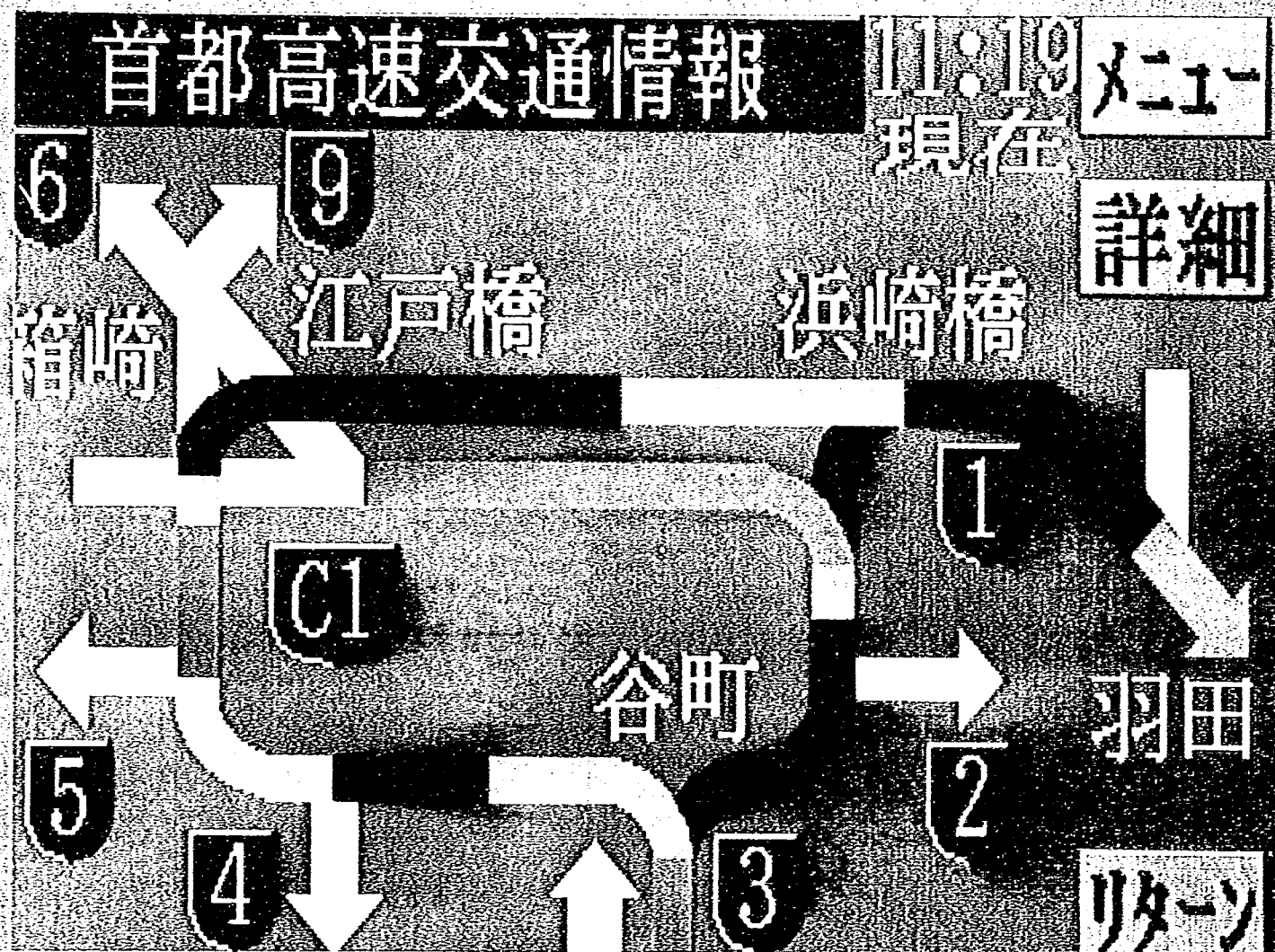


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Technical Memorandum
of PWRI NO. 3203

Proceedings of the 1st U.S. - Japan IVHS Group Meeting of the U.S. - Japan Cooperation on Highway Science & Technology

21st-23rd April, 1993
Tsukuba



August, 1993

Road Bureau, Ministry of Construction
Public Works Research Institute (PWRI)
Federal Highway Administration (FHWA)
Highway Industry Development Organization
Japan Digital Road Map Association

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1. Preface

The 1st U.S.-Japan IVHS (Intelligent Vehicle Highway System) Group Meeting was held in PWRI for 4 days from April 20, 1993 to April 23 pursuant to the Implementing Arrangement between the Ministry of Construction (MOC) of Japan and the Federal Highway Administration (FHWA) of the United States of America on Highway Science and Technology.

The arrangement, which was concluded in May 1992, aimed to promote and enhance public safety and community welfare by fostering research, development and improvement of highway structures and surfaces, and to promote, encourage, and advance a system of safer, more economical, efficient, and environmentally sound highway transportation through research, development and cooperation. The U.S.-Japan Workshop on Advanced Technology in Highway Engineering which was held in December 1992 also in PWRI, resolved to conduct 8 group meetings on topics such as pavement, highway bridges, IVHS, road traffic safety and others. It was agreed then that the objectives of the IVHS group meeting are to encourage research & development and to exchange governmental evaluations of system tests and implementation of IVHS, and that the 1st group meeting would be held in April 1993 as an initiation of the cooperative efforts.

MOC has drawn the Long-term Vision of Road Improvement toward the beginning of the 21st century, one of which proposes development and implementation of Advanced Road Transportation System (ARTS) which is a major IVHS activity in Japan. One of the goals of the 11th 5-year Road Improvement Programs which span from 1993 to 1997 is to enhance road traffic information system for the advancement of information services. On the other hand, in the U.S., the Intermodal Surface Transportation Efficiency Act (ISTEA) was enacted in December 1991. Furthermore, the New 6-year Road Improvement Program incorporates the development of IVHS and the

launching of implementation toward the 21st century. Therefore, it is just necessary for MOC and FHWA to exchange present status and to study advanced technologies. It is expected that the group meeting will foster better understanding with each other and contribute to the development of IVHS technologies.

A total of 70 persons participated in the 1st U.S.-Japan IVHS Group Meeting. Five engineers from FHWA and some private companies in the U.S. were invited to make presentations and to discuss IVHS.

Professors, engineers and administrators from MOC and some public corporations, as well as engineers from some foundations and private companies in Japan joined the meeting.

It was our great pleasure that we could get a great deal of accomplishment from the viewpoint of not only information exchange about status of IVHS activities and results of research & development but also friendship between the U.S. and Japan through the group meeting. Finally, we would like to express our gratitude to all participants and to all the people who cooperated in the group meeting and made the conference a success.



Makoto Nakamura

Contact person of Japanese IVHS Group
Chief, Traffic Engineering Division,
Road Department,
Public Works Research Institute

2. Program

21 April (Wednesday)

9:00 - 9:30 Registration

9:30 - 10:00 Opening ceremony

Mr. Yukihiro Sumiyoshi/Director General, PWRI

Mr. C. John MacGowan/Chief, IVHS Research Division,

Turner-Fairbank Highway Research Center, FHWA

Mr. Hiroo Kanzaki, Director, Road Department, PWRI

10:00 - 10:15 Commemoration picture

(Break)

10:30 - 11:30 Keynote speech from Japan side

"How to propel the ARTS project"

by Mr. Tadao Iwatate/Deputy Director, Road Traffic Control

Division, Road Bureau, MOC

11:30 - 12:30 Keynote speech from U.S. side

"Status of IVHS in the U.S."

by Mr. C. John MacGowan/Chief, IVHS Research Division,

Turner-Fairbank Highway Research Center, FHWA

(Lunch)

14:00 - 14:40 Presentation (1) from Japan side

"Vehicle Information & Communication System (VICS)"

by Yoshitaro Masuda/Technical Councilor, Highway Industry

Development Organization

14:40 - 15:20 Presentation (1) from U.S. side

"1993 IVHS Operational Tests"

by Mr. Robert L. Rupert/IVHS Operational Test Team Leader,

Office of Traffic Management & IVHS, FHWA

15:20 - 15:40 Questions & Answers

(Break)

16:00 - 16:40 Presentation (2) from Japan side

"Headway and Lateral Control System/Results of Transmission Experiment Using Leakage Coaxial Cable (LCXs) in the Quasi-Microwave Bandwidth"

by Mr. Yohei Hioki/Chief Researcher, Traffic Engineering Division, PWRI

Mr. Yutaka Yamada/General Manager, System Engineering Department, Telecommunication Division, Oki Electric Industry Corporation, Ltd.

