believes that the Legislature would approve it too. "We approved it in San Diego County," he noted.

Ward Elliott, a government professor at Claremont McKenna College and longtime proponent of "congestion pricing," said: "We have the most jammed roads and the most polluted air in the county and should, therefore, be more receptive at ground level, not less, than people in other cities."

But in Minnesota, officials recently dropped plans for toll lanes after a challenger to the governor whipped up a public frenzy.

"We just don't have the congestion here yet where people are desperate," said Robert Johns, associate director of the Center for Transportation Studies at the University of Minnesota. He said the public culture there is "very egalitarian and is not ready to help the rich get to work faster."

Closer to home, Orange County officials recently backed off from a proposal to open up new carpool lanes on a section of the Riverside Freeway as toll lanes. The lanes would have extended the existing toll lanes to the Los Angeles County line. Opponents objected to "charging people to use a road that they already paid for." Orange County, nonetheless, plans to study toll lanes on the Orange Freeway.

Toll lanes soon will open in Houston and are under study for a stretch of U.S. 101 through Sonoma County in Northern California and in Dallas, Phoenix, Portland, Ore., and Boulder, Colo..

One of the ideas behind the toll lanes is to get better use out of underused carpool lanes.

"To the extent that there are [underused carpool] lanes in the L.A. area, [toll lanes] offer probably one of the few remaining opportunities to squeeze a little more traffic out of the system," Orski said.

On the other hand, some carpool lanes are becoming congested.

"In order to keep the carpool lanes flowing smoothly," said Deborah Redman, REACH project manager, "we may in a number of corridors face the issue of having to raise the eligibility to get on carpool lanes, from two persons to three persons, like it is in most of the rest of the country."

Joel Fox, president of the Howard Jarvis Taxpayers Assn., said that adding toll lanes could win public support if it is clear that toll payers are financing the lane, and it is "not being subsidized by those who are watching the fast cars go by."

## THE DIEBOLD INSTITUTE FOR PUBLIC POLICY STUDIES, INC.

The Diebold Institute for Public Policy Studies, Inc. is an operating foundation established in 1968 by John Diebold, Chairman and founder of The JD Consulting Group, Inc., formerly The Diebold Group, Inc. Exploring the public-private interface to achieve maximum societal benefit from technological change is the principal focus of the Institute's activities.

The Institute, which pioneered some of the early work on the concept of privatization, aims to explore the participation of the private sector in the delivery of public services. It undertakes projects that enable the study of these issues.

A lecture program at Harvard University examined technology, business and policy, as well as the role of profit. The Institute has a research interchange arrangement with over 100 academic and research institutions. In addition, it manages the Marietta Schweitzer Fellowship Fund, which provides scholarships for Europeans studying in the United States.

Its current work, the information-based infrastructure project, is an international cooperative effort whose goal is to assess the value of information technology in societal infrastructures and, where appropriate, bring about the policy conditions to improve the quality of life for a broad segment of the general public. Policies are evaluated to determine which stimulate and which inhibit development of effective information-based infrastructures in the United States, Europe, and Japan.

Just as the commercial application of information technology has impacted and improved business, critically important areas of public life could also make dramatic gains through further use of technology. Public infrastructures that could be improved by information technology include road transportation, health care and environmental monitoring and response studies, education, communications and public safety.



# TRANSPORTATION INFOSTRUCTURES

## *The Development of Intelligent Transportation Systems*

**THE DIEBOLD INSTITUTE FOR PUBLIC POLICY STUDIES, INC.**

Studies Prepared for
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Another major social issue is how ITS costs will be allocated. Will costs be borne by the general public (through taxes) or only by direct users of the technology (e.g., through tolls)? If costs are passed on directly to users, the potential exists for road systems that discriminate against the poor and favor the wealthy, thereby creating political and social problems. It must be determined whether the benefit of the actual users paying for their increased convenience outweighs the potential for discrimination, or whether the general public benefit of ITS justifies its being paid for through taxes, as are many other public systems.

Loss of control is inherent in various intelligent transportation systems, and the driver's unwillingness to accept this could be a potential barrier for the technology. For example, with dynamic route guidance systems the driver relinquishes control over route choices. With collision avoidance systems the driver relinquishes control over the vehicle when the threat of an accident is imminent. With the automated highway, the driver loses total control of the vehicle for that segment of the trip. People may be reluctant to give up any of these control choices.

Moreover, the process of learning about and using ITS components may be stressful for drivers. There will be a need for advanced driver education because ITS will complicate vehicle operation. In this regard, suppliers will face the challenge of developing good ergonomic designs when creating ITS. In addition, the volume and continual exchange of information from traveler information systems might create "information overload," resulting in distraction or disorientation. Drivers would have to learn to adapt to the constant flow of information. Perhaps the driver's ability to handle these information systems while operating a vehicle should be evaluated, because of the potential impact on public safety.

Finally, ITS may be perceived as competing with other possible solutions to highway problems, for example, building more roads, investing in public transportation systems, or reducing traffic volumes. Without some recognition that ITS can conflict with other societal goals and that guidelines are needed to resolve these conflicts, ITS will struggle to achieve its full potential.

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# 5

# The Need for Cooperation between the Public and Private Sectors

Implicit in the previous chapters' discussions is the recognition that ITS technologies may not be adopted, much less achieve their potential benefits, unless there is close cooperation between the public sector and the private sector. The two sectors have different, but often complementary, strengths. For example, the public sector is skilled at developing infrastructure and ensuring equity and social cohesion, and the private sector is skilled at innovating and responding to rapid change. According to David Osborne and Ted Gaebler (1992):

> Business does some things better than government, but government does some things better than business. The public sector tends to be better, for instance, at policy management, regulation, ensuring equity, preventing discrimination or exploitation, ensuring continuity and stability of services, and ensuring social cohesion. . . . Business tends to be better at performing economic tasks, innovating, replicating successful experiments, adapting to rapid change, abandoning unsuccessful or obsolete activities, and performing complex or technical tasks.

If ultimately there is to be successful implementation of ITS, it will be necessary (1) to effectively join the strengths of the two sectors at various stages from conceptualization through R&D, and (2) to understand the kinds of organizational approaches that facilitate public-private endeavors. Many current R&D and pilot programs for ITS in the United States, Europe, and Japan already bring together government and industry.

In the United States the ITS program has never been considered exclusively, or even primarily, a federal program. In fact, reports by the U.S. Department of Transportation (DOT) and ITS America (the nation's focal research and educational organization for ITS, formerly called IVHS America) have concluded years ago that the ITS program must be a cooperative effort (U.S. DOT 1990), that the private sector should have primary responsibilities for developing ITS technologies (U.S. DOT 1992), and that private firms may ultimately account for as much as 80 percent of total expenditures for ITS products and services (IVHS America 1992).

Moreover, analysis of the obstacles facing information-based highway transportation infrastructures indicates the need for (1) a "champion" for ITS who can operate in a multi-interest environment and who is willing to take risks, (2) entrepreneurial vision to identify commercial opportunities, and (3) the ability to operate innovative services efficiently. These are characteristics of the private sector rather than the public sector, which makes the majority of investments in today's transportation system. This points to the importance of the private sector taking a major role in the funding and operation of ITS *in partnership with* the public sector.

## PUBLIC SECTOR–PRIVATE SECTOR PARTNERSHIPS IN ITS

### Advantages of Public-Private Partnerships

If deployment of ITS technologies is left solely to the public sector, the potential for these technologies to improve the performance of the highway transportation system may not be realized. There are numerous reasons for pursuing partnerships between the public and the private sectors in the development of ITS.

#### *Marketplace Expertise*

The private sector has experience in developing, marketing, and commercializing new technologies and products. Furthermore, private-sector participation is often needed to provide the technical expertise required to market new products. Private firms are usually better able to gauge the market's response to a new product or service. Demands for ITS products will vary according to geographic location, type of trip, user willingness to pay for ITS products and services, and other factors. Some travelers may even be willing to pay for additional levels of service, but public agencies have minimal experience in providing separate products and services to different segments of the market and generally find this approach politically difficult. Thus a strategy that starts with serving niche markets and broadens ultimately to the general public requires private sector participation.

#### *Technical Expertise*

The technical expertise required to operate and maintain certain ITS technologies is beyond the current capability of many state and local transportation departments. In some cases the personnel needed to deploy, operate, and maintain ITS products and systems will come through the retraining of current staff, but in other cases public agencies may find it more cost-effective to enter into a contractual arrangement with one or more private firms to provide specific ITS products or services. Moreover, private firms can more easily establish ad hoc business relationships with other firms. This is in contrast to public agencies, which generally require detailed, formal agreements before they can work with private firms or other government agencies.



#### *Revenue Generation*

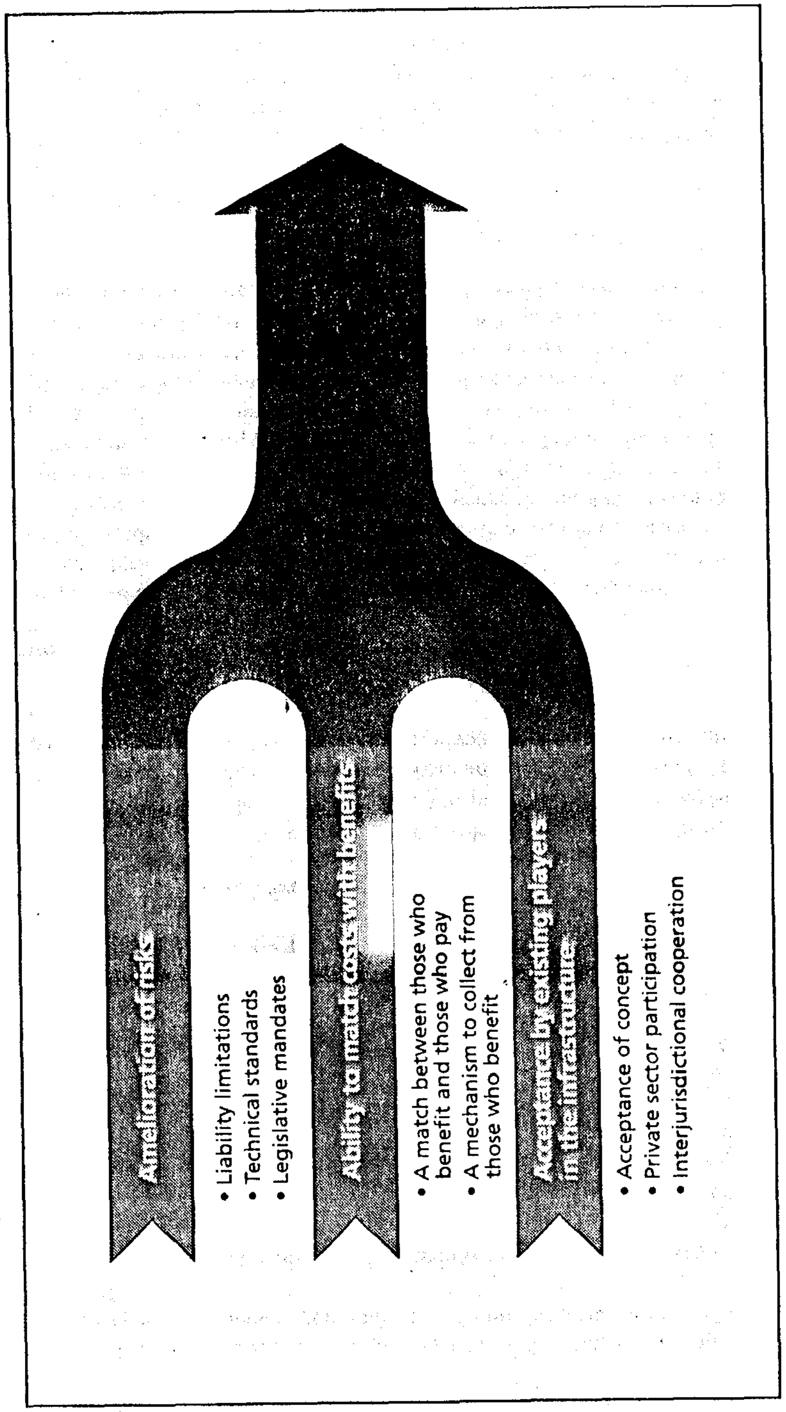
In terms of generating revenue, it would be costly for state and local transportation agencies alone to fund the deployment of new ITS technologies. Thus, a greater financial role for the private sector in transportation seems necessary. This could take several forms, including direct investment and indirect support through advertising. In fact, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 (see Chapter 1) encourages the creation of pubic sector–private sector partnerships to finance highway transportation projects. Although there will be difficulties along the way, the ITS program may offer opportunities to generate revenues by allowing firms to advertise on highway advisory radio, variable message signs, and other traveler information services.

#### *Data Collection*

Data collection is another area in which cooperation between public and private sectors may be useful. Private firms are usually restricted from installing hardware that is physically connected to public roadways, but because certain ITS technologies do not require actual physical connection to roadways, there is less need to rely exclusively on public agencies to gather traffic data. Indeed, several private firms already use probes and surveillance cameras to collect traffic information. In a related scenario, it may be desirable for government agencies to collect data and have a private firm provide traffic information using that data.

An interesting approach has been developed in Westchester County, New York. The county awards contracts, or franchises, to firms that collect and analyze data. Recently, Westchester awarded an exclusive franchise to a firm to collect, assemble, and disseminate traffic information throughout the county. The contractor must provide traffic information and/or data to the county and is then permitted to sell specific traffic information/data, as determined by the county. The franchise also allows the firm to offer certain services (e.g., incident management and variable message sign operation) based on the data it collects.