16:40 - 17:20 Presentation (2) from U.S. side

"Design Features of a Subcarrier based Traffic Information Channel (STIC)"

by Mr. Frank J. Mammano/ATIS & Communications Research Chief, IVHS Research Division, Turner-Fairbank Highway Research Center, FHWA

17:20 - 17:40 Questions & Answers

22 April (Thursday)

9:00 - 9:40 Presentation (3) from U.S. side

"In-Vehicle Safety Advisory Warning Systems (IVSAWS)"

by Dr. Gregory L. Mayhew/Project Technical Director, Hughes Aircraft Corporation

9:40 - 10:20 Presentation (3) from Japan side

"Preparation and Application of Digital Road Map in Japan"

by Mr. Masao Shibata/Executive Director, Japan Digital Road Map Association

10:20 - 11:00 Presentation (4) from U.S. side

"TravTek Evaluation Overview"

by Dr. Joseph I. Peters/Assistant Vice President and Director Human Performance Technology Department, Science Applications International Corporation

11:00 - 11:30 Questions & Answers

11:30 - 12:00 Closing ceremony

Mr. Yutaka Anzaki, Research Coordinator for Road Traffic,
PWRI

Mr. Frank J. Mammano, ATIS & Communications Research Chief,
IVHS Research Division, Turner-Fairbank Highway Research
Center, FHWA

(Lunch)

13:30 - 17:00 Discussion on U.S.-Japan IVHS Cooperative Efforts

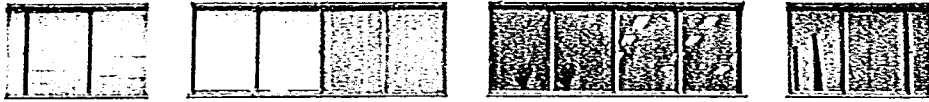
23 April (Friday)

Tokyo study tour

○VICS beacon demonstration

○Traffic control center of the Metropolitan Expressway
Public Corporation

3. Picture



4 . Records of Keynote speeches

4 . 1 Japan side

"How to propel the ARTS project"

by Mr. Tadao Iwatate/Deputy Director, Road Traffic
Control Division, Road Bureau, MOC

A R T S

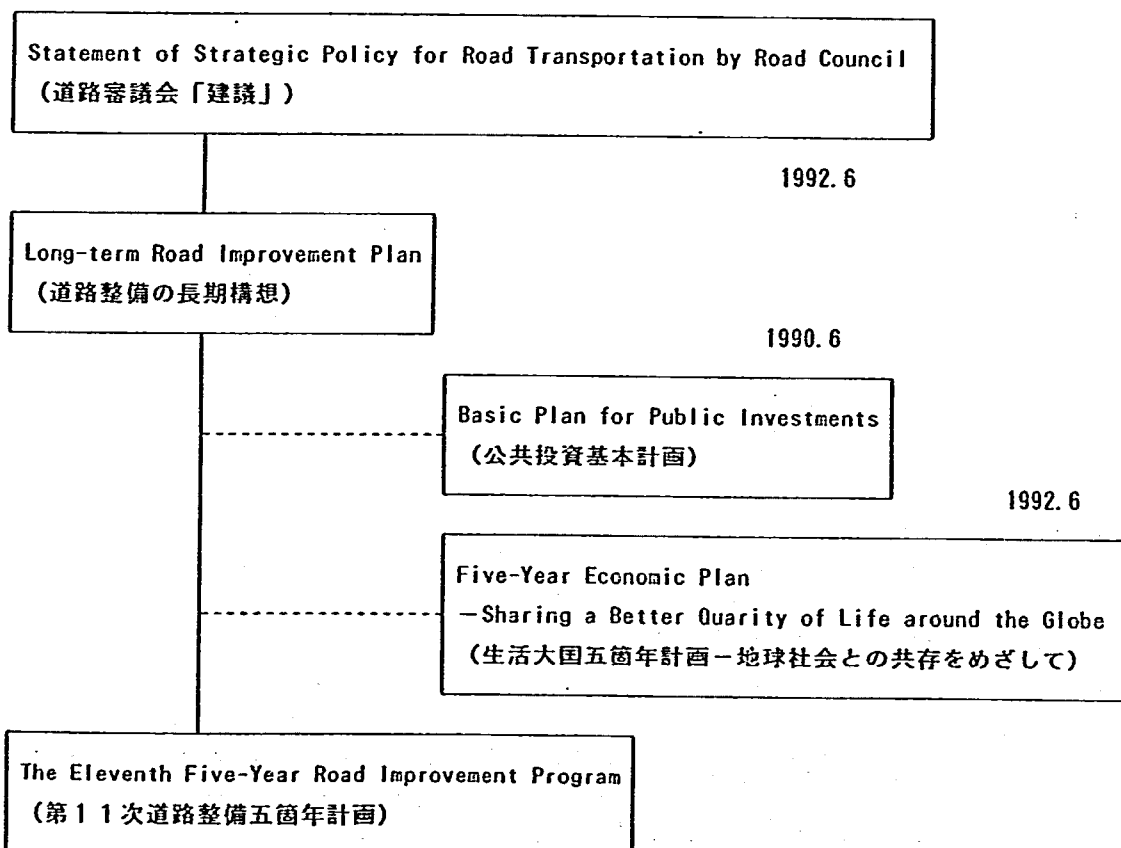
A D V A N C E D

R O A D

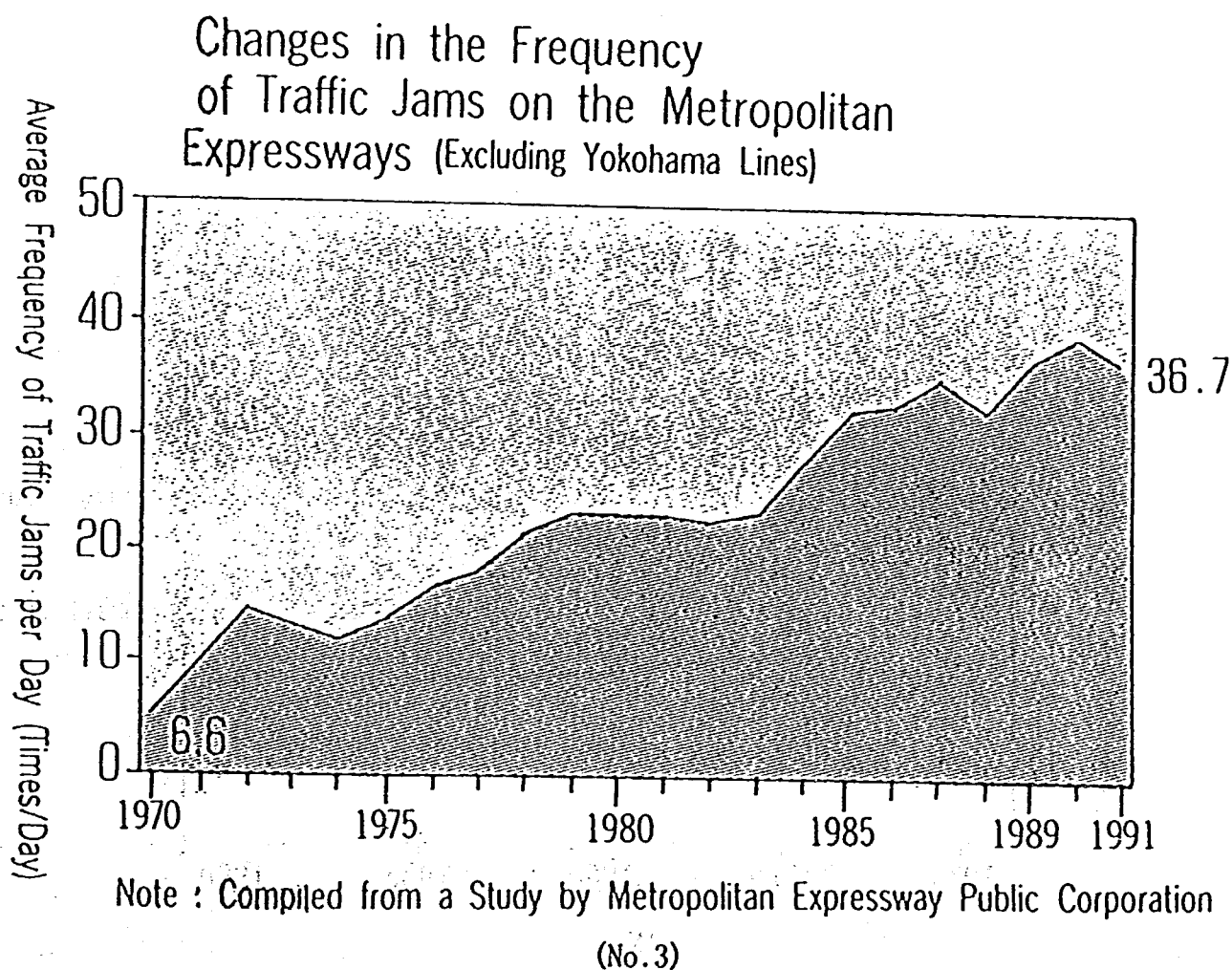
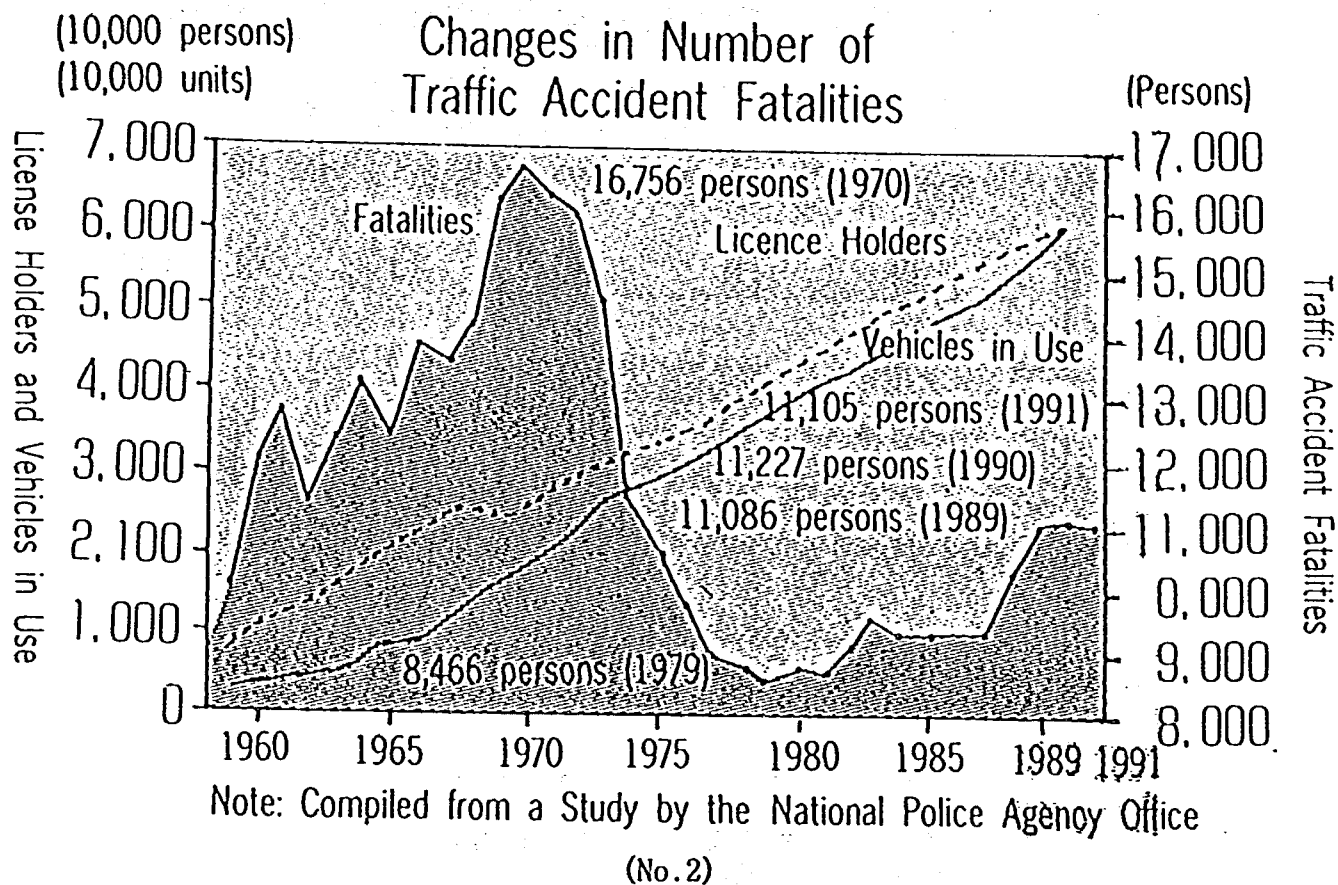
T R A N S P O R T A T I O N

S Y S T E M

A Renewed five-year Road Improvement Program
(新しい道路整備五箇年計画について)



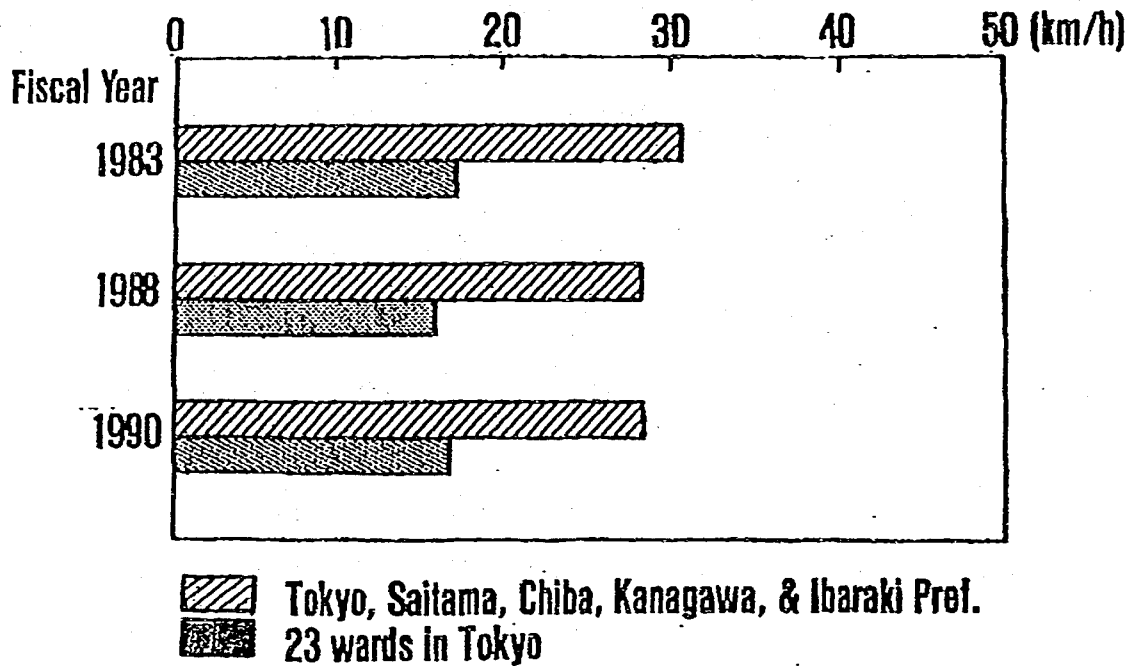
(No.1)



Traffic Congestion in the Tokyo Metropolitan Area

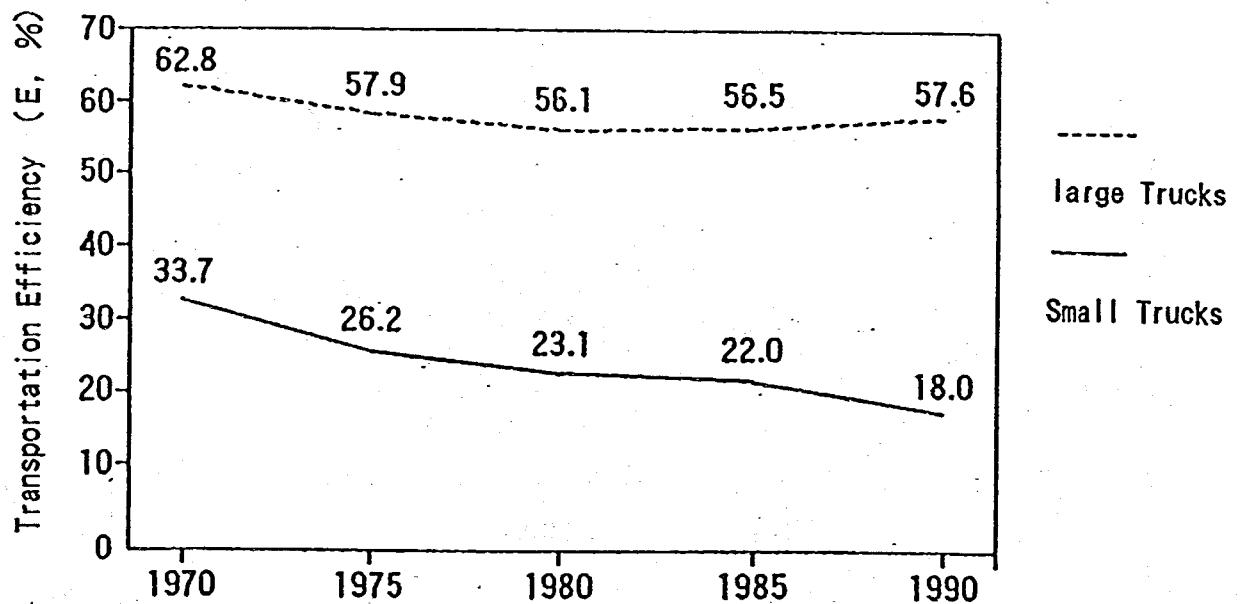
Average Travel Speed at Peak Hour

(National Highway & Principal local-road)



(No. 4)

Trend of transportation Efficiency by Trucks



(No. 5)

The concept of the Eleventh Five-Year Road Improvement Program

(where to go; what to do)

(第11次道路整備五箇年計画の基本的方向)

(1) To facilitate inhabitants' convenience

(生活者の豊かさを支える道路整備の推進)

(2) To establish animated regional development

(活力ある地域づくりのための道路整備の推進)

(3) To foster better global environment

(良好な環境創造のための道路整備の推進)

(No.6)

Concrete Plans of the Eleventh Road Improvement Program

第11次道路整備五箇年計画の具体的な施策について

(1) Mobility and efficiency (利便性の向上)

- transportation demand management
- accessibility enhancement of public transit systems
- acquisition of parking space to lessen on
- advanced information service system
- adequate construction works on surface streets etc.