HELP, Inc., is another example of a private-sector participant in highway operations. This organization was formed following the completion of an operational test, HELP/Crescent, a U.S. DOT–sponsored multistate, multinational research effort involving the Federal Highway Administration, Transport Canada, more than a dozen states, and several motor carriers. It tested an inte-




Design: Two Twelve Associates, Inc.

**Figure 5.2**
**Factors Determining the Rate of Private-Sector Investment in Societal Infrastructure**



advanced travel information systems, for which marketing expertise is a key success factor. The ISTEA also exhorts metropolitan areas and states to develop "transportation improvement programs," which must consider private-sector funding for transportation in general and ITS in particular. As a result, substantial amounts (additional to the $660 million) will be invested in ITS areas (e.g., automatic toll booths and variable pricing) that are expected to accompany the purchase of existing roads and the construction of new ones by private investors.

The second is the April 1992 Executive Order on Privatization of State and Local Government Assets, which directs federal agencies to approve requests by state and local governments to privatize infrastructure assets; it indicates specifically that "assets" are meant to include roads, tunnels, bridges, and the like. Previously, the Office of Management and Budget had insisted that the federal government be repaid its past grants in the event the infrastructure was sold. The Executive Order did away with this disincentive. State and local governments now are able to keep the majority of the proceeds of such privatization. Thus, the Executive Order has gone a long way toward removing any remaining blocks to action.

We must now focus attention on ways in which incentives that will encourage utilization of advanced technologies can be built into routine infrastructure-financing. This should create a strong "demand pull," a force that would be of immense importance in unleashing the innovations necessary to create an infrastructure suitable to an advanced industrial society.

Finally, the ideas developed in the preceding paragraphs need to be validated through operational tests of private-sector participation in ITS. Key roles to be tested are private-sector funding of ITS and private-sector operation of ITS. A recommended approach would be to identify a number of major ITS projects willing to include the private sector as a provider of risk capital and/or as an operator of ITS. The next step would be to develop joint business plans, perhaps with some assistance from the U.S. Department of Transportation's Federal Highway Administration. Once agreement has been reached, operational tests should be carried out and extensive feedback should be provided to interested parties.

## Encouraging Pay-for-Use Services

A major obstacle to the implementation of ITS is the view that it must be free at the point of use. In an alternative approach, ITS could be viewed as a revenue source for municipalities, ITS services could be charged for on a pay-for-use basis (as is the case with toll bridges and toll roads), and investment priorities could be set according to the profit-generating potential of proposed projects. An added attraction to this approach is that incentives can be introduced to encourage/discourage certain types of behavior by highway users. For example, travel during periods of low vehicle usage might carry lower rates than travel during high usage periods.

Encouraging pay-for-use ITS services must be done in two steps. First, it is necessary to convince transportation authorities that insisting on ITS services being free at the point of use will significantly impede the development and delay the benefits of ITS. The initial expense and operating costs of ITS are not likely to be supported by the public sector. If the private sector has to forego revenue opportunities, it will be effectively eliminated as a potential investor. A focused awareness campaign is needed to get this message across.

Second, analysis is needed to determine why such pay-for-use highway transportation services as toll roads and toll bridges are considered acceptable and what benefits the users perceive they are receiving. Once these findings are known, they should be used to identify the parts of ITS for which pay-for-use would be acceptable.

Adam Smith's words in *The Wealth of Nations* (1776) are relevant to this issue:

> [T]he erection and maintenance of the public works which facilitate the commerce of any country, such as good roads, bridges, navigable canals, harbors, etc., must require very different degrees of expense in the different periods of society. . . . It does not seem necessary that the expense of those public works should be defrayed from the public revenue. . . . The greater part of such public works may easily be so managed, as to afford a particular revenue sufficient for defraying their own expense, without bringing any burden upon the general revenue of society. A highway, a bridge, a navigable canal, for example, may in most cases be both made and maintained by a small toll upon the carriages which make use of them.

## Introducing Niche Services

Yet another major obstacle to the implementation of ITS is the view that it must be a universal service. It is time to create a climate in which the introduction of niche services is seen as beneficial. Again, a campaign focused at transportation authorities is necessary to demonstrate that the insistence upon ITS services being universal from the outset will significantly impede the development of ITS.

The introduction of niche services is often an important precursor to the development of universal services. A good example is the telephone, which once was affordable only to a few people. Now it is available in the majority of homes in the United States and Western Europe. In Japan autonomous in-vehicle navigation systems were originally introduced as low-function gadgets for "the motorist with everything." Progressively the price was reduced and the quality improved, and now the systems are well on their way to becoming a standard feature in vehicles in Japan.



A succession of niche services may very rapidly evolve into a more universal service and, at any rate, will make more manageable the ultimate task of expanding ITS to incorporate all travelers. In many cases, those who do not subscribe to and pay for an ITS service will nevertheless benefit from its use by others. This is certainly the case with automated toll booths; also, approaches that divert equipped drivers from congested roadways to alternative routes benefit other drivers by relieving congestion.

Complementary to encouraging departments of transportation to establish niche services, research should be carried out to identify the most commercially attractive niche services.

## Establishing Guidelines for Resolving Conflicts with Other Societal Goals

ITS development can in some cases conflict with other societal goals such as personal privacy, preservation of the environment, and local control of transportation. It can also be in competition with other potential solutions to highway transportation problems, including investment in public transportation. The importance of each of the goals and solutions will vary enormously from location to location, so no general approach is relevant to all situations. The best approach is to establish guidelines on good practice.

Establishment of guidelines for handling conflicts with other societal goals is a task that should be carried out by an organization with no vested interests in selling ITS equipment or services. The guidelines should encompass (1) how to predict conflicts with other societal goals, (2) how to develop ITS to accommodate other societal goals, (3) how to interrelate ITS solutions with other approaches for solving highway problems, and (4) how to present ITS solutions to groups that are concerned about possible infringements on their interests.

The guidelines would derive from the experience gained during projects such as the Electronic Toll and Traffic Management (ETTM) project in the New York/New Jersey/Pennsylvania area. During development of the technical specifications for this electronic toll-collection system, a number of privacy issues were considered. One aspect was the freedom to choose whether to use the system or not. The ETTM specification requests a mechanism to deactivate the system for selected trips. Another concern relates to the use of transaction data. ETTM intends to keep the data confidential. Video enforcement and speed limit enforcement also raised privacy issues. Regarding video enforcement, only the license plate (not individuals themselves) will be photographed. Liability will be imposed on the owner of the vehicle. In addition, legislation is to be passed prohibiting the use of video enforcement or electronic toll data for speed limit enforcement.

### Improving the Quality of Benefit Assessment Procedures

Prospects for the deployment of ITS would be greatly enhanced if the procedures used to investigate ITS benefits were improved. Parties who are involved in this process should include potential suppliers of ITS goods and services; lawmakers at federal, state, and city levels; and departments of transportation at all levels. Improving the quality of the analytical tools will be a three-stage process.

It would begin by raising the awareness of interested parties about the social and commercial opportunities provided by ITS. At the same time, these interested parties should be made aware of gaps in our knowledge about the relative importance of the benefits. For example, we do not know whether rapid identification of and response to incidents on the highway would be more beneficial than traffic management. An awareness presentation must be prepared and delivered to interested parties.

The second stage would involve improving our conceptualization of vehicle user behavior and traffic patterns. Much can be achieved through surveys and simulations without the need for expensive experimentation. For instance, we do not know how many journeys vehicle users make for which the time of the journey could be shifted. Such information could help identify what type of pretrip information would be most useful to travelers. A program of urgent research to improve our conceptualization of vehicle user behavior and traffic patterns must be developed and evaluated.

The third stage will involve carrying out further ITS experimentation. Improved conceptualization will enhance our ability to predict the most promising ITS applications. These improved predictions will have to be tested in commercially oriented, model ITS projects in selected metropolitan areas to gain practical experience of the likely costs and benefits of ITS.

An area to which special attention should be devoted is that of commercial vehicle operations. It has been noted that half the potential benefits of ITS derive from commercial vehicles—a group of road users that would be willing to pay for appropriate ITS services. Furthermore, any improvement in efficiency would directly enhance national competitive advantage because of the economic gains that would result.

All the issues discussed in this section would benefit from an international sharing of research results and, in some cases, from joint projects. The similarity of approaches to highway transportation in the United States and Europe makes joint research especially attractive. One fruitful area for international collaboration is that of standards setting for ITS. Another area that might benefit greatly is that of determining the cost-benefit for the most promising ITS applications. This knowledge is key to determining priorities for investing in ITS.



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# *Looking Down the Road: Transport Informatics and the New Landscape of Privacy Issues*

*by Phil Agre*

Two technologies, computer networking and public-key cryptography, have transformed the landscape of technology-and-privacy issues. This article illustrates the changes and explores their consequences by describing the emerging privacy issues regarding transport informatics, primarily in the United States.

*Transport informatics* is a European term for the use of information and communication technologies in transportation (Giannopoulos 1993, Hepworth 1992). It encompasses a wide variety of activities whose underlying unity is not always obvious. The largest institutional focus for transport informatics research and development in the United States has been the Intelligent Vehicle-Highway Systems (IVHS) program of the U.S. Department of Transportation (DoT). The industrial partners of the IVHS have recently switched to the more general term *intelligent transportation systems (ITS)* in order to include a broader range of surface transportation modalities—especially city streets. The ITS program aims to define a common architecture for the many state and private initiatives concerning transport informatics.

Despite its potential for increased efficiency, transport informatics can also lead to significant invasions of privacy through the automated tracking of individual vehicles (Agre and Harbs 1994). This is a matter of considerable concern, since pervasive surveillance of citizens' road travel could chill the freedom of association that is crucial to a democratic society. Most of this article focuses on these issues; the last part of the article places the issues in a larger context by exploring how the privacy movement can best respond to, and take the initiative in, the emerging privacy landscape.

## *What Exactly Is Transport Informatics?*

Transport informatics does not refer to any specific technology, nor has it sprung from any single technical breakthrough. It includes a broad range of applications that have become economically feasible as the basic price of computation and communication—especially digital wireless—has dropped. Working groups invested considerable effort in the late 1980s and early 1990s identifying and classifying the potential applications: commercial logistics, regulatory automation, traffic information services, route planning, law enforcement, and so forth (U.S. Department of Transportation 1992). This work was both technical and political, and it produced a framework for cooperation among producers and users of the new technology (Klein 1993).

Transport informatics is both supply-driven and demand-driven, in that "push" from hopeful producers of the technology is at least as important as "pull" from potential users. On the supply side, the end of the Cold War left many defense companies looking for new markets. They proceeded in their accustomed manner by developing a strong alliance with the government—in this case, the Department of Transportation. To coordinate this alliance, they have formed an organization called ITS America, an official advisory board to the DoT, whose membership includes companies, state departments of transportation, and university research groups (IVHS America 1993). Many observers have expressed concern that these defense-oriented firms are developing baroque architectures that may be poorly matched to the needs of a civilian market. A bias toward centralized control is evident throughout the many projects in existence and on the drawing board. Privacy advocates in particular have expressed concern over proposals to use potentially invasive technologies, such as video surveillance and vehicle identification transponders.

A major aspect of the supply-side picture is significant government support, primarily at the state and regional level, for automated toll collection. Although only a modest amount of this toll collecting has been implemented, much more is planned. Budgetary considerations and pressures for privatization drive this trend; at an ideological level it is motivated by economic arguments for the reduction of taxpayer subsidies to road users. This theory is sometimes called "congestion pricing" (Wallace 1995), although it is doubtful that the tolls would actually amount to true "prices" in a competitive market.

On the demand side, the market for transport informatics includes both industrial and consumer applications. (Other application domains, such as military and civilian government transport are not treated in this article, nor are regulatory automation and environmental programs such as emissions monitoring.) As is often the case, industrial users are far ahead in their use of transport informatics, and consumer applications may tend to follow the models already established by commercial users.

For a decade now, industrial distribution systems have been undergoing a quiet revolution as a result of improved information and communication technologies. Just-in-time scheduling, for example, reduces the unproductive capital devoted to inventories, while also making rough spots in the chain of production evident to central management. Likewise,Wal-Mart and the large "warehouse" retail stores depend on continual stock monitoring to schedule shipments of goods directly from factories. These and related developments require greater predictability in every link of the distribution chain, which has led to the construction of "integrated logistics" systems. It has become common, for example, to think of highways, train tracks, and other shipping routes as metaphorical conveyor belts in a global factory. Information technology makes this metaphor a reality by tracking the spatial location of every vehicle and

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package in real time. It is difficult to overestimate the consequences of integrated logistics for the world economy and its participants. Although it provides much of the motivation for transport informatics, integrated logistics is a much broader phenomenon. Its economic and technical logic is wholly straightforward and exceedingly powerful, but this logic includes no concept of privacy. Simply taking this model, with its exclusive focus on integration and efficiency, and transplanting it from commercial to consumer applications would almost certainly lead to significant privacy problems.

These two forces, the supply side and the demand side, converged in the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Along with the architecture development program I have mentioned, this legislation instructed the DoT to conduct research into a variety of social issues, including privacy. One result of this research was a DoT report to the Congress entitled Nontechnical Constraints and Barriers to Implementation of Intelligent Vehicle-Highway Systems (U.S. Department of Transportation 1994). The words *constraints* and *barriers* indicate something of the attitude toward privacy of the ITS establishment: privacy concerns have generally been treated as obstacles to the systems' development, rather than as part of their necessary functionality.