(2) Traffic safety enhancement (安全性の向上)

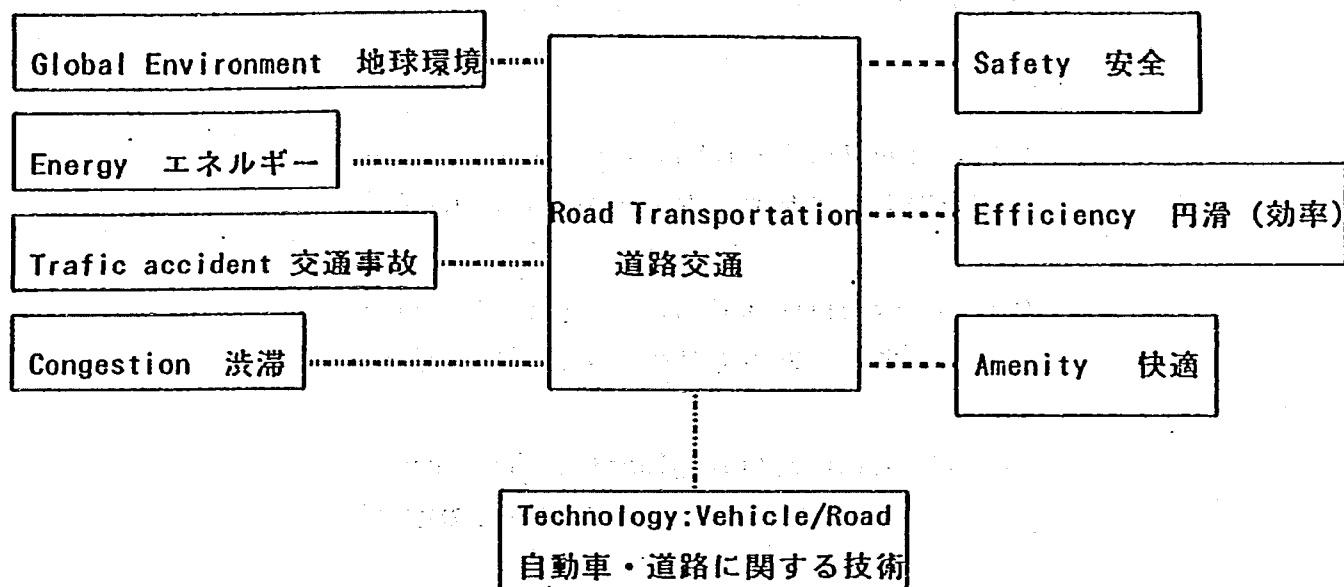
- scientific analysis of accident causes, comprehensive planning, implementation of countermeasures
- the installation of a variety of safety facilities
- highway safety system (smart highways, motorist's safety aids) etc.

(3) Logistics strategy (ロジスティクスの高度化)

- freight transport networks
- advanced road traffic information systems etc.

(No.7)

Architecture of Road Transportation in Next Generation



(No.8)

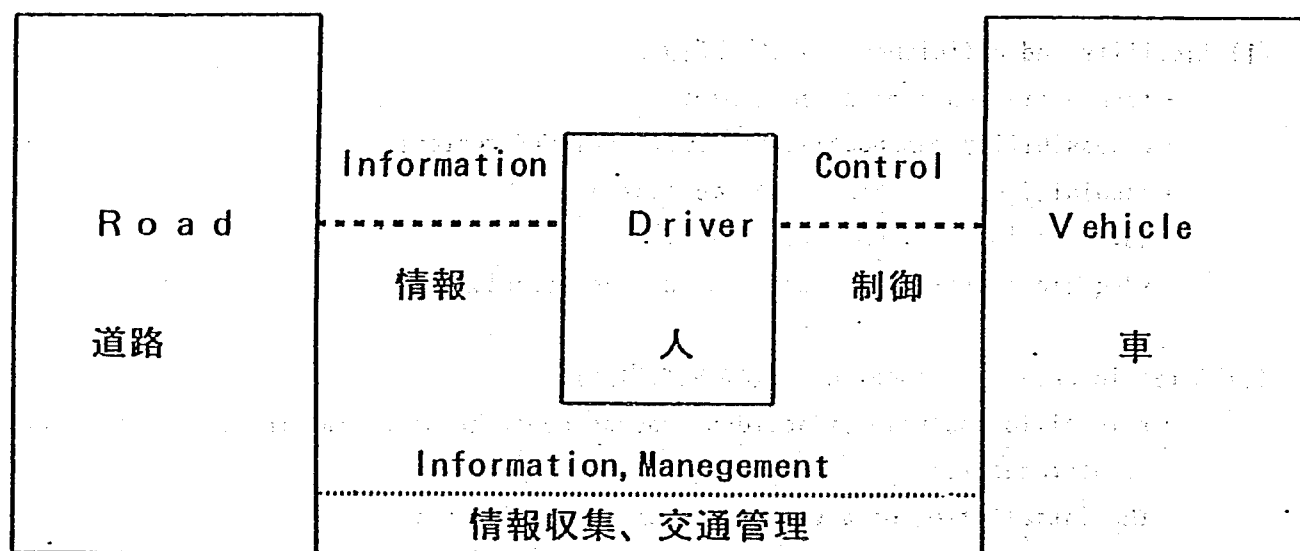


Fig-A

(No.9)

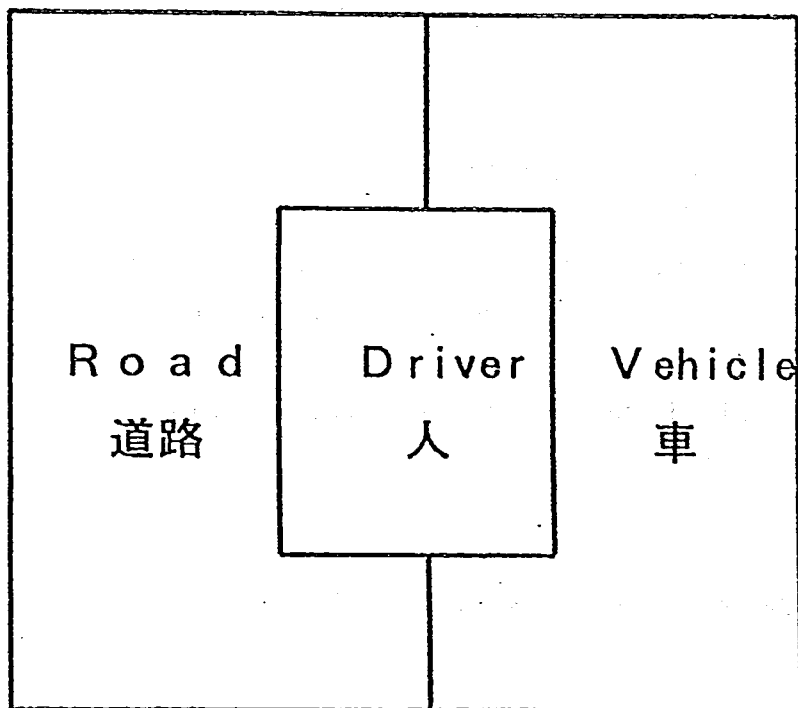
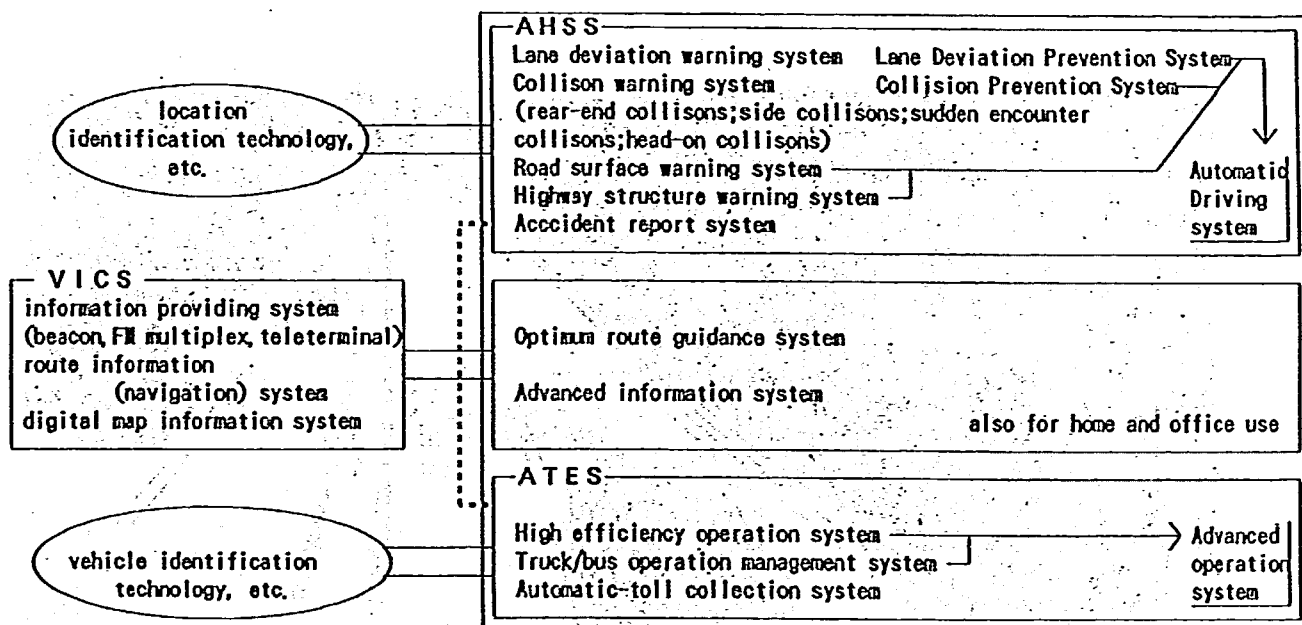