## *Technical Choices and Privacy Risks*

Privacy risks arise in transport informatics systems in several ways. Generally, these involve planned or coincidental surveillance of users' movements and other behavior. (For a more detailed survey see Alpert [1995].) Examples of applications and their privacy implications include the following.

- The automated real-time tracking of commercial trucks is a workplace privacy issue for truck drivers and many other logistical workers. At the same time, the tracking systems reduce the arbitrary pressures associated with crudely estimated normative schedules (Lappin 1995).
- At least one rental car company has been experimenting with systems to track its cars (Marks 1994, Wald 1994). This facility, based on the Global Positioning System, is promoted as providing drivers with directions and emergency services. But clearly it could also be used to track the company's property. The nature of the renter's legitimate expectation of privacy in the face of these technologies remains to be established.
- Many regional transportation authorities are installing hundreds of video cameras on heavily traveled routes (Simon 1995). Ostensibly meant to detect congestion, accidents, road debris, and other conditions requiring official intervention, these cameras may find other applications that raise civil liberties concerns. These traffic-flow cameras generally do not have the resolution to read license plates, but other cameras have been installed (for example, on underpasses) specifically for that purpose, as in tracking vehicles for statistical purposes. Other proposed surveillance technologies include systems that track individual drivers' cellular telephones or vehicle identification transponders.
- Some conceptual papers on ITS have envisioned more coercive applications, in which automated monitoring systems would "provide the individual driver with immediate feedback on his behavior. In case a driver neglects these efforts to correct his misbehavior, the same information could be used to enforce correct behaviour by various means, such as fines, license or speed limitation (policing)" (Organization for Economic Cooperation and Development 1992: 25).

In the rest of this section, I examine in more detail the use of Automatic Vehicle Identification (AVI) for roadway toll collection. This issue is important both in its own right and because it raises many broader concerns regarding the whole area of personal data collection by ITS systems.

Databases of individual drivers' toll payments could have a wide variety of potential secondary uses, from marketing to law enforcement to civil litigation to political repression. AVI is typically implemented using a transponder, an electronic unit roughly the size of a cigarette package, usually attached to the bumper or dashboard of the car, that interacts through digital radio signals with roadside beacons. A car entering a tollway will "hear" a request for identification from the nearby beacon, and respond by transmitting its identification number. The details vary, but the most common design is for the beacon to relay this number to a central computer that deducts the necessary sum from a prepaid account and returns an acknowledgment to the beacon. Drivers without adequate funds in their accounts will be notified to pay in cash at a conventional toll booth.

The crucial issue is whether this payment system is anonymous. This in turn depends on both the transponder-beacon communications and the architecture for registering drivers' payments. For example, if the transponder transmits the driver's license number or vehicle identification number (VIN) then the system is definitely not anonymous. Normally, though, the transponder transmits its own serial number. Therefore, the system as a whole is anonymous if this number is not associated with any other identifier that can be connected to the individual. Unfortunately, in the United States, the transponder number is most often associated with a driver's account number—whether a bank account number or the number of a debit account maintained by the road authority. The E-Pass system in Orlando, Florida, for example, issues each customer a monthly statement that includes the customer's name and address, together with a complete list of toll payments for the month. Each entry on this statement lists the precise time and location of the toll payment, including which lane the driver

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was in (Garfinkel 1995). Many such systems do permit customers to pay anonymously with cash, but this option is usually much less convenient and is rarely used once the system has been in operation for a few months.

Inherently anonymous toll-payment architectures are possible, and at least one is under active development. This is an AVI system being developed by the Amtech Corporation (Dallas, Texas) based on "digital cash." Digital cash is a scheme invented by David Chaum (1992) and marketed by his company Digicash (Amsterdam); it is based on public-key cryptography and permits parties to a transaction to transfer funds reliably in electronic form without having to identify themselves to one another. Although law-enforcement authorities are concerned that digital cash may lend itself to money-laundering, tax evasion, and other financial crimes, toll-collection provides one potential application of digital cash for which criminal abuses are hard to imagine. Unfortunately, although digital cash has enjoyed a great deal of official attention in Europe and Japan, I have seen no evidence that any American authority is planning to use it. Many have never even heard of it.

(Eric Hughes has pointed out to me that other anonymous toll-payment schemes are conceivable as well. For example, a customer might remotely instruct her bank to create a temporary account from which a short series of toll payments might be drawn; the road authority would be able to connect these payments to one another without being able to connect them to the customer.)

## *Privacy protection*

Early decisions about ITS payment architectures may have lasting effects. Technical standards are often difficult to change once they become entrenched in the market, and if non-anonymous schemes become prevalent then only the most courageous agencies will pursue anonymous alternatives. ITS America, though, has pursued privacy issues primarily through the development of a set of "Fair Information and Privacy Principles," currently in "draft final" form (Phillips 1995). These principles are important because they will provide guidance to numerous industry and government people—largely urban planners and transportation engineers—who have little prior experience with databases of personal information or the privacy issues they imply. A copy of these principles is available on the WorldWide Web at: http://weber.ucsd.edu/~pagre/its-privacy.html. Not surprisingly, the draft principles are extremely weak. They make no mention of anonymity. In fact, they explicitly state that personal information collected through ITS may be used for non-ITS purposes, stipulating only that drivers be notified and given the opportunity to opt out. They suggest that law-enforcement uses of ITS information be authorized by state governments, and they propose no limits on the law-enforcement uses that state governments might authorize. The principles are voluntary, and they suggest no procedures through which compliance with them might be monitored. Nor do they specify which organizations will be liable when individuals are harmed through the improper use of ITS information.

Individuals' ITS records have virtually no statutory privacy protection (Glancy 1995). Moreover, neither tort law nor the Fourth Amendment promise much protection (Halpern 1995, Weisberg 1995). The United States, unlike most industrial countries, has no generalized regulatory machinery for privacy protection. Furthermore, since most ITS systems will be operated by public agencies such as state transportation departments and regional transportation authorities, the records on individual toll payments that these systems maintain will often fall within the scope of state open records laws. (See Connors article, this issue.) ITS America's draft privacy principles recognize this danger—but instead of recommending changes in the law, they effectively suggest that the records be held by private entities.

The ITS America privacy principles are scheduled to be revised and adopted early next year. (A small number of privacy advocates attended a meeting in Washington to discuss the principles in July 1995 and expressed their strong concerns; another meeting is tentatively scheduled for November to review the issues in the context of ITS architecture development.) Short of comprehensive data protection legislation, however, it is doubtful that even the strongest privacy principles would have any significant effect. Once databases of personal information from ITS systems grow, a wide variety of organizations will start proposing secondary uses for the information. It is impossible to predict with certainty that abuses will occur, but numerous other privacy-sensitive technologies provide strong and discouraging precedents. Telephone companies, for example, must respond to an enormous volume of subpoenas for their records; transportation authorities that maintain individually identifiable information in their databases may find themselves in the same position. Subpoenas are not costly to issue, though they may be expensive to comply with, and ITS information should be as attractive as phone company records for a variety of legal purposes.

In my view, therefore, the technical issues are far more important than the language of voluntary principles. Individually identifiable information, once collected, is virtually certain to be abused; inherently anonymous architectures avoid the whole problem by not collecting the information in the first place. It is this kind of foundational design choice that must be faced early in the process to avert needless privacy erosion in the rush to implement ITS systems.

## *The New Landscape of Privacy*

So far, I have painted a pessimistic picture of the prospects for privacy protection in American ITS schemes. Viewed in the broadest context, though, AVI-based toll collection is about the most tractable privacy issue that one might hope to encounter for several reasons:

- The dangers are easily explained to the public.

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- The combination of government and industry participation provides those of all political persuasions with an enemy of their choice.

- The functionality provided by the systems does not actually require them to collect individually identifiable information.

- None of the key special interest groups involved in ITS have a strong reason to promote secondary uses of toll information.

- A straightforward technological solution can make the systems inherently anonymous.

The good news, then, is that some hope exists that AVI-based toll collection might be conducted in a manner consistent with privacy protection. The bad news, of course, is that if privacy advocates cannot prevail in this case, then the prognosis for other cases is poor indeed. Whether the news is good or bad, it is important for privacy advocates to view the American ITS program, and transport informatics generally, as part of a newly emerging landscape of privacy issues.

As I mentioned in the introduction, this new landscape is the product of two technologies: computer networking and public-key cryptography. Computer networking is not itself a new technology, but only in the last few years has it begun to have a pervasive influence on industrial practices. At the most basic level, networking makes it possible to envision applications that are unified functionally despite being distributed across a large geographic territory. Transport informatics, of course, is centrally concerned with the coordination of activities spread over large areas, particularly when employed as part of an integrated logistics system that creates tight linkages across a global system of production and distribution. At a more subtle level, networking makes possible the integration of computational processes across different functions and organizations. As a practical matter, this means that information technologists find themselves trying to interconnect database systems that have arisen independently in a wide variety of local circumstances. This is not just a technical problem of conversion between different data formats. More importantly, it is also a semantic problem: each database is likely to reflect the vocabulary and conventions of the particular work group that created it (Robinson and Bannon 1991). This not only makes the technical task more difficult, but also increases risks of harm to individuals, since personal data held in one system may be totally inappropriate for use in another. Transport informatics provides strong motivations for firms to interlink their machines over networks so that, for example, a shipping firm's customers can automatically check on the status of their shipments. Likewise, secondary uses of information collected by AVI toll-collection systems would be greatly facilitated by unrestricted real-time networked access to those databases. In all such cases, however, the meaning and quality of the data, even if suitable for the original purpose, may generate serious privacy questions when transposed to a new context and combined with personal information from other databases.

Computer networking, then, creates the conditions for greatly increased risks to individual privacy. Public-key cryptography, on the other hand, creates the conditions to greatly alleviate these risks. As Marc Rotenberg has pointed out, cryptography significantly changes the view of technology that has been implicit and explicit in most analyses of the social effects of technology. For the past fifty years, social theorists have, with some justification, identified technology with social control. Privacy advocates, as a result, have often been placed in the position of criticizing technology as such, or else arguing for the reduction or limitation of technical functionality. Digital cash and other technologies based on widely available strong cryptography, though, effectively invert the political situation. (See Biddle article, this issue.) By allowing privacy advocates to take a pro-technology stance, these new technologies cast the opponents of strong privacy protections as those who cling to technologically backward methods.

The challenge, of course, is to ensure that privacy-enhancing technology is actually used. This depends upon both political and market forces. Although information technologies are dropping in price, their development and use are nonetheless powerfully driven by standards. Consider, for example, the success of the Internet's TCP/IP protocol, which is effectively reducing the need for other internetworking protocols. TCP/IP permits interconnection with a huge number of existing networks that already use TCP/IP, and this compatibility generally outweighs the narrow advantages of any specific alternative. By analogy, in the case of toll-collection, much depends on the type of electronic financial infrastructure that develops in each region of the world. At the moment, it seems likely that Europe will develop an anonymous scheme based on a variant of digital cash such as Mondex, whereas the United States will develop a non-anonymous system modeled on credit cards—for example, the electronic payment system being developed by Visa (Holland and Cortese 1995). Of course, several different payment systems may still arise, but once a non-anonymous system becomes a well-established standard, privacy concerns alone may be unable to create the market conditions for the construction of an anonymous alternative.

Another problem is the depth to which privacy invasion is ingrained in the practices of computer system designers (Agre 1994). The point is not that most system designers consciously set out to invade anybody's privacy. Instead, the problem lies in the practice of creating internal representations that mirror reality in a point-by-point fashion, so that a system can only support an activity by "capturing" it. The first step in current-day system design, after all, is to define a set of data structures to be maintained—for people, types of vehicles, the vehicles themselves, roads, lanes, accounts, transactions, dates, times, and so on—and

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a convention for creating identifiers for each type of data structure. For example, people might be identified by Social Security number, vehicles by government-assigned vehicle identification numbers, and so forth. Such a system might protect anonymity by simply omitting any representation of individual people. But doing so would be difficult in practice, given that so many existing systems do represent data in an individually identifiable fashion, thus permitting a person's identity to be reconstructed easily through the merging of records from different sources.

The widespread use of public-key cryptography to protect privacy, then, will require a considerable change in mindset among programmers. In effect we are witnessing two different revolutions: the computer networking revolution and the consequent merger of all the world's databases, and the public-key cryptography revolution with its potential to protect individual identities without limiting system functionality. The question is, which revolution will happen first?

The answer to this question, of course, depends on numerous factors, not the least of which is pure chance. Privacy advocates can play several roles:

- They can ensure that designers and standards committees are aware of technical options that protect privacy without sacrificing functionality.
- They can build and publicize demonstration systems that employ digital cash and other privacy-protecting technologies.
- They can explain the issues to the press and the public, refusing to allow themselves to be positioned as opponents of technology.
- They can use the Internet to keep some technologically adept communities up to date on the issues as they evolve, asking Internet participants to track the issues in their own localities and spreading news of public hearings and other opportunities to present the issues.
- They can provide grassroots support for industry alliances that push for strong cryptography against government proposals that threaten both civil liberties and commercial security.
- They can provide background information, policy analysis, technical assistance, and media connections to citizens' groups that are organizing protests against privacy-degrading projects—such as bad implementations of ITS, particularly for purposes of congestion pricing.
- They can identify, organize, and train local privacy activists.

Most fundamentally, though, privacy advocates can exert an influence by working with a range of other groups. Conditions should be auspicious for this kind of coalition-building. "Digital convergence," after all, is not just a technical phenomenon. It is also a political phenomenon, as an enormous variety of individuals and groups become aware of previously unimagined common interests concerning information technology and its uses. Privacy advocates today, for example, have strong allies among librarians, doctors and nurses, trade unionists, ethnic activists, advocates for the elderly, conservative opponents of overreaching government, and many others. Concern about privacy has also taken on its own life as a cultural phenomenon; the general public is aware in an abstract way of the threats to their privacy, but most people have little concrete understanding of the exact nature of these threats. This vacuum is often filled by strange dystopian tales about microchips being implanted in people's bodies; correct information about the dangers to privacy would be considerably more useful and empowering.

We are thus faced with the task of keeping the political dialogue about technology and privacy as technically sound and broadly inclusive as possible. In this way, we can hope to ensure that transport informatics in particular, and similar systems across the broader landscape more generally, will evolve in a way that provides the benefits of automation while retaining maximum protection of personal privacy.

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California sought to obtain printouts of arrest records for use in a private business. Of the six California counties approached, only two raised objections to handing over these records, although the state's Information Practices Act lists such records as "confidential." (Peninsula Time Tribune, April 4, 1991, p. 4.)

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site has been extensively updated, largely through the work of CPSR's summer interns, Patrick Weston and Daniel Bressler. The URL for the web site is

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We have improved the web site in the following ways:

1. We have eliminated out-of-date material.
2. We have added quite a lot of new material.
3. We have enhanced the consistency of the pages so that they present a common look-and-feel with as much symmetry of structure as we could maintain.

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Project Publication

FROM THE DANISH BOARD OF TECHNOLOGY

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# On the way to intelligent traffic

**- results from a consensus conference**

**Scepticism about traffic informatics predominates. A panel consisting of 14 laymen does not see any substantial economic, environmental or safety benefits from massive public investments in traffic informatics. - Perhaps with the exception of public transport.**

The total amount of traffic is increasing, and in the future one of the tools to control traffic will be the use of information technology - also known as traffic informatics.

The basic idea of traffic informatics is that the right information at the right time can make road traffic more efficient, environmentally friendly, economical and comfortable. Thus, there are great expectations to the technology, but what about possible drawbacks and problems?

**What is traffic informatics?**

Traffic informatics may be defined as:

The application of modern information technology within the traffic sector. By modern information technology we understand computers and data communication.

There is a need to clarify where and how traffic informatics should be used, and thus the direction in which the population wants traffic to develop.

The Danish Board of Technology therefore held a consensus conference about traffic informatics at Christiansborg Palace from 28 to 31 October 1994 .

The purpose of the conference was to review the technological level of traffic informatics and to evaluate and answer questions about application possibilities and consequences in relation to for example safety, the environment and the economy.

Another purpose was to generate interest and disseminate knowledge in order to popularise the discussion about the subject and to contribute to making the basis for traffic policy decisions in this area more qualified.

*The Danish Board of Technology initiates overall assessments of the possibilities and consequences inherent in the technological development - and promotes popular debate on technology.*

*The results of the Board's projects and debating activities express the opinions of the involved experts or laymen.*

TeknologiNævnet

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## Main conclusions of the final document of the layman panel

The layman panel is predominantly sceptical about traffic informatics. The main conclusions of the final document of the panel fall within the following headings:

### Economy

The prognoses, on which the economic calculations for the introduction of traffic informatics are based, are a projection of traffic development during the last twenty years.

The basic viewpoint of the panel is that there is no substantial evidence indicating that considerable economic, environmental or safety benefits will be derived from massive public investments in traffic informatics. Therefore, the panel does not at present recommend the public sector to spend a lot of resources in this area. However, there may be benefits for public transport.

Clearly, manufacturers and businessmen exert a pressure for the introduction of new technology. Any socio-economic benefits as such depend on the system chosen, and the distribution between public and private funding.

### Safety

As regards general road safety, traffic informatics may solve some problems but may at the same time cause new ones to arise. Traffic informatics may be used to increase safety, but hardly to an extent that can make road safety a conclusive argument for the introduction of traffic informatics on a large scale.

Traffic informatics in the form of navigation systems and variable signs may give road-users the possibility of concentrating about traffic and may thus improve road safety.

On the other hand, the panel worries that the introduction of traffic informatics may jeopardise road safety if it involves techno-stress in drivers (stress, apathy, inattentiveness, etc.). There is also a risk that drivers lose their skills, so that they are not able to drive a car manually.

The panel finds that in the short term road safety is best and most cheaply promoted by investment in traditional, low-technology safety measures.

### The environment

It is the impression of the panel that traffic informatics is of only marginal importance to the solution of environmental problems in traffic.

Environmental considerations can therefore not be used as an argument in favour of the introduction of traffic informatics.

Indirectly, however, traffic informatics contains a possibility of making public transport more attractive - this may result in fewer cars on the roads which is an advantage to the environment. The panel recommends that traffic informatics is used to further public transport - also for environmental reasons. Moreover, the panel wants traffic informatics to be used to improve the interaction between various forms of transport.

**What are the goals to be achieved in traffic informatics?:**

- **Route guidance** Current travel directions in relation to a keyed in destination
- **Parking guidance** Travel directions in relation to vacant parking spaces in a certain area
- **Automatic user payment** Registration and levy of tolls, for example for driving on a motorway
- **Automatic police control** Monitoring and registration of road-users' (illegal) behaviour
- **Collision and avoidance systems** Systems which by means of detectors register that a vehicle is on a collision course and which warn about and/or prevent an imminent collision
- **Automatic speed guidance or regulation** Systems that advise about - or automatically regulate - the speed of the vehicle to a suitable level on the basis of for example road surface, weather conditions, type of road, etc.

### Registration

As a number of traffic informatics systems are based on the collection and treatment of personal information, a range of new registers will come into being. It may be registers for toll payment, traffic registration or identification of vehicles or drivers.

When databases are established it is important to collect only data which is necessary in connection with the operation of the traffic informatics system.

The panel demands that registration in systems registering persons must be voluntary. Efforts should be made to ensure as much anonymity as possible.

### Public transport

Traffic informatics may be used to make public as well as individual transport more efficient, and similarly interaction between the various forms of transport may be improved. Interesting experimental projects have already been launched. The panel recommends that these efforts be continued.

There are large differences as regards the benefits derived by public transport in various areas from traffic informatics. In the country, it is particularly important that the systems are made more flexible, so that large buses do not run with few passengers. In major cities there are important environmental and safety reasons to limit the number of cars in the city centres. This should be effected partly by making public transport more attractive, partly by improving the interaction between various forms of transport.

Moreover, "park your car and take the train" schemes may be devised where drivers can park in the suburbs and take public transport to the city centre.

> **Facts about the consensus conference**
>
> The consensus conference is a public hearing where a panel of interested and well-prepared laymen question a number of experts. The laymen have been found on the basis of broad and careful selection. The conference lasts four days, of which three days are open to the public.
>
> The first two days the interviewing panel listens and asks questions to the experts about a number of subjects, laid down in advance by the laymen themselves. On the basis of this, the panel sums up its evaluations in a final document which is presented to the conference participants and the public on the last day of the conference. The final document is subsequently published in the form of a report which also contains all the experts' contributions. The report is distributed to participants in the conference, members of the Danish Parliament and other interested parties. The consensus conference was prepared by the Secretariat to the Danish Board of Technology in co-operation with a planning group.

The panel emphasises the importance of giving high priority to public transport in connection with the development of traffic informatics.

### Pedestrians and cyclists

As product development in traffic informatics is controlled by expected market potential, it has until now been aimed at cars and related means of transport. Pedestrians and cyclists have, on the other hand, not been considered by the product development in traffic informatics yet.

If traffic informatics is used to improve public transport, it will also benefit pedestrians and cyclists as it may, among other things, reduce the amount of motor traffic.

With the existing technology, the panel does not find that traffic informatics will benefit children in traffic. It cannot replace traditional traffic training and information. The panel recommends the exploration of the possibilities to use traffic informatics to help children in traffic.

### Impact on human psyche and behaviour

There are some built-in inconsistencies in the fact that, on the one hand, this technology has a lot of advantages and, on the other, a number of unintended side effects such as stress reactions, apathy, distraction, inattentiveness and a false sense of security. The panel recommends the involvement of both professional behaviourists and user panels as early in the product development as possible. The same applies in connection with testing and approval of equipment.

### Legislation

It is the impression of the panel that, by and large, current legislation is a sufficient framework for the introduction of traffic informatics. However, the panel is aware of some areas where things may develop in such a way that current legislation is not adequate:

- New systems for data registration. Today it is legal to register sensitive personal information in private registers on three conditions: the person must provide the information himself, he must know that it is registered, and it must be necessary for the company to register the information. It may, however, be anticipated that a number of problems may arise if the systems are able to register where we have been when.

- Safety systems, etc. which, to be effective, require that everybody has them. However, the panel does not believe that any of the existing systems are so effective that they deserve to be introduced by law.

- Automatic speed registration. This system is based on the idea that any fine for speeding is imposed on the owner of the vehicle - regardless of whether another person was driving it. The panel wants this matter of responsibility to be settled.

- The panel believes that it should be obligatory for the driver to pull over if he wants to use electronic equipment involving a risk that he impedes or inconveniences other road-users.

### The decision process

The equipment and fitting out of vehicles are matters increasingly controlled by international bodies. General traffic planning is carried out at different levels, so that there is room for local decisions.

The panel expects that in the years to come there will be sweeping and to a wide extent unpredictable development in the traffic informatics area. As this technology is to be employed by users on a large scale in a dangerous and sensitive environment, it is of utmost importance that the technology is developed in an appropriate way and that it is very easy for the users to operate.

To achieve this result it is necessary constantly to involve the users in the further development of traffic informatics technology before it is finally developed, approved and marketed. This objective may be attained in several ways, but the panel finds that it is of great importance that users and drivers are constantly involved before the technology is released and large investments made.

*(Source: Final document and expert consultation paper from the consensus conference held from 28 to 31 October 1994, the Danish Board of Technology series of reports 1995/1 (not translated))*

**Interviewing panel:**

Allan Christensen, 45, associate professor
Anders Peter Larsen, 44, consultant at a job centre
Anita Herdahl, 37, school teacher
Ann Tina Bahnsen, 30, assistant data programmer
Bente Rasmussen, 52, case attendant in the Danish Maritime Authority
Dorthe Lillelund Andersen, 25, agronomist student at the Royal Veterinary and Agricultural University, Copenhagen
Dorthe Jensen, 22, student at Roskilde University Centre
Fritz Gram Pedersen, 64, retired senior clerk from Telecom A/S
Harry Blunck, 52, business economist, currently unemployed
Irene Hansen, 30, nurse, studies computer science at the University of Copenhagen
Kurt Nielsen, 32, computer consultant
Ove Reinø, 31, engineer
Poul Erik Møller, 49, controller at Bang & Olufsen
Tove D Sørensen, 57, careers guidance officer, currently unemployed

**Expert panel:**

Finn Krenk of the Road Directorate
Per Hedelund of Siemens
Erik Toft of the Ministry of Transport
Niels Helberg of the Danish Council of Road Safety Research
Jens Elsbo of Copenhagen Transport
Lizzi Haaning of the Danish Cyclist Association
Ivan Lund Pedersen of NOAH Traffic
Ib Rasmussen of the Road Safety and Transport Agency
Kurt Markworth of the Municipality of Aalborg
Michael Warming of the Danish Building Research Institute
Stig Franzén of Chalmars Teknik Park, Gothenburg
Steffen Strip, computer ethics consultant
Kim Steen-Petersen of the Danish Road Association
Jan Kildebogaard of the Road Directorate
Leif Nielsen of the Federation of Danish Motorists

**Planning group:**

Jan Kildebogaard of the Road Directorate
Leif Hald Petersen of the Danish Transport Council
Thomas Krag of the Danish Cyclist Association
Knud Th. Pedersen of the Federation of Danish Motorists
Henriette Hye-Knudsen of the Secretariat to the Danish Board of Technology

The final document and expert consultation paper from the consensus conference held from 28 to 31 October 1994 have been published in Danish in the report series of the Danish Board of Technology - *På vej mod intelligent trafik,* 1995/1 (121 pages - Price: DKK 75.00)

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EUROPEAN COMMISSION
DIRECTORATE-GENERAL III
INDUSTRY
Legislation and standardization and telematics networks
Standardization

Brussels, 5 July, 1995
KHL/uk/5695-000
DGIII/B/2

**M/**

**SOGITS N 879**
**(For formal consultation)**

**BC-T-335**

# DRAFT STANDARDISATION MANDATE FORWARDED TO CEN/CENELEC/ETSI IN THE FIELD OF INFORMATION TECHNOLOGY AND TELECOMMUNICATIONS

## TITLE

Work programme for electronic toll systems standardisation.

## PURPOSE

The purpose of this mandate is to prepare a work programme for the development of voluntary European harmonised standards covering the elements involved in electronic toll systems such as IC-cards.

The standards shall support Directive 93/89/EEC on " the application by Member States of taxes on certain vehicles used for the carriage of goods by road and tolls and charges for the use of certain infrastructures" with particular reference to common technical standards to promote interoperability.