Fig-B

(No.10)

System Configuration of ARTS(Advanced Road Transportation System)



(No.11)

A H S S (advanced highway safety system)

First step : warning



Second step: warning + automatic lateral control
warning + automatic braking/steering control



Third step : full automatic control

A T E S (advanced transport efficiency system)

automatic toll collection system

truck/bus operation management

new freight transport system

(No.12)

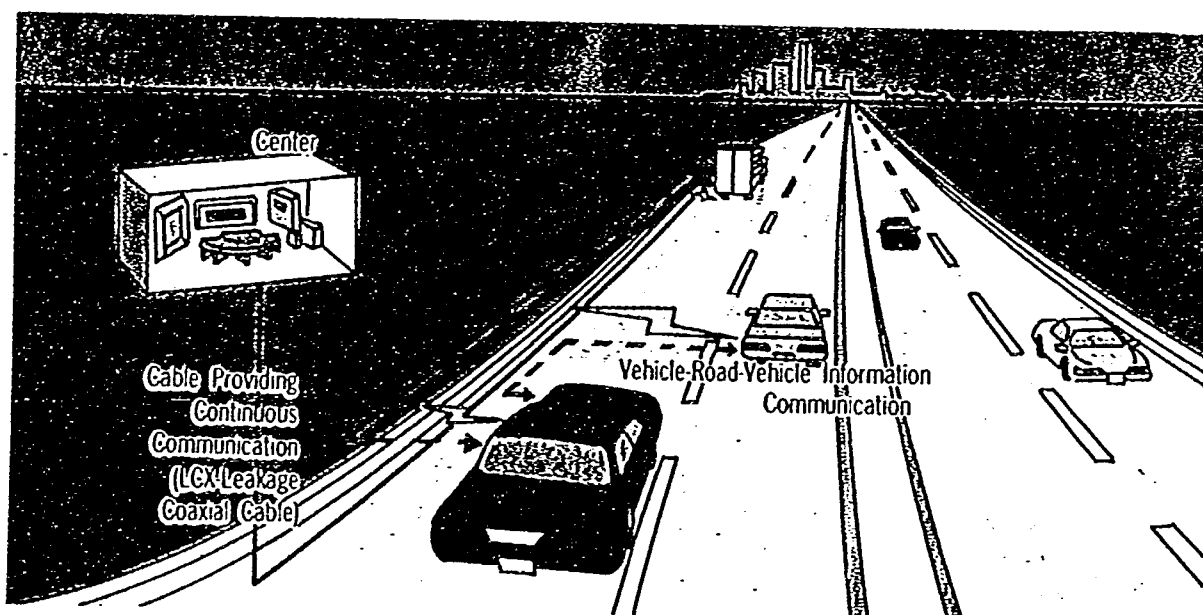


Image Diagram of ARTS

(No.13)

4 . Records of Keynote speeches

4 . 2 U.S. side

"Status of IVHS in the U.S."

by Mr. C. John MacGowan/Chief, IVHS Research Division,
Turner-Fairbank Highway Research Center, FHWA

Status of IVHS in the U.S.