## JUSTIFICATION

Directive 93/89/EEC demands the Commission to present a report to the Council before 31 December 1997 on implementation of the Directive taking into account of developments in technology. Directive 93/89/EEC also calls for the introduction of electronic toll and/or user-charge systems bearing in mind the desirability of achieving inter-operability between those systems

CEN has recognised the importance of this area, which is covered by several Technical Committees. CEN TC278 is dealing with *Road Traffic and Transport Telematics,* where WG1 is responsible for *Automatic Fee Collection and Access Control*. CEN TC224 is

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EUROPEAN COMMISSION
DIRECTORATE-GENERAL III
INDUSTRY
Legislation and standardization and telematics networks
Standardization

Brussels, 5 July, 1995
KHL/uk/5696-000
DGIII/B/2

**M/**

**SOGITS N 878**
**(For formal consultation)**

**BC-T-336**

**DRAFT STANDARDISATION MANDATE FORWARDED TO CEN/CENELEC/ETSI IN THE FIELD OF INFORMATION TECHNOLOGY AND TELECOMMUNICATIONS**

**TITLE**

Standards for IC cards for road toll collection.

**PURPOSE**

The purpose of this mandate is the establishment of voluntary European Standards covering the elements involved in using IC cards to provide automatic fee collection of road toll.

**JUSTIFICATION**

Existing IC-card standards will provide a solid set of tools and building blocks for implementing Automatic Fee Collection systems. However, in order to enable true inter-operability and compatibility of systems, more than a common set of tools is required. It is essential that, from the wide variety of choices which the common set of tools provide, also common choices are made. This mandate support the development of standards which will provide the specification of these common choices.

**ORDER**

This mandate shall require the establishment of European Standards covering the elements involved in using IC cards to provide automatic fee collection of road toll

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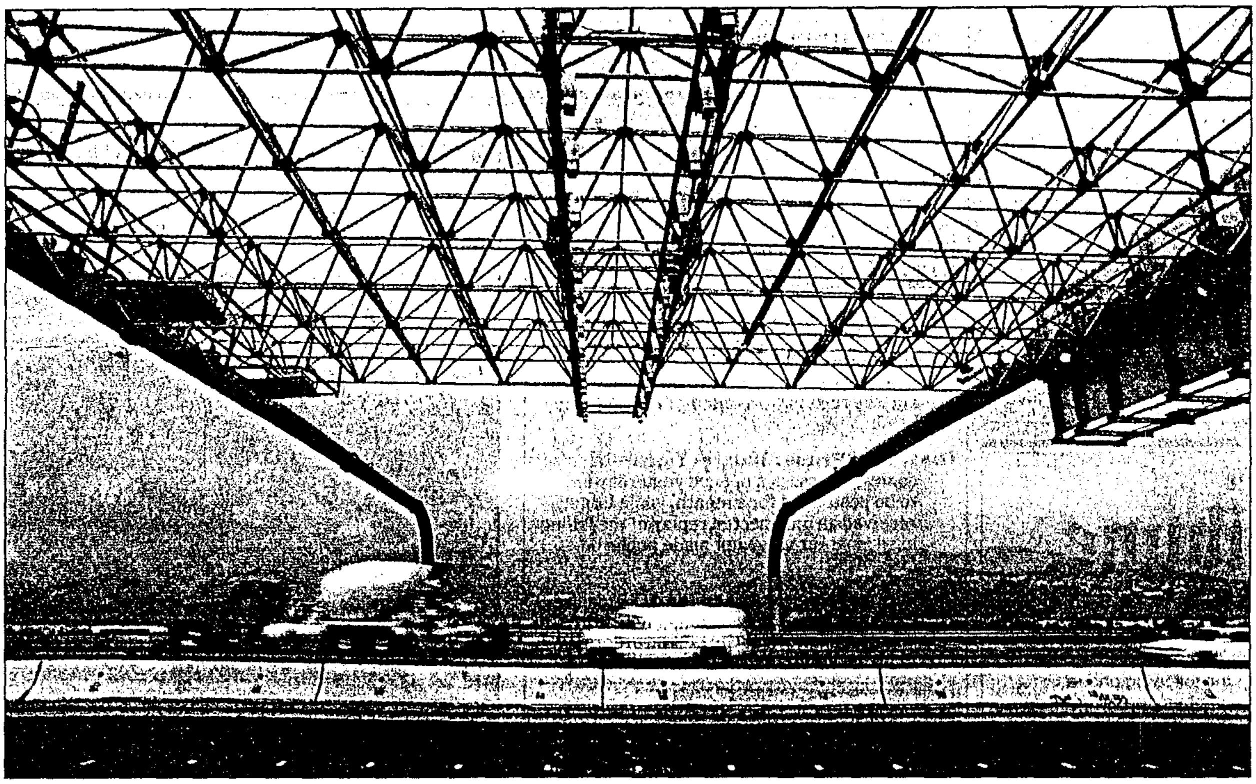
Telex COMEU B 21877 - Telegraphic address COMEUR Brussels

THE SAN DIEGO UNION-TRIBUNE Wednesday, December 20, 1995
City Final



## OPENING SOON: THE TOLL ZONE



Union-Tribune / JERRY RIFE

*Traffic passes under an array of sensors that will be used to control toll traffic on state Route 91 in Orange County.*

# Orange County toll road to blaze trail

## *10-mile-long private highway will be first of its kind in state*

By URI BERLINER
Staff Writer

Cindy Langston has such a grisly commute on the traffic-clogged Route 91 freeway in Orange County that she's exhausted when she finally sits down to work in Anaheim at 7 a.m.

By the time she completes the hour-plus return trip to her home in Riverside County, she has just enough energy to gulp down a microwaved dinner and crawl into bed.

Life in the slow lane is a drag.

Relief could be on the way. A 10-mile private toll road — the first of its kind in California — will open along the freeway's median later this month. Two asphalt lanes in each direction, the $126 million project has tongues wagging over its new technology and controversial pricing structure.

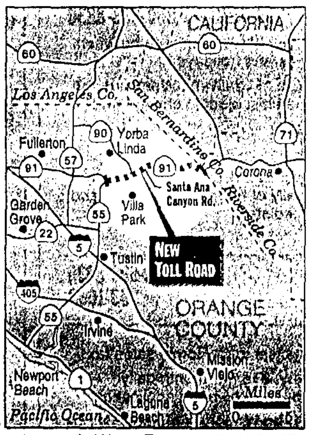
According to the developers, the California Private Transportation Co., the road will cut pollution and save rush-hour commuters up to a total of 40 minutes daily. Critics say it's the first step to separate highways for the affluent and the poor.

Langston, an accounts receivable clerk, favors anything that cuts her freeway hassle. But there's a catch. If she drives alone during rush hour, she *must pay $2.50 in each direction; when she commutes with her regular car pool, the trip is free.*

"It's a bit pricey, but it's great if you're in a car pool," she said.

The experiment — dubbed the 91 Express Lanes — is the first automated toll road in the world. The system uses overhead antennas to read wallet-sized transponders attached to motorists'

See **Toll road** on Page A-31




Union-Tribune / JIM BURNETT

PAGE 2 OF 2


Union-Tribune / JERRY RIFE

**Pay as you go:** *When motorists travel state Route 91's express lanes, transponders such as this will be read by overhead antennas and toll fees will be automatically charged to the motorists.*

# Toll road

## Critics raise the issue of haves and have-nots

Continued from A-1

windshields. Customers hear a beep when tolls are automatically deducted near the road midpoint. The technology includes methods to catch scofflaws who attempt to use the toll road without paying.

Along with high-tech gadgetry, the project employs customer come-ons that harken back to the Burma Shave billboards of the '50s. As they approach the road, motorists pass one large sign, "When Heavy Traffic is a Pain," followed by another, "Move on Over to the FasTrak Lane."

Under a franchise agreement with Caltrans, the private operator will collect tolls for 35 years, with a cap on profits, after which the project reverts to the state. The developer also pays the California Highway Patrol for police services.

The fate of the Orange County venture will be watched closely, especially in San Diego County, where an 11-mile private parkway is in the planning stage.

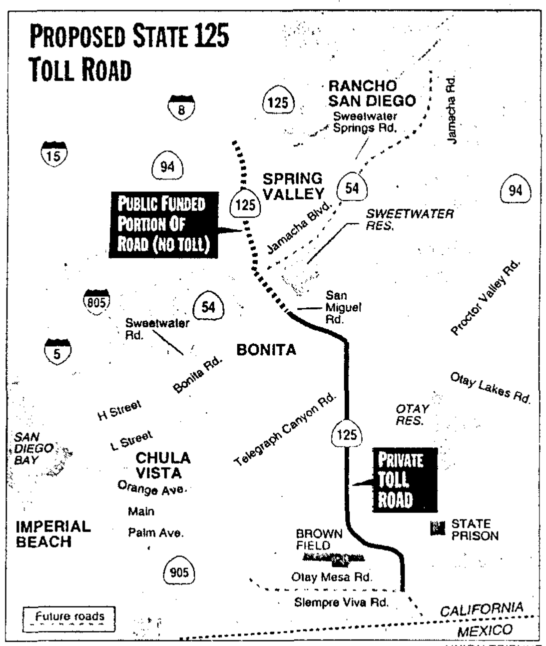
Unlike many European and Asian countries, the United States finances all its highways publicly. When a 14-mile toll corridor between Washington's Dulles Airport and northern Virginia opened in September, it became the nation's first private toll road in more than 50 years.

The project opened six months ahead of schedule, as thousands of gridlock-weary suburbanites toasted with champagne at a ribbon-cutting ceremony. But elsewhere, notably in California, road privatization has drawn heated opposition as well as strong support.

Private toll roads are "un-Californian" and will hurt low- and middle-income drivers, insists state Senate Leader Bill Lockyer, D-Hayward.

"The poor schlub who has no alternative will sit in traffic as the Lexuses fly by," said Duane Peterson, press spokesman for state Sen. Tom Hayden, D-Santa Monica. "It's a strategy to have first-class freeways for those who can afford them and second-class roads for those who can't."

Of course, not everyone agrees. Rather than punishing low-income motorists, the extension will reduce congestion even for motorists who don't use the toll lanes, said Robert Poole of the Reason Foundation in Los Angeles.




UNION-TRIBUNE

Poole is considered the intellectual force behind the market-based approach to road construction. In 1989, the state enacted a bill with his philosophical imprint that allows Caltrans to award private transportation franchises.

Four demonstration projects have been selected, including State Road 125 South, a parkway between State Route 54 and Otay Mesa in San Diego. That $400 million venture, backed by transportation giant Parsons Brinckerhoff Inc. and a French firm, Transroute International, is undergoing environmental review. Developers hope to open the road by late 1998 or early 1999.

"The private sector is willing to put up money to do this; we're seeing it all over the country," said Poole.

But will motorists, who already pay gas taxes for highways (and a half-cent sales tax in San Diego County) fork over tolls for the privilege of driving an uncongested road?

"This is an experiment in the road as a consumer product," said Greg Brooks, a spokesman for the Orange County developers. "We've had thousands of calls to our service center for information. Less than 5 percent of them have been negative."

Commuters view the toll lanes with mixed feelings, said Gary Cherms of the Norco Chamber of Commerce in Riverside County. "They're complaining, but if people can get home 20 minutes faster, they'll be glad. I think the road will pay for itself."

Cherms disputes the idea that the toll will separate automotive haves from have-nots. The primary users, he said, are likely to be residents with modest incomes and brutal commutes to Orange County or even to Los Angeles.

But Langston, the accounts receivable clerk, said only the wealthy will be able to afford a solo commute: "When you add your gas, it's $200 a month. That's as much as a car payment."

To toll supporters like Poole, privatization is the only way to add roads and repair existing ones without raising taxes.

"The gas tax (the major source of highway revenues) keeps shrinking in inflation-adjusted terms," he said. "We need an additional source of funding."

More important, privatization backers say projects like 91 Express introduce realistic market-pricing to driving. Fees are stiff during peak demand hours; relatively cheap when traffic is light. The approach, says Poole, not only reduces congestion, but is fair: ordinarily, taxpayers pick up the tab for roads they may never drive on; toll roads are financed only by people who use them.

Still, some drivers balk at the 91 Express. "It seems expensive," said Susan Pylant of Corona in Riverside County. "And when prices are low you don't have much traffic on the free road, so I don't understand why you'd use it."

But the developers, who looked at more than 75 potential sites before proposing the Orange County road, are convinced they have a winning formula.

Poole hopes the project spurs a transportation revolution in which roads get built because of consumer demand instead of pork-barrel politics.

In the case of Express 91, where car pools of at least three occupants ride free, the project has forged an unlikely alliance: free-market enthusiasts and environmentalists.

"We're excited about it," said Michael Cameron, an economist with the Environmental Defense Fund in Oakland.

Environmentalists favor "congestion pricing" because it figures to reduce pollution: Fewer freeway trips equal cleaner air. The Environmental Defense Fund contends traffic will decline by 25 percent on the 91 freeway by 1999.

But toll-road opponents counter that any reduction in congestion will come at the expense of low and middle-income drivers. "They would be forced off," said Lockyer. "Wealthier drivers would benefit."

Critics also say private road projects are uneconomical because developers keep a portion of the revenue as profit.

"The contractors and their lobbyists aren't interested in a fiscally prudent transportation system," said Peterson, Hayden's spokesman.

Just the opposite, countered Brooks, the developer's spokesman. Because labor costs and interest payments mount during every day of construction, private firms are anxious to build roads faster than such public agencies as Caltrans.

The future of private roads is unlikely to be settled by ideological disputes. Ultimately, it will be up to motorists. Do they want to pay more for a faster trip or a smoother stretch of highway?

Keep your eyes on the toll road. Drivers will be voting with their steering wheels.

[Note: I received this on the Internet, so I cannot be completely certain that it is an accurate version of the article. I have no reason to believe that it isn't, though.]

London Times February 18 1997

A prototype meter on the windscreen is charged using a smartcard. A "ray-gun" tolling system would deduct credit during motorway travel

Motorway drivers face billing by electronic beam

BY JONATHAN PRYNN, TRANSPORT CORRESPONDENT

DRIVERS face having to pay for using motorways by early next century after the development of "ray-gun" tolling technology.

Trials of the tolling system, which uses microwaves to detect and charge passing vehicles, are showing big improvements in reliability, although it is not yet in use anywhere in the world.

If the system goes ahead, every car using the motorways would have to be fitted with a dashboard meter costing =A320 to =A330. The meter would be "read" by microwave beams emitted from overhead gantries. Motorists could pay either by charging up a smartcard or by receiving a monthly bill.

Cars without a meter or with no credit would be photographed by automatic cameras similar to speed cameras and the drivers would risk prosecution.

Early tests in Germany showed the equipment to be highly inaccurate and thousands of motorists would have been charged for journeys they did not make. However, recent advances at the transport research laboratory in Berkshire suggested that only one car in 10,000 would be wrongly charged. Scientists on the project aim to cut the figure to one in ten million.

The Government wants to introduce tolling to raise money for improving roads and to increase the cost of motoring to persuade more people to use public transport. Critics have argued that the tolls would simply force traffic off the motorways on to untolled roads, leading to more congestion. Continental-style tolling booths have been ruled out because of the volume of traffic on British motorways and because of the land they take up.

Tim Wander, a spokesman for the GEC-Marconi consortium, one of two working on a tolling system for British roads, said the technology was now so advanced that the sensors could detect and separately charge two cars driving bumper to bumper at 100mph.

Patrick Clipperton, business development manager of Bosch Telecom, the rival consortium, said talks were going on in Brussels to introduce a unified system across Europe.

The technology could also be used by the police: each sensor can detect the size, make and speed of the cars passing the gantries. John Watts, the Roads Minister, who was visiting the trial site yesterday, said no decision had been taken on whether the police would have access to the data.

Mr Watts said that if trials proved successful the technology would be tested on a stretch of the M3 near Basingstoke before a final decision was taken on whether tolling should go ahead. Levels of tolls have not been set but when the policy was first announced by the Government in 1993, they were estimated at 1.5p per mile for cars and 4.5p per mile for heavy goods vehicles.

Mr Watts said that the tolls could be set at different levels at different times of day to discourage rush-hour traffic or to encourage lorries to travel at night.

Technical and legislative obstacles mean that tolling is unlikely to be introduced for about six years. However, motoring organisations are already complaining that Britain's 21 million drivers contribute far more to the Treasury's coffers than they get back through spending on roads. Labour has said that it would scrap the trials because the system would force traffic on to smaller roads.

# Beyond Self-Serve: Robots and Magic Wands

By LAURA KOSS-FEDER

BUYING gasoline is a chore; drivers want to get in and out of the gas station as quickly as possible and be on their way.

To help ease the process, some big gasoline retailers are experimenting with new gadgets, including radio transmissions, robot arms and scanner technology. All are intended to move motorists along — and maybe even without the smell of gasoline on their hands.

"This is a fiercely competitive business, and the gasoline companies are trying to differentiate themselves from each other," said Ed Maran, an associate analyst with A. G. Edwards & Sons in St. Louis.

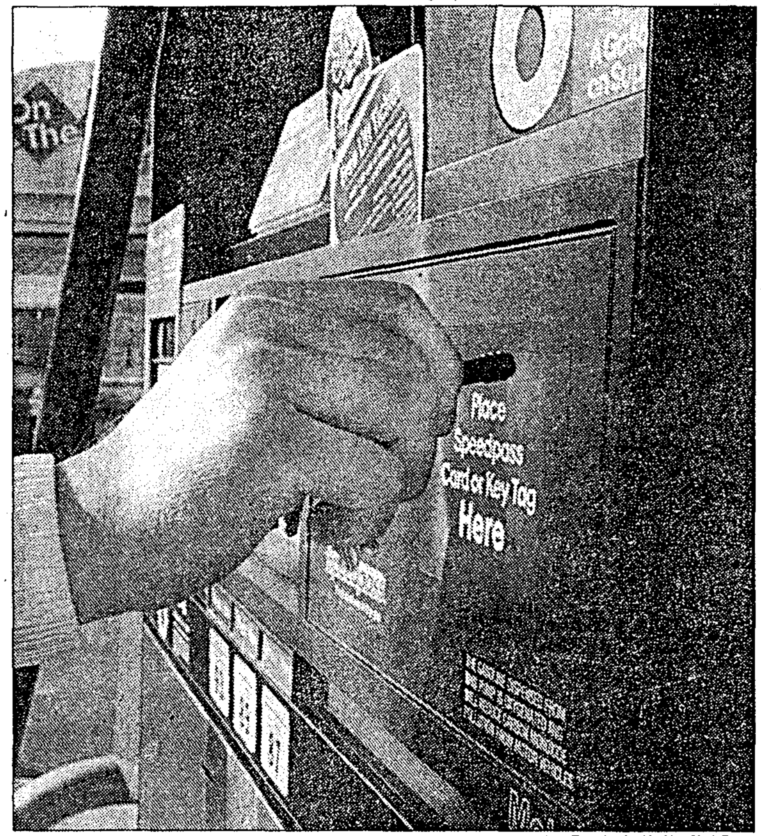
One of the best-known programs is the Mobil Corporation's Speedpass system. Introduced in May and now available at more than 2,500 Mobil stations, it allows customers to buy gas at the pump and have the charge automatically billed to a pre-selected credit card. Enrolled drivers are given a tag, which can be attached to a key ring or placed in a vehicle's rear window. Motorists can wave the key tag at a scanner at the pump, or stop at a special pump that scans the window tag; either tag activates the fueling.

To bolster the use of Speedpass, Mobil discontinued the sign-up fees, which originally ranged from $4.95 to $10.95. Joe Giordano, Mobil's acting pricing and technology manager, said research showed that consumers using Speedpass increased their gas purchases by about one per month.

Shell Oil is testing its similar Easy Pay system, consisting of an electronic keychain device that is also waved in front of a scanner at the pump. The device costs $3.99, and the service is now available at 125 of Shell's 9,000 stations. Shell is not yet sure whether the one-time fee for the device will remain, said Art Driscoll, manager of product development for Shell Oil Products.

Early next year, Shell will also begin

Mobil's "Speedpass," a chip on a key chain, charges gas purchases to a credit card when the chain is waved at a pump.




Amy Toensing for The New York Times

testing its Smart Pump, an automated fueling system. A robotic arm automatically pumps gas through a special fuel cap that replaces the car's original cap. The new cap can still be used for conventional fueling at other gas stations, Mr. Driscoll said.

The Smart Pump also requires a low-range radio transmitter that is mounted to the windshield. Once the customer selects a grade of gas, the automated fueling arm moves around the car, finds the fuel cap, opens the fuel door and dispenses gas. A typical self-service fueling would be cut from four minutes to about two, according to the company.

Mr. Driscoll said Shell had not decided whether to charge for the service. "Research has shown us that customers will pay a premium for this level of service," he said. "While we don't want to put any barriers to people using this service, I wouldn't be surprised if customers would pay a transaction fee of 75 cents or $1."

Texaco plans to test a system similar to Smart Pump in the first half of 1998, using a radio impulse to signal an automatic robotic arm to find the gas cap and pump gasoline.

Dick Arold, brand manager for Star Enterprise, a Houston-based oil refining and marketing company that is half-owned by Texaco, said Star would test the program in two or three Texaco gas stations, which have not been chosen yet. The service would be available to credit card users who run their cards through automatic readers. Customers would also need a special gas cap and a button-sized transponder affixed to their cars.

Star has not decided whether to charge customers for the service; if so, Mr. Arold estimated, the cost could be a nickel a gallon more than traditional self-serve gasoline prices.

Texaco is also testing a cash "acceptor" in five stations in Phoenix; the technology automatically accepts paper currency at gas pumps. Mr. Arold said the technology might be combined with the robotic arm, perhaps in a year or so, to accommodate customers who prefer to pay with cash.

Some new services have nothing to do with dispensing gasoline. The Chevron Corporation is considering a program with the San Francisco Giants that would allow customers to buy and receive baseball tickets at automated teller machines at Chevron stations. A test may be undertaken in 1998 at one or two stations in Northern California.

IT'S too early to tell whether these services will pay off in new business — or whether they could create problems. For instance, the signal devices that allow automatic charging of gas purchases essentially function as credit cards do, so they might become a target of thieves and hackers.

"There has been a mention of security as a concern," said John Callanan, publisher of the Journal of Petroleum Marketing, the monthly publication of the Petroleum Marketers Association. "There could be the opportunity for someone to hack into something and break into certain codes."

And what about a possible technical malfunction, say, of a robotic arm? "One of the most important components to any of these services is that they be mistake-free," Mr. Arold said. "One of the biggest disasters would be if something went wrong and there were damage to a car."

Another potential negative is that customers won't understand how the services work. "Some may think that if something is installed on their car, they won't be able to buy gas at another brand's station; this isn't true," said Ed Rothschild of Podesta Associates, a Washington consulting firm.

Finally, the services are geared toward customers who pay with credit cards. But cash-paying customers make up about 65 percent of all gasoline buyers, Mr. Driscoll said. □

# Technology May Not Drive Nation's Productivity, but It Can Hail a Taxi

■ **Growth:** Optimists say statistics do not fully reflect business gains, like improvements at Yellow Cab. However, skeptics say evidence is lacking.

By ART PINE
TIMES STAFF WRITER

DALLAS—Is America's economic productivity finally rebounding after years of relative stagnation? For one perspective, just call a Yellow Cab the next time you're here.

Chances are that the supervisor can tell instantly which of the company's 450 taxis is nearest you—and available—and can send it immediately. If there is no cab in your area, the next closest one is dispatched automatically.

Yellow Cab is guiding its taxis with the same technology that the Defense Department developed to provide navigation systems for its missiles and aircraft: the satellite-based global positioning system.

A GPS set in every cab continually tracks each taxi's location and transmits it to the dispatcher, who can follow it on a monitor. The system automatically searches for the nearest taxi that is available and even calculates the likely fare, based on estimated distance.

The system is a boon not only to customers. James E. Richards, Yellow Cab's president, says it has transformed the way the firm does business, enabling managers to deploy cabs more efficiently, saving thousands of dollars annually on labor and operating costs, and all but eliminating cheating by drivers and dispatchers.

"I have to say I'm amazed myself," Richards said.

The revolution at Yellow Cab is only one of thousands of dramatic efficiencies being achieved every day at large and small businesses all over the country, using not only computers but also other high-technology equipment including lasers and biotechnology.

It is one of the paradoxes of today's economy that this torrent of technology is not fueling a sustained increase in the nation's productivity—the output per work hour of the average American worker.

The issue is important because rising worker productivity is what ultimately lifts the standard of living of all Americans.

Until 1973, U.S. productivity had been growing at a robust 2.5% to 3% a year, raising living standards sharply and helping, in general, to keep inflation low. Since then, however, productivity growth has averaged a disappointing 1%—and even less since the mid-1980s.

But productivity has spurted in the last six months, rising at a 2.4% annual rate last spring and 4.1% in the summer quarter. Analysts are sharply divided over whether these are aberrations or the start of a trend.

Even the Federal Reserve is split over the issue. In minutes of its November meeting, which were made public earlier this month, the Fed's policy-setting Federal Open Market Committee cited the recent increase in productivity growth as one reason (along with the economic turmoil in Asia) that it did not raise interest rates. But several members of the panel were clearly skeptical.

Essentially, there are two schools of thought about the "productivity paradox."

The optimists believe that the statistics are flawed and have not fully captured the recent gains in productivity, much as the consumer price index may be overestimating the inflation rate. In the last six months, they say, the productivity numbers are finally catching up.

Ed Yardeni, chief economist for the Deutsche Morgan Grenfell investment firm, argues that stepped-up productivity growth is one of the few credible explanations for the U.S. economy's extended period of high growth and low inflation.

Yardeni believes that the improved productivity has led to a "new economy" that will enable the United States to enjoy continued economic growth and low inflation well into the 21st century.

"It really is the Goldilocks economy," Yardeni said—as in, not too hot, not too cold.

If Yardeni is correct, the benefits could be enormous. Even a 1-percentage-point rise in annual productivity, proponents argue, could add so much to the nation's economy that the extra tax revenue would provide full Social Security benefits for the baby boom generation.

Others, however, are skeptical about such assertions. Barry P. Bosworth, an economist at the Brookings Institution think tank, argues that despite the gains of the last two quarters, the longer-term statistics "don't support any notion that we have evidence of improving productivity."

The past few quarters' improvement in the statistics "are typical of what happens at this stage of any expansion," when output is rising rapidly and business is trying to hold its hiring down, Bosworth contends. "We've heard these kinds of arguments before."