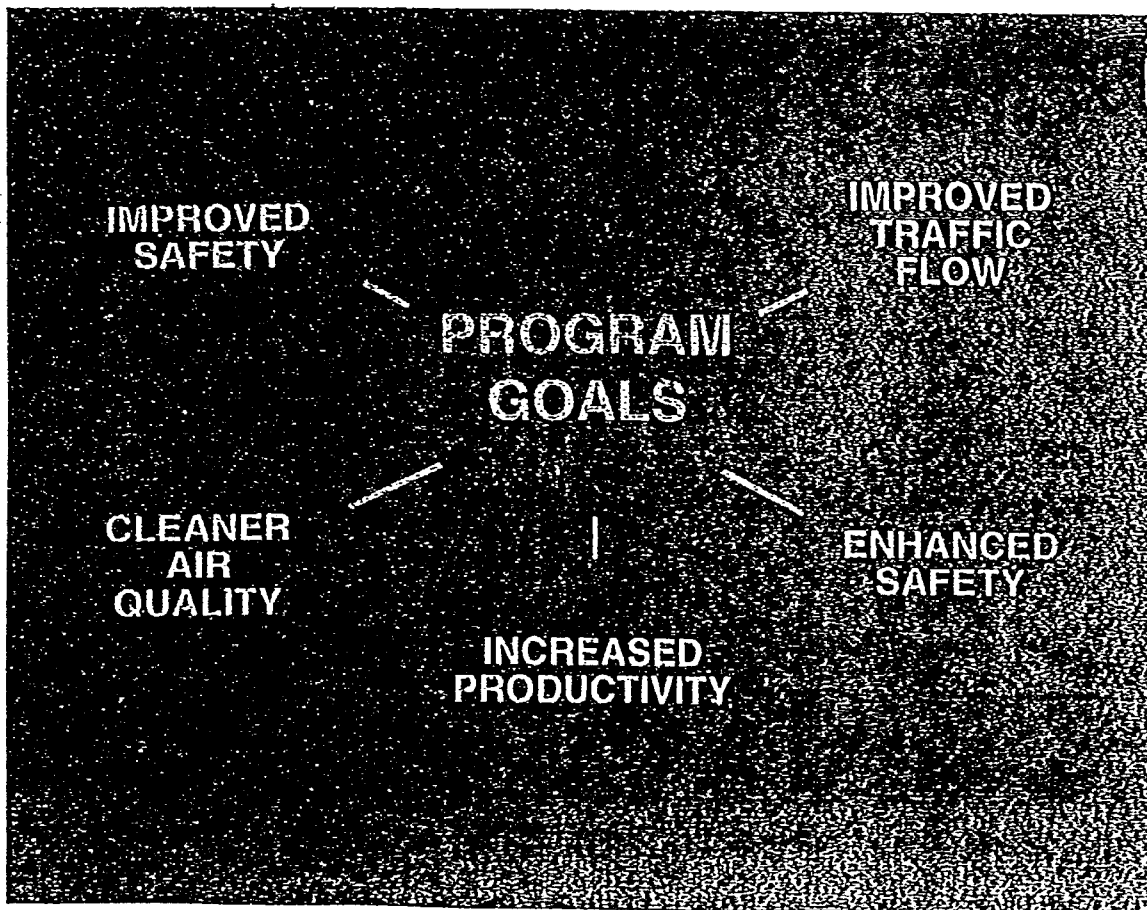
First U.S.-Japan IVHS Meeting

21 April 1993

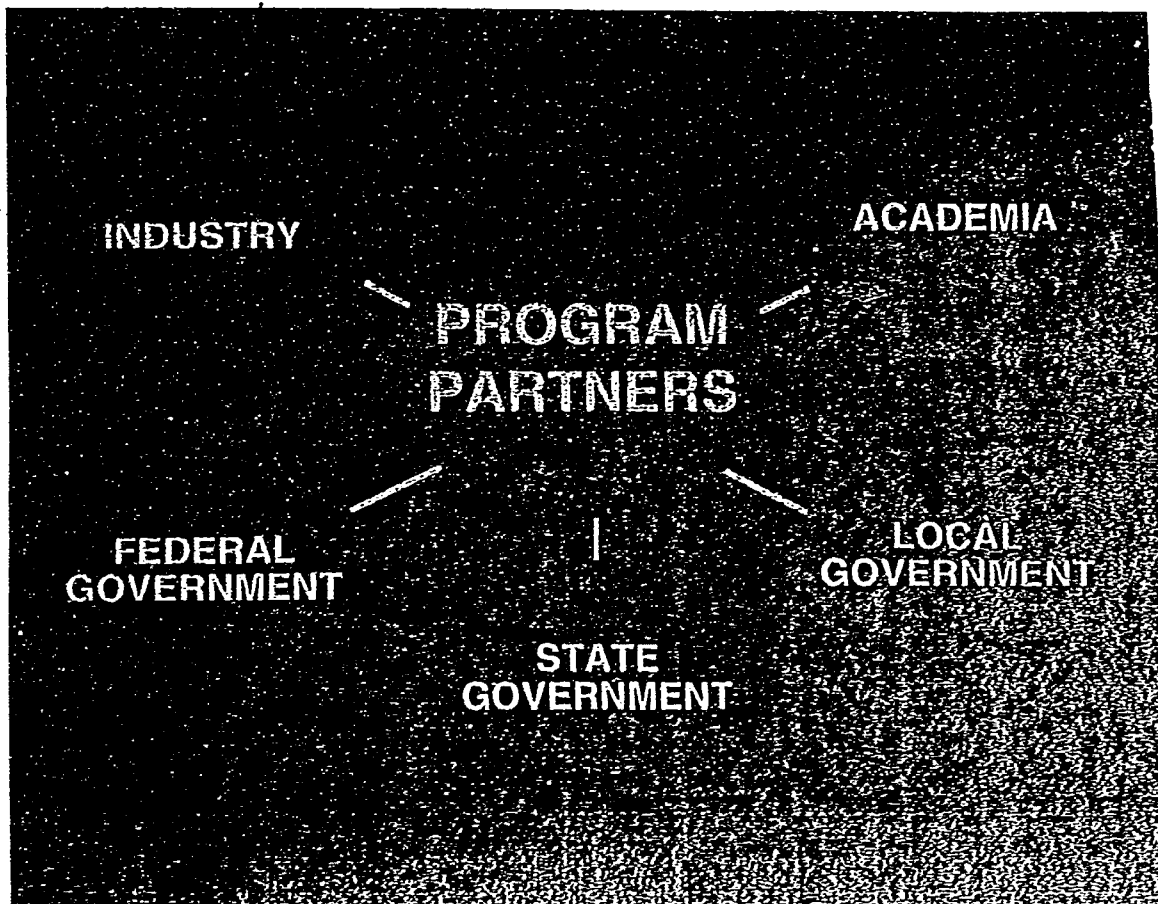
C. John MacGowan

AN UPDATE OF IVHS PROGRAM ACTIVITIES

- ☐ Investment and Program Planning
- ☐ Research and Development
- ☐ Operational Testing
- ☐ Deployment Support
 - System Architecture and Standards
 - Institutional Issues
 - Planning and Financing
- ☐ AHS



(No. 2)



(No. 3)

INVESTMENT

- ☐ **ISTEA** provided \$113 million per year through FY-1997
- ☐ Supplemental R&D funding in the neighborhood of \$50 million per year through annual appropriations process
- ☐ Possibility of expanded program ranging from an extra \$75 million in FY-94 to \$100 million in FY-97 as part of Rebuild America initiative
- ☐ Substantial DOT funds will leverage private sector investment

(No.4)

PROGRAM ACCELERATION

- ☐ Expanded R&D and Operational Testing Programs
- ☐ Advanced Technology Applications
- ☐ Commercial Vehicle Operations
- ☐ Automated Highway System

(No.5)

PROGRAM PLANNING

- ☐ Strategic Plans prepared by IVHS AMERICA and DOT
- ☐ Program Planning activity underway
 - Cooperative with IVHS AMERICA
 - Discrete plans for set of user services
 - Systematic approach, culminating with point where service is deployable
 - Integration of program across user services
 - Ties with deployment support activities

(No. 6)

RESEARCH AND DEVELOPMENT

- ☐ Development and assessment of alternative system concepts for providing user services to meet needs
- ☐ Exploration of alternative technologies for accomplishing system functions (i.e., surveillance, communications, etc.)
- ☐ Estimation of costs and benefits of system concepts and technologies

(No. 7)

MAJOR R&D PROJECTS

☐ ADVANCED (VISION BASED) VEHICLE CONTROL SYSTEM, PHASE II	\$ 220,000
☐ ASSESSMENT OF EFFECT OF IN VEHICLE DISPLAY SYSTEM ON DRIVER PERFORMANCE	\$ 730,430
☐ COMMERICAL VEHICLE SAFETY SYSTEMS	\$1,071,000
☐ DESIGN OF SUPPORT SYSTEMS FOR ATMS	\$2,942,679
☐ HUMAN FACTORS DESIGN OF AUTOMATED HIGHWAY SYSTEMS	\$5,086,582
☐ HUMAN FACTORS IN ATIS AND CVO DESIGN EVOLUTION	\$3,401,337
☐ HUMAN FACTORS IN ATMS DESIGN EVOLUTION	\$4,216,359
☐ IN-VEHICLE SAFETY ADVISORY AND WARNING SYSTEM	\$ 936,736

(No.8)

MAJOR R&D PROJECTS

☐ NETWORK-WIDE OPTIMIZATION MODELS	\$1,405,212
☐ PATH AVCS RESEARCH PROGRAM	\$1,275,000
☐ REAL TIME TRAFFIC ADAPTIVE SIGNAL CONTROL SYSTEM	\$3,217,382
☐ RURAL APPLICATIONS OF ADVANCED TRAVELER INFORMATION	\$1,373,501
☐ SIMULATION OF INTERSECTION AND URBAN INTERCHANGE OPERATIONS	\$ 369,555
☐ SYSTEMS PLANNING FOR AUTOMATED COMMERICAL VEHICLE LICENSING AND PERMITTING SYSTEMS	\$ 568,536
☐ TRAFFIC MODELING TO SUPPORT ATIS	\$ 434,016
☐ TRAFFIC MODELS FOR TESTING REAL-TIME SIGNAL CONTROL LOGIC: PHASE 1	\$ 839,365

(No.9)

OPERATIONAL TESTS

- ☐ Understanding of user service requirements
- ☐ Identification of acceptable system concepts and technologies
- ☐ Measurement of user service benefits and costs

(No. 10)

MAJOR OPERATIONAL TEST PROJECTS

- ☐ **TravTek**
Orlando, Fl.
 - Dynamic route guidance, 100 vehicles
- ☐ **Advance**
Chicago, IL.
 - Dynamic route guidance, 5000 vehicles
 - Vehicles are probes for traffic flow data
- ☐ **Smart Corridor**
Los Angeles
 - Integration of freeway and arterial signal systems
 - Expert system for management,
 - 13 miles to be expanded to 80 miles of I-10
- ☐ **Cellular Surveillance**
Washington DC
 - Use cellular telephone infrastructure and telephones as probes for traffic location, speed and volume surrogates
- ☐ **Smart Commuter**
Houston Tx.
 - Real-time transit information system,
 - Real-time carpool forming system

(No. 11)

MAJOR OPERATIONAL TEST PROJECTS

- ☐ **HELP/Crescent**
*Interstate 5/10 west coast
Washington to Texas and
Canada*
 - 2000 trucks with AVI
 - In data collection phase
 - States plan to form non-profit organization to operate in future
- ☐ **Advantage I-75**
*Interstate 75
Florida to Michigan
and Canada*
 - Preclearance after 1st station
 - AVI procurement in process
 - Start data collection Winter 93
- ☐ **Multi State**
*Iowa, Minnesota,
Wisconsin*
 - Track trucks to get mileage
 - Automation of state gas tax determination
- ☐ **I-80**
*Interstate 80 from
California to New York*
 - Begin deployment of national truck network

(No. 12)

SYSTEM ARCHITECTURE GOALS

Framework for National System

- ☐ Define system interfaces to achieve compatibility across country
- ☐ Retain local flexibility in deciding services to be provided
- ☐ Must be open and robust to accommodate different technologies and products
- ☐ Must allow for introduction of services over time and technical innovation

(No. 13)

SYSTEM ARCHITECTURE PROGRAM

- ☐ 3 to 5 contract teams to define alternative architectures
- ☐ Down-select to 1 to 3 teams to perform detailed evaluation of remaining architectures
- ☐ Selection of "best" architecture by 1997
- ☐ Consensus process important in decisions leading to selection of best architecture

(No. 14)

STANDARDS

- ☐ Coordinated through IVHS AMERICA
- ☐ SAE designated secretary to ISO IVHS technical committee
- ☐ Need for many standards to flow from architecture studies
- ☐ Early activity in certain areas - map data base and AVI

(No. 15)

INSTITUTIONAL ISSUES

- ☐ Goal is to evolve institutional framework in parallel with technical framework
- ☐ Issues being addressed include:
 - Public/private partnerships
 - Multi-jurisdictional and multi-agency cooperation
 - Government procurement, e.g., intellectual property rights
 - Product liability
 - Privacy
 - Education and training needs

(No. 16)

PLANNING AND FINANCING

- ☐ ISTEA requires better management of transportation services
 - Congestion Management System
 - Safety Management System
 - Intermodal Management System
- ☐ IVHS infrastructure deployment must be addressed in Statewide and metropolitan area plans
- ☐ Providing support for IVHS deployment studies
- ☐ Many financing methods
 - Customer purchase
 - Federal-aid funding
 - State and local sources

(No. 17)

Automated Highway Systems (AHS)

- ☐ Motivated by expected improvements in congestion, safety, and quality of travel benefits
- ☐ Congressional requirement for demonstration of prototype in 1997
- ☐ Initiating series of studies that will examine important technical and system issues
- ☐ Intend to enter into agreement with one or more consortia to cooperatively undertake system development
- ☐ Program goals are long range, the 1997 demonstration is but one important milestone along the way

(No. 18)

5. Records of Presentations

5. 1 Japan side

(1) "Vehicle Information & Communication System (VICS)"

by Yoshitaro Masuda/Technical Councilor, Highway
Industry Development Organization

(OHP-No.1)

The table and graph describe road traffic conditions in Japan. The graph on the upper right indicates how the annual number of road accident fatalities has changed. There are 60 million vehicles on the road, which is about 3 times as many as there were 20 years ago. About the same number of people hold drivers licenses. The annual number of road accident fatalities peaked in 1970 at 16,765, fell to half that figure by 1979, but has begun rising recently, surpassing 11,000. The table on the lower left indicates changes in traffic congestion conditions in Tokyo and its surroundings. The average driving speed during peak hours in the 23 wards of Tokyo has been declining, and now stands between 16 and 17 Km/h. Traffic congestion at this level causes substantial losses for both individuals and for society as a whole. In an effort to contribute to the resolution of these problems, new road traffic systems such as the Vehicle Information and Communication System (VICS) are being introduced, and research and development work is continuing on the next generation of road traffic systems.