Whatever the statistics show, the anecdotal evidence of productivity gains is impressive by any standard.

- Dell Computer Corp. now routinely asks customers to place their orders over the Internet, eliminating the need to maintain huge inventories, sprawling warehouses and large staffs. Its newest factory is being built without space for storing excess stock.
- Quad Graphics, a Milwaukee printing company, has installed robot-assisted stacking, storage and retrieval systems that enable it to use wider, faster presses and to save money on postage by automatically storing magazines by ZIP Code.
- Russell Corp., a textile maker in Alexander City, Ala., has put in computer-controlled spinning and cutting equipment that has helped it double production with the same number of employees and buildings. The system uses robots to help consolidate manual operations.

Those who contend that the economy is changing cite such examples, multiplied many times over, as strong evidence that productivity must be improving dramatically despite the sluggishness reflected by the official statistics.

They cite a variety of factors that may have spurred productivity in recent years: Globalization of the economy has prodded companies into seeking to reduce costs. Government deregulation has made firms more efficient. Business investment has mushroomed.

Finally, they point out that current techniques for measuring productivity are geared primarily to manufacturing, although the nation now produces about $1.50 worth of services for every $1 worth of manufactured goods.

Service firms have been among the biggest beneficiaries of the efficiencies generated by the computer revolution.

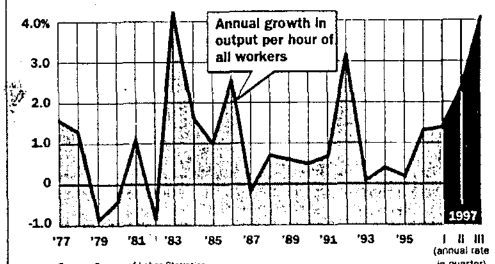
John T. Pearl & Associates, a Peoria, Ill., insurance firm, has just installed a computer system that has cut the time it takes for its underwriters to process applica-

**Please see ECONOMY, A21**



## The Productivity Record

From 1948 to 1973, U.S. productivity, as measured by the output per work hour of the average American worker, grew at an average of 2.8% a year, raising living standards and helping to keep inflation low. Since then, however, productivity growth has averaged a disappointing 1%. But productivity has spurted in the past six months, rising at a 2.4% annual rate last spring and 4.1% in the summer quarter.




Source: Bureau of Labor Statistics

Los Angeles Times

# ECONOMY: Productivity Statistics Being Scrutinized

**Continued from A20**

tions from 45 days to less than 10.

Moreover, laptop computers enable field agents to provide instant rate quotes right in front of potential customers, quickly fill out detailed application forms and check on the status of applications. Customers can even buy policies over the Internet.

W. Michael Cox, chief economist at the Federal Reserve Bank of Dallas, points out that the government's productivity-measuring techniques also do not adequately gauge improvements in the *quality* of goods or services being produced, which also adds to efficiency.

Cox points out, for example, that automobiles are built so much better these days that business buyers are saving millions of dollars on maintenance, operating costs and replacement. Yet efficiencies such as these, he says, are not reflected in the productivity figures.

Levi Strauss & Co. has installed computer-controlled lasers that enable it to cut and sew custom-fit jeans for individual buyers using measurements taken in stores and transmitted electronically to the factory—a service unimaginable even a few years ago.

"The productivity is showing up everywhere but in the numbers," Cox asserted.

Frank Stafford, a University of Michigan economist, argues that productivity gains have been all the greater because the statistics exaggerate the number of hours worked.

Although statistics suggest that Americans are working longer hours than they used to, time studies show that they spend a greater share of those hours—up to six each week—doing things not related to their work—from making personal phone calls to playing solitaire on computers.

Stafford's conclusion: "The productivity slowdown in the mid-1970s and mid-1980s was substantially a measurement problem."

Allen Sinai, economist at Primark Decision Economics, adds that productivity has not seemed to reflect the effect of new technology because it often takes years before the benefits of an invention can be fully exploited.

For the first several years after the invention of the microprocessor in 1971, he points out, computers were used as little more than efficient calculators and typewriters.

Likewise, when laser technology was invented in the late 1960s, officials at Bell Labs refused to patent it because they thought it had no application in telecommunications. Only after fiber optics came of age did Bell fully realize the laser's potential.

Today, by contrast, imaginative firms have combined these and other technologies in all kinds of productive ways.

Soli-Flo, an Oceanside, Calif., company, uses lasers and the global positioning system to improve efficiency in dredging lakes and rivers. The GPS guides dredges automatically, eliminating costly overlaps caused by conventional surveying, which is imprecise and slow.

Thanks to sophisticated software programs, even companies with worldwide reach can keep daily tabs on an array of operations.

Wal-Mart, for example, has developed a computer software system that enables it to download data from cash registers across the country every night and use the information to replenish and distribute its inventory—even notifying suppliers when to step up their production lines.

Businesses have needed time to get used to such innovations. Gerry Gustafson, a Rockford, Ill., plastics manufacturer, says his firm did not begin investing in the new high-tech equipment until it was nearly driven out of business by better-equipped competitors.

"We'll never become obsolete again," he vowed.

For all the anecdotal evidence, there are still plenty of skeptics.

David A. Wyss, an economist at DRI/Standard & Poor's, predicts that the spurt of productivity growth last spring and summer will prove to be a fluke. "I don't think this is the start of the New Economy," he said.

Larry Mishel of the Economic Policy Institute, a liberal research group, is another defender of the productivity data.

While productivity may have been underestimated, he says, the error is unlikely to be very large—maybe the difference between growth of 1.1% a year and 1% a year—and certainly will not support assertions that the improvement has led the country into a New Economy.

Daniel E. Sichel, a senior economist for the Federal Reserve Board, is a skeptic for a different reason: No matter how dazzling the computer revolution may seem to Americans fascinated with images on a monitor, he says, its effect on productivity has been overstated.

Computer technology constitutes only 2% of business investment in capital stock, Sichel says, and much of that is simply to replace older computers, which become obsolete in almost no time.

Here in Dallas, however, Yellow Cab President Richards says technology's effect can scarcely be overestimated. Far from being just a gimmick, he says, the new system has already sped up taxi response times, saved money on operations and provided more capacity for growth.

Drivers love it because they no longer have to scramble to learn the best times and places to wait for customers or to defend themselves against other drivers who may try to poach. In-cab monitor screens show every cabby where the busiest parts of town are.

It also has virtually eliminated the payola system that enabled dispatchers to play favorites by saving choice fares for those cabbies who were willing to slip them a few dollars each month. These days, the computer picks out the nearest available cab. It's incorruptible.

Another benefit: Cabbies can signal the dispatcher quietly—with the touch of a button—if they get into an accident or a passenger pulls a gun on them. The dispatcher can give police the taxi's location without having to ask the driver.

"There's just no reason to have to sit around idly anymore waiting for business to come my way," said Brad Elliott, a 24-year-old driver who joined the company a year ago. "For myself, I love it. It's a great system to have in place."

Richards concedes that the system was so full of bugs during its first few months that the company nearly boxed it all up and sent it back to the manufacturer.

Drivers pushed buttons willy-nilly, overloading the emergency signal. The system crashed repeatedly. Errors and gaps in the database left the system so hobbled that the company once was unable to send a taxi to a woman who needed to get to a hospital.

"We were certainly unhappy for a while," Richards said.

No more. Now he reports that driver turnover is down substantially, the firm is attracting applicants from other companies and Yellow Cab is expanding its business steadily without adding dozens of new employees.

"I don't think we've yet realized all the potential," he said.

Los Angeles Times MONDAY, JANUARY 12, 1998 D1

# Road Scholars

IRIS SCHNEIDER / Los Angeles Times

From left, researcher Phyllis Nelson, student Buddy Nelsen and UCLA professors Oscar Stafsudd and Ioannis Kanellakopoulos.

## 'Smart' cars that could revolutionize transportation and reduce pollution are moving closer to reality with technology being developed in the Southland.

By KAREN KAPLAN, TIMES STAFF WRITER

For most people, the thought of doubling the number of cars on the Southland's crowded highways inspires dread and maybe a little road rage. But for a group of research engineers along the Tech Coast, it is something of a Holy Grail.

These researchers at UCLA, USC, UC Irvine and UC Riverside are developing intelligent transportation technologies that, when fully implemented, could boost freeway capacity as much as 200% while reducing travel time and cutting back on air pollution.

"Certainly there's been a whole sequence of technological innovations since Henry Ford, but the thing that hasn't changed since Henry Ford's time is the interaction between the vehicle and the roadway," said Steven Shladover, deputy director of Partners for Advanced Transit and Highways, a research effort administered by UC Berkeley that receives about $6 million a year from the California Department of Transportation, as well as funding from other sources.

PATH's goal is to make cars "smarter" by enabling

Please see CARS, D6

## Traffic Control

"Smart" cars could increase the traffic capacity of today's freeways without requiring any new road construction. Sensors and actuators would work in tandem to pack more cars in traffic lanes. The devices would help vehicles maintain a safe distance from one another and keep them cruising at a constant speed, eliminating much of the abrupt acceleration and braking that causes traffic jams and adds to air pollution.

### How It Works

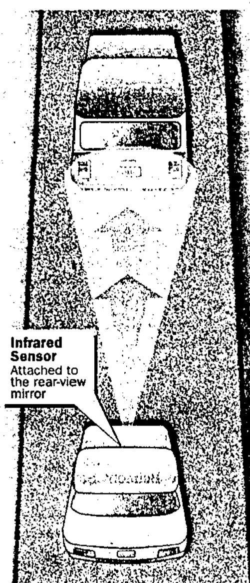
Researchers are designing intelligent cruise-control systems that allow one car to follow another. The high-tech car will automatically slow down if the car ahead slows, or speed up if the lead vehicle accelerates. Tiny sensors attached to the front of a car can measure the distance between it and the vehicle ahead. Engineers at UCLA are using infrared technology to build an inexpensive system that uses lasers like those found in compact disc players.

**Capturing Reflections**

A laser bounces off reflective patches in the taillights and reflective paint in the license plate. These reflections become data that are recorded and "compared."

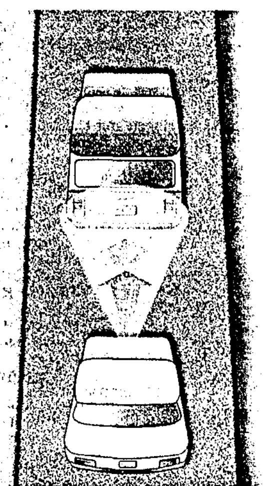
**Electronic Snapshots**

A microprocessor instructs a charge-coupled device, or CCD, to take an electronic picture (brown arrow) of the car in front. A split second later, a laser fires and the CCD camera takes another picture (pink arrow), this time with the laser illuminating reflective patches on the taillights and the license plate.



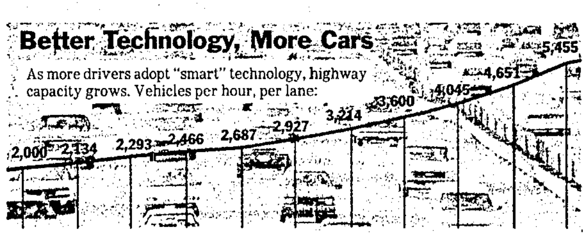

**Gauging the Distance**

The CCD repeats this process over and over, comparing the position of the license plate and taillights, which enables it to determine the relative speed of and distance between the two cars.



**Tell Me What to Do**

After measuring changes in the relative distance, the microprocessor decides whether the car should speed up or slow down. Commands are then sent to tiny actuators controlling the car's throttle and brakes.




Sources: Center for Advanced Transportation at USC; UCLA

MATT MOODY / Los Angeles Times

COVER STORY

# CARS: 'Smart' Technology Could Revolutionize Driving

Continued from D1

them to communicate and synchronize their positions with other vehicles on the road. That would allow for a smoother flow of traffic, which—in theory—would prevent collisions, reduce congestion and cut hydrocarbon emissions 10% to 20%.

"These technologies offer an opportunity for making some really significant improvements in the way the transportation system works, just like modern electronics have improved many other aspects of life," Shladover said. "This makes it possible to significantly improve the efficiency and safety and comfort and convenience and emissions and fuel economy associated with travel."

Futurists have envisioned intelligent transportation systems since the 1930s, but not until last summer were researchers able to provide a practical demonstration of an automated highway: 10 driverless Buicks cruising along a carpool lane in northern San Diego County.

Moving from that stage to implementation, however, will require more research.

In order for cars to coordinate with one another, they must have intelligent cruise-control systems. Instead of merely maintaining a constant speed, a car with intelligent cruise control could, in theory, maintain a constant distance behind another car, automatically speeding up or slowing down in response to changes in the lead vehicle. Intelligent cruise-control systems could also guide cars around curves or into another lane when necessary.

In prototypes under development at UCLA and elsewhere, tiny sensors mounted on a car gather data about nearby vehicles and lane markers, then feed the information to an on-board microprocessor, which uses it to calculate relative speed and distance. The microprocessor sends commands to chip-size machines called actuators, which control the car's throttle and brake to make it speed up or slow down.

The challenge is to build not only a working system, but an inexpensive one. Engineers at UCLA are using infrared sensors instead of more pricey radar to track distances between cars, for example.

UCLA's IRIS system (for Intelligent Ranging with Infrared Sensors) packs a microprocessor, a semiconductor-based camera known as a charge-coupled device and a low-power laser into a contraption about the size of a garage door opener.

The CCD camera takes an electronic picture of the car ahead. A fraction of a second later, it takes a second picture, this time with the laser illuminating special reflective patches on the lead car's taillights and license plate.

The system then produces a digital image of the lead vehicle's taillights and license plate and compares the pictures. By repeating this process over and over, the chip can use standard triangulation techniques to determine the relative speed of the car ahead. (A two-camera system that determines the actual distance between the vehicles and the speed at which they are traveling is also under development.) The information is used to decide whether the car should speed up or slow down.

The IRIS system is at least four to five times cheaper than a comparable radar-based system, said Ioannis Kanellakopoulos, a UCLA electrical engineering professor who has spent the last seven months developing IRIS with professor Oscar Stafsudd and researcher Phyllis Nelson. They are testing the hardware on a car at the Westwood campus and are in talks with several potential industry partners about commercializing the technology.

Researchers at the Center for Advanced Transportation Technologies at USC expect intelligent cruise control to practically eliminate the familiar "slinky effect" that occurs when a road disturbance causes pockets of backed-up traffic. In a traffic jam, anxious drivers speed up as much as they can when the car ahead of them starts to move, then are forced to slam on the brakes and come to a quick stop, creating frustrating stop-and-go conditions, said Petros Ioannou, director of the USC center.

With intelligent cruise control, cars would be programmed to synchronize their speed with the vehicles ahead of them, eliminating the herky-jerky pattern of such tie-ups.

A study conducted by Ioannou found that as more drivers install intelligent cruise-control systems, more cars could be on the freeway at once without a corresponding increase in travel time.

In a single hour, a typical freeway lane can handle about 2,000 cars traveling at 60 mph. If half the cars on the road were equipped with intelligent cruise control, the same lane could carry nearly 3,000 cars in the same period. With 80% of cars equipped, the capacity is more than 4,000 cars in an hour, and if all cars had the technology, nearly 5,500 vehicles could use the single freeway lane.

UCLA's Kanellakopoulos is also working on a computer model to simulate the behavior of big-rig trucks driving in synchronized platoons. He and others believe the trucks could be strung together like train cars using "electronic tow bars"—sensor and actuator systems that could eliminate the need for human drivers in all but the front-running rig. An 18-wheeler near PATH headquarters in Berkeley is being outfitted for automated-driving tests in April.

At UC Riverside, electrical engineering professor Jay Farrell is using data from global positioning system satellites—the core of the system now used to provide the electronic map displays found in many rental cars—to develop a more precise technology that can tell cars exactly where they are.

Farrell says technology he is developing should be able to pinpoint a vehicle's location to within 1 centimeter (0.4 inch) by keeping track of the number of radio wave cycles in a GPS signal to calculate how far a receiver is from a specific satellite. Once the precise distance is known, a vehicle can use a navigation system of gyroscopes and accelerometers to calculate its changing position as it moves away from the starting point.

But Farrell said combining GPS navigation with intelligent cruise control so a car can figure out where to go and then drive there is at least 10 years away. More funding is needed to resolve some "nitty-gritty technical issues," such as how often the system would have to confirm its location with the GPS system. An even bigger hurdle, he said, is improving obstacle detection so that cars can maneuver around occasional highway nuisances, like a sofa fallen off the back of a truck.

Researchers at the Institute of Transportation Studies at UC Irvine are developing traffic management software to reduce gridlock caused by collisions, stalled cars and other roadway disturbances.

The center uses traffic data supplied over fiber-optic networks in real time from Caltrans to test its computer models, said Baher Abdulhai, a research engineer at the institute. One program under development would divert traffic from highways to surface streets to circumvent accidents and automatically adjust the timing of traffic lights in order to accommodate the additional cars.

It's not just convenience that might be enhanced by these new systems. A reduction in hydrocarbon emissions could also result if the systems reduce the amount of time vehicles spend on the roads, said Matthew Barth, an electrical engineering professor at UC Riverside.

Moreover, by cutting down on stops and starts, smart driving will improve air quality, because a car's emissions control system is most effective when the car is being driven at a steady rate, Barth said.

However, if intelligent transportation technologies improve freeway conditions so much that drivers take to the roads in greater numbers, all of these benefits could be wiped out, he acknowledged.

Even with all the technical obstacles, members of the PATH consortium are convinced that solving them is cheaper than the alternative.

"We either have to manage our existing capacity better or build more roads," Abdulhai said. "But we don't have money for more roads, and we don't have space for more roads, and the environment can't handle new roads."

**Karen Kaplan covers technology, telecommunications and aerospace. She can be reached at karen.kaplan@latimes.com**

THE WALL STREET JOURNAL - Marketplace - B1
Wednesday, December 4, 1996

**TECHNOLOGY**

# *Privacy Concerns Are Roadblocks on 'Smart' Highways*

By Ross Kerber
*Staff Reporter of* The Wall Street Journal

Are "smart" highways too nosy?

Many states are installing high-tech roadside sensors that promise to speed traffic, eliminate tollbooths and cut costs. Trucking companies have invested in similar equipment—often linked to satellites—to improve fleet management. But the government's easy access to the lode of data being compiled on drivers alarms privacy advocates.

Sixteen of the nation's 65 regional toll authorities now use such monitoring equipment, which collect a lot more than motorists' change. The devices—often located in or near tollbooths—can pinpoint vehicle whereabouts at specific times. Roadside cameras can photograph motorists and their cars' license plates, thus recording the routes they frequent and the distances they travel.

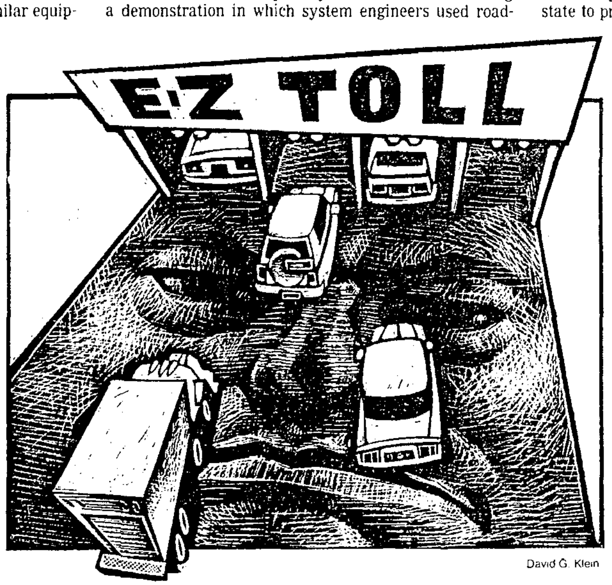
Makers of smart-highway devices, including **General Motors** Corp.'s Hughes Electronics unit and **Lockheed Martin** Corp., have high hopes for the products' potential. One Hughes official forecasts industry sales of $2 billion of automated toll-collection systems alone over the next five years. But such optimism is tempered by worry that a backlash by motorists will slow installation.

Fears of abuse, even if misplaced, could delay state-sponsored projects, says D. Craig Roberts, an attorney for ITS America, a consortium of auto makers, manufacturers of smart-highway devices and public transportation agencies. "From our perspective, this is a potential show-stopper," Mr. Roberts says of rising privacy worries. "It's like a big nail in the road."

Working with the various public toll authorities as well as the American Civil Liberties Union, Mr. Roberts's group has been trying to draw up ground rules governing when a driver's whereabouts may be checked using automated highway devices. In Florida and New York, for example, police already use toll records to check suspects' whereabouts and investigate stolen vehicles.

"What's frightening is when there are no protocols for control of the information," says Randy Morris, a commissioner of Seminole County, Fla.

Last summer, Mr. Morris led a successful drive to dismantle a traffic-monitoring system in the county. He became concerned about privacy violations after watching a demonstration in which system engineers used roadside cameras to zoom in on pedestrians who had nothing to do with traffic flow.




David G. Klein

Of the various smart-highway systems, automated toll collection is the most extensively used; tens of thousands of U.S. motorists participate. Along State Route 91 near Los Angeles, for example, two corporations have built what amounts to a four-lane stretch of private highway, accessible only to motorists who purchase an automated radio device for their cars. Drivers' credit cards are charged periodically for their use of the road, as calculated by the system. Those who wish more anonymity can go to a toll office and pay cash. The lanes were built by a joint venture of Bechtel Group Inc. and Peter Kiewit Sons' Inc.

Privacy concerns have led officials elsewhere in the state to proceed cautiously. Earlier this year, the California Air Resources Board tabled a proposal that would have required installation of transponders in new cars to alert authorities when a vehicle's antipollution device failed. Some board members were concerned about a public outcry similar to one that has erupted over the state's practice of photographing license plates in order to survey motorists affected by planned road repairs.

The surveys are being conducted by the California Department of Transportation, which also does the camera work. Jim Drago, an agency spokesman, says he has heard from about 500 motorists fuming with comments like "Isn't this the ultimate Big Brother looking over me? Where is this going?" Nonetheless, the camera surveys continue because they generate a higher response rate than random direct-mail questionnaires.

Phil Agre, a University of California at San Diego professor who has consulted with the ACLU on highway-privacy issues, argues that individual citizens shouldn't have to take special action to keep the government out of their business. "Anonymity should be your right to begin with," he says, suggesting that toll agencies use billing systems akin to prepaid telephone calling cards.

Privacy concerns are also slowing adoption of an automated truck-weighing system in several Western states. The system, called PrePass, is operated by a Phoenix-based consortium, Help Inc., which is supported by Lockheed Martin and includes representatives of trucking companies and some Western states on its board. It operates at six locations along Interstate 5 in California, as well as on certain highways in New Mexico and Arizona.

About a mile before a truck reaches a station equipped with the PrePass system, its weight is calculated as it

*Please Turn to Page B7, Column 1*

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## Privacy Concerns Are A Growing Roadblock On 'Smart' Highways

*Continued From Page B1*

drives over sensors buried in the pavement. A few seconds later, the driver gets an automated radio notification if the truck is heavy enough to require a stop at the weigh station. As a truck proceeds along the highway, PrePass tracks its route. Trucking companies participate voluntarily; Help bills them up to $2.50 for each remote measurement.

Clients praise the system for saving time and fuel, but plans to expand it have hit snags. Before adopting the weighing equipment, Oregon, Idaho and Washington officials wanted assurances that they could use Help's information to enforce collection of freight taxes, which are partly based on distance traveled.

Help decided not to install equipment in Oregon, for fear that some truckers would stop participating. Officials in Washington and Idaho never got to the negotiation stage. Participating truckers argue that automating such records would subject them to selective enforcement, because nonparticipants wouldn't be singled out. Help says its records in California, New Mexico and Arizona aren't scrutinized by state officials.

To mollify such concerns, Help also says it intends to destroy weight data shortly after it is recorded. "You can't subpoena data that doesn't exist," says Richard Landis, Help's president.

The trucking industry is also watching a case involving Artic Express Inc., an Ohio-based hauler. The Federal Highway Administration has subpoenaed the records that Artic keeps through a satellite truck-tracking system made by Qualcomm Inc. of San Diego. The federal agency is investigating whether Artic meets driver drug-testing and rest requirements. Artic is challenging the subpoena.

# Singapore Moves Toward Eléctronic Tolls for Vehicles

By Michael Richardson
*International Herald Tribune*

SINGAPORE — In a major step toward a transportation network for the 21st century, Singapore has awarded a contract to create an electronic toll system to reduce automobile congestion in the city-state.

The system, described as the world's first for urban traffic management, will use electronic debit cards installed on all of Singapore's 650,000 motor vehicles. The so-called smart cards will be slotted into small holders mounted inside the windshield.

As vehicles pass under electronic scanners mounted on gantries leading to congested areas and busy highways, charges will be deducted from credit stored in the cards. The first phase of the system, which will cost 197 million Singapore dollars ($140 million), will start operation in late 1997. It will be extended in stages to provide island-wide coverage by the end of the century.

A contract for the program was awarded Friday to Philips Singapore, Mitsubishi Heavy Industries and Miyoshi Electronics of Japan and CEI Systems & Engineering, a subsidiary of the Singapore government's Singapore Technologies group.

One advantage of electronic road pricing is that charges can be automatically raised at peak periods or on busy routes to discourage the use of private vehicles without involving lines of motorists at toll booths.

Since 1975, Singapore has restricted rush-hour access to the city center to drivers who have bought special permits, which have to be displayed on windshields and are monitored by police manning entry checkpoints.

The government also imposes hefty taxes on cars and makes people who want to own them bid for the right to do so. That privilege costs about 18,250 dollars for small automobiles and 45,000 dollars for medium- size family sedans. Under government regulations, cars more than 10 years old must be taken off the road.

This system has succeeded in controlling traffic flow much better than in most other East Asian cities.

Despite some of the world's highest ownership prices, Singaporeans are turning to cars in ever-growing numbers as their affluence increases.

Roads now occupy 11 percent of Singapore's 587 square kilometers, about the same area as housing. Mah Bow Tan, the communications minister, warned last month that if trends continued, roads could take up 16 percent of the island-state by 2010.

He said that the increase would be at the expense of housing, schools, offices, factories, parks and gardens.

"I do not think Singaporeans are prepared to accept that," Mr. Mah added.

The Land Transport Authority was instructed by the government recently to prepare a White Paper by mid-November to detail how Singapore could develop and sustain a world-class transport system.

The country already has a mass rapid transport system that runs underground in the business district and on elevated rails elsewhere.