(OHP-No.2)

These are the next generation road traffic system related projects now underway in Japan. Research and development of road vehicle communication technology commenced with the Comprehensive Automobile traffic Control System (CACS) project conducted by the Ministry of International Trade and Industry 20 years ago. This was followed by the Road/Automobile Communication System (RACS), the Ministry of Construction project, and the Advanced Mobile

Traffic Information and Communication System (AMTICS) conducted in the same period by the National Police Agency. The functions characteristic of these two systems were similar in many respects, and it became necessary to integrate and improve their information and communication functions. Vehicle Information and Communication System (VICS), which was born as a product of this series of projects, introduced the first practical use of roadway information communication between the road and cars travelling on it. The Ministry of Construction's Advanced Road Transportation System (ARTS) project, the Ministry of International Trade and Industry's Super Smart Vehicle System (SSVS) project, and the Ministry of Transportation's Advanced Safety Vehicle (ASV) project, which are now in progress, are intended to develop next generation systems. All three projects are managed by organizations composed of industrial, academic, and administrative bodies, and each has been planned and implemented to achieve specific development goals.

(OHP-No.3)

The purpose of VICS is to obtain information about congestion, parking availability, etc. from information sources, and provide it to drivers. Drivers will be able to use this information to choose which route to travel. The result will be safe, smooth, efficient traffic and a reduction in damage to the environment. With its implementation, it will be possible to integrate independently developed systems, effectively exploit radio frequency resources, and develop various classes of media in mutual harmony. The advantages obtained through the use of VICS will not only benefit drivers, but everyone who travels.

(OHP-No.4)

A liaison council established by the public sector and a promotion council formed by private sector companies are undertaking positive and broad-reaching activities while aiming at a mutual

interrelationship in order to promote VICS. Actual VICS promotion work is the responsibility of three committees and eight subordinate subcommittees. The commerce committee is studying the basic form of VICS and the commercial operation of the system. The research committee is studying the systems to be used to handle the various kinds of media that will be part of VICS. The experimental committee is making all studies and preparations in order to achieve the success of VICS demonstration experiments. The key members of each committee and subcommittee are technicians from the information communication, and automobile manufacturing industries.

(OHP-No.5)

The flow-chart presents the total VICS concept, with the flow of VICS information as its principal element. Roadway management bodies and traffic police, which have gathered road traffic information they need to carry out their administrative functions, will provide this information to VICS. To prepare this information for use, the VICS center (tentative name) will edit and process it, then distribute it to VICS subsystems. The VICS subsystems (information provision media) now being considered include beacons, FM multiplex, and teleterminals. At the final stage, benefits will appear as drivers use the information. These effects will only be realized when large numbers of drivers use the information, and VICS begins to make an ever greater contribution to society as a whole.

(OHP-No.6)

These are examples of the information which VICS is now expected to provide to drivers. The first class of road traffic information will be indications of sections of the road where traffic is congested and the level of this congestion. Secondly, it will provide information about temporary regulations: where and during what time periods they are in force, and their causes. The third

class of information will be traveling time information, which will indicate the time needed for traveling through a particular section. Another type of road traffic related information VICS will provide will be parking lot information: locations of parking facilities, and information indicating whether or not each is full or can accommodate more cars. Accident information is also expected to be available.

(OHP-No.7)

The next issue is the form in which drivers will be able to receive and utilize the information provided by VICS. Three representative forms of information presentation now at the concept stage are introduced below through demonstrations of how each will be used to present traffic congestion information. The first is the map display format. This method, one which will probably be used in high function in-car equipment, will display information from VICS by superimposing it on digitalized map data stored in the vehicle. As shown in the example, roads, railway lines, and railway stations are displayed on the map, and various types of roads are indicated by different color lines. The VICS information is displayed along the sides of roadways indicating the location and level of congestion on each roadway. This in-car equipment provides a self-locating function, and the ▲ point indicates where the car is at any moment. One of the advanced functions of the in-car equipment uses VICS data to determine and indicate the optimal route. A line of black dots is used to indicate the optimal route around the congested area to the drivers destination, which in this case, is above the top of the map segment displayed on the screen. An advanced-function in-car equipment will also be able to provide left and right turn indications at intersections. In this example, the driver is being instructed to turn right at the next intersection by the arrow in the lower right corner of the screen.

(OHP-No.8)

The second example is a Deformation Format. With this type, deformation maps, diagrams, and letters are created at the VICS system media center, transmitted to cars as congestion information, and are displayed exactly as received. The in-car equipment is simplified, but its applications are limited. This example of congestion on an expressway near the center of Tokyo includes indications of the location (and level) of the congestion.

(OHP-No.9)

This third example shows a display consisting only of letters and numbers. This letter and number information is provided for display on a relatively small screen on the in-car equipment. In this case, the display indicates the name of the road and the section of that road where the congestion has occurred, its length, cause and level. These are typical examples of ways in which drivers can make use of VICS information, but it is likely that various new approaches will be developed as a result of the popularization of the system and future studies of its application.

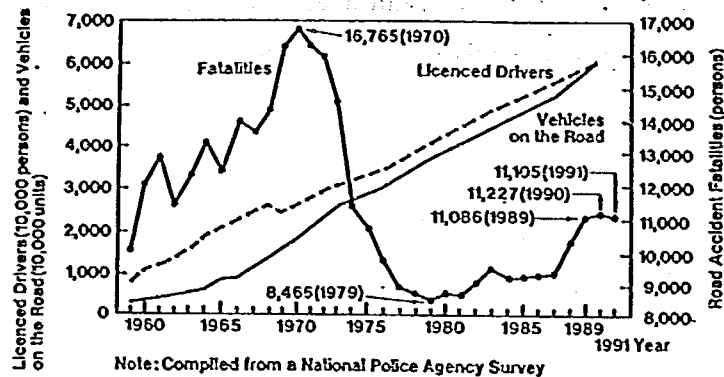
(OHP-No.10)

This is a conceptual diagram of the demonstration and testing system. Demonstrating and testing the system is an extremely important step if working systems are to be introduced and their use is to spread. This system will be used to increase public awareness of the social utility of VICS and to confirm and assess the technology used in the system. Testing will begin in June 1993 with a trial operation of the FM multiplex subsystem, and when all testing is completed, an open demonstration and trial will be performed on the ninth and tenth of November. The testing will be conducted within an area 20 km by 20 km in the center of Tokyo, and along an 84 km stretch of the Tomei Expressway from Tokyo to Gotemba. The media used for the trials will be FM multiplex and beacons, and it will operate almost

exactly like future working systems. With all concerned anticipating a successful trial, preparations for all aspects of the event are progressing steadily.

1

Changes in the Number of Road Accident Fatalities Etc.



Changes in the Traffic Congestion Situation in Tokyo and its Surroundings

Average Driving Speed During Peak Hours (Km/hours on national and principal regional roadways)

	1983	1988	1990
Twenty-three wards of Tokyo	17.3	16.0	16.8
1 metropolitan prefecture 4 rural prefectures	30.7	28.3	28.5

Note: 1. Based on a Ministry of Construction road traffic census

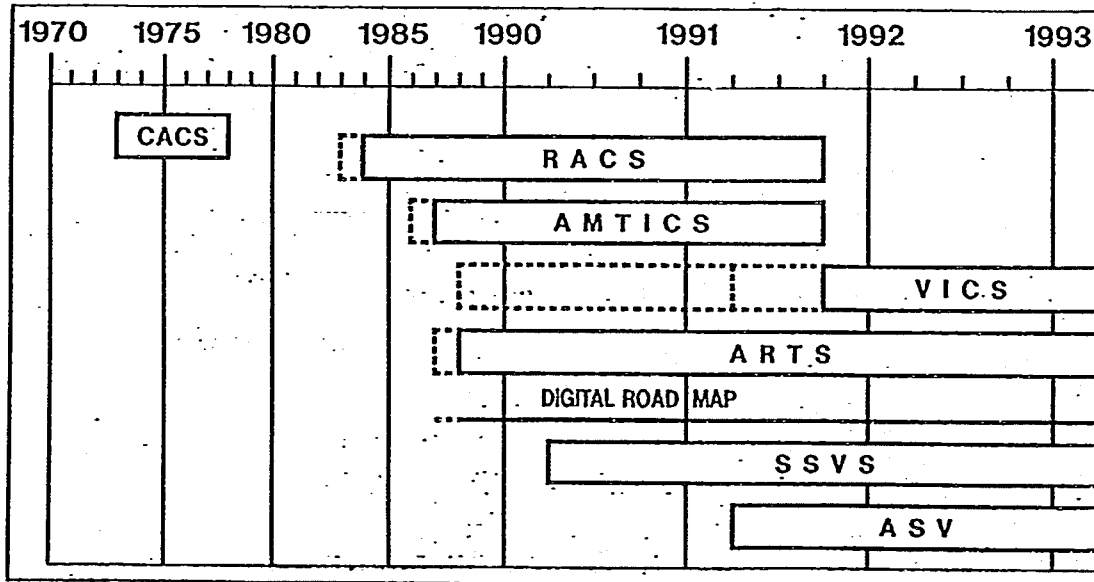
2. 1 metropolitan prefecture 4 rural prefectures: Metropolitan Tokyo and the prefectures of Saitama, Chiba, Kanagawa, and Ibaraki.

HIDO

(No. 1)

2

Next Generation Road Traffic System Related Projects Underway in Japan



HIDO

(No. 2)

3

Goals and Characteristics of VICS

★ The goals of VICS

- Provision of road traffic information to moving vehicles
- Safe and smooth traffic movement and preservation of the environment
- Integration of information provision systems
- Harmonious development of all media

★ Characteristics of VICS

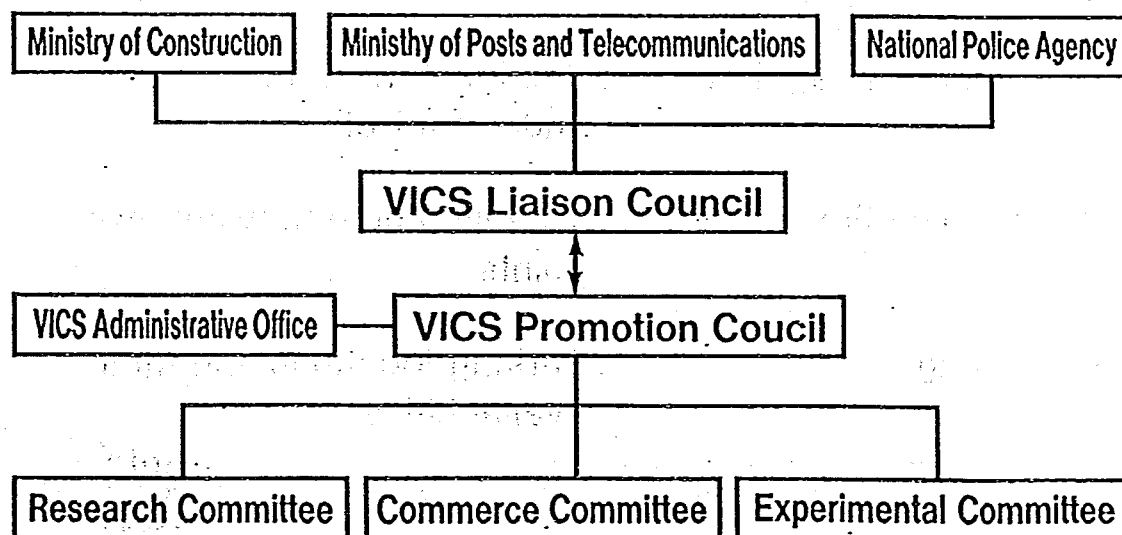
- The pursuit of individual advantage benefits society as a whole

HIDO

(No. 3)

4

VICS Project Promotion System (As of April 1, 1993)

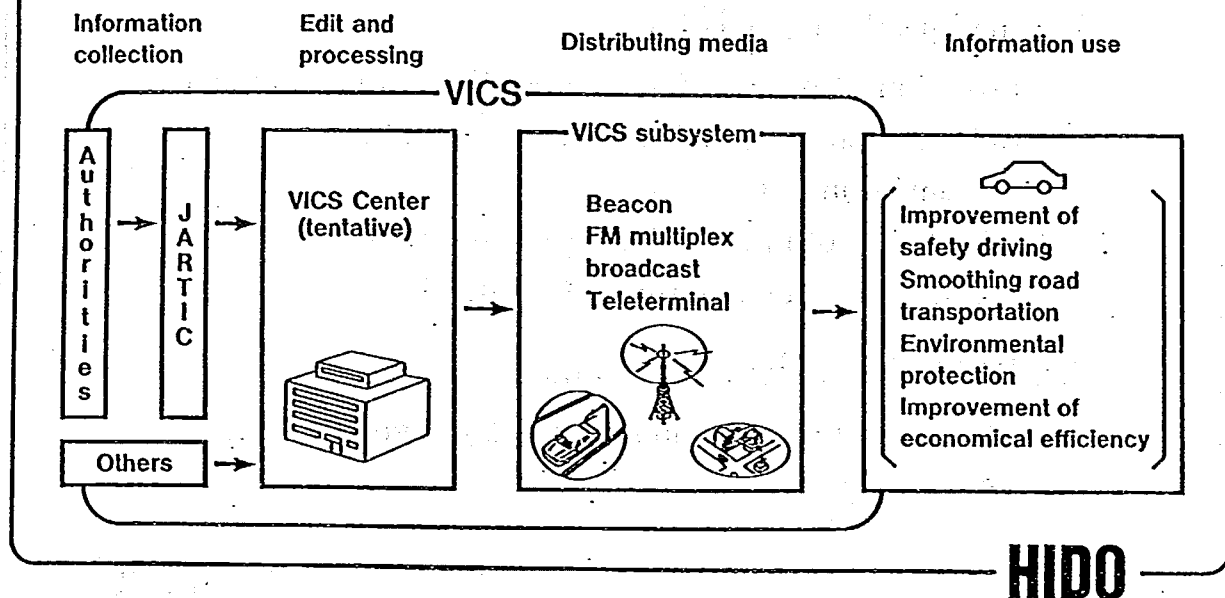


HIDO

(No. 4)

5

General Concept of VICS



(No.5)

6

Information Service Items(Tentative)

- | | |
|--------------------------|--|
| (1) Traffic congestion | : Section and level of congestion |
| (2) Temporary regulation | : Section, time, and causes under controll |
| (3) Traveling time | : Traveling time between two points |
| (4) Parking | : Parking locations and their availabilities |

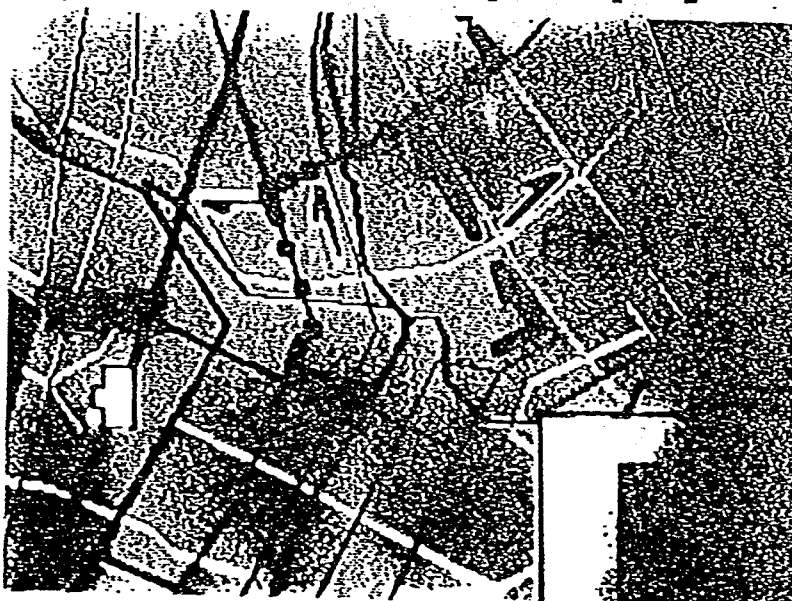
...etc.

HIDO

(No.6)

7

Service Images (1) Map Display Format

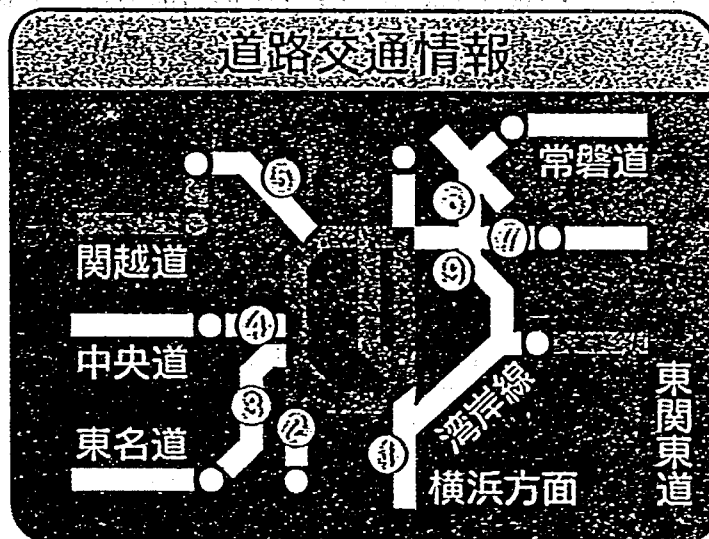


HIDO

(No.7)

8

(2) Map Display (Deformation Format)



HIDO

(No.8)

9

(3) Character Display Format

渋滞

12:50現在

東名高速 上り 川崎-東京

3km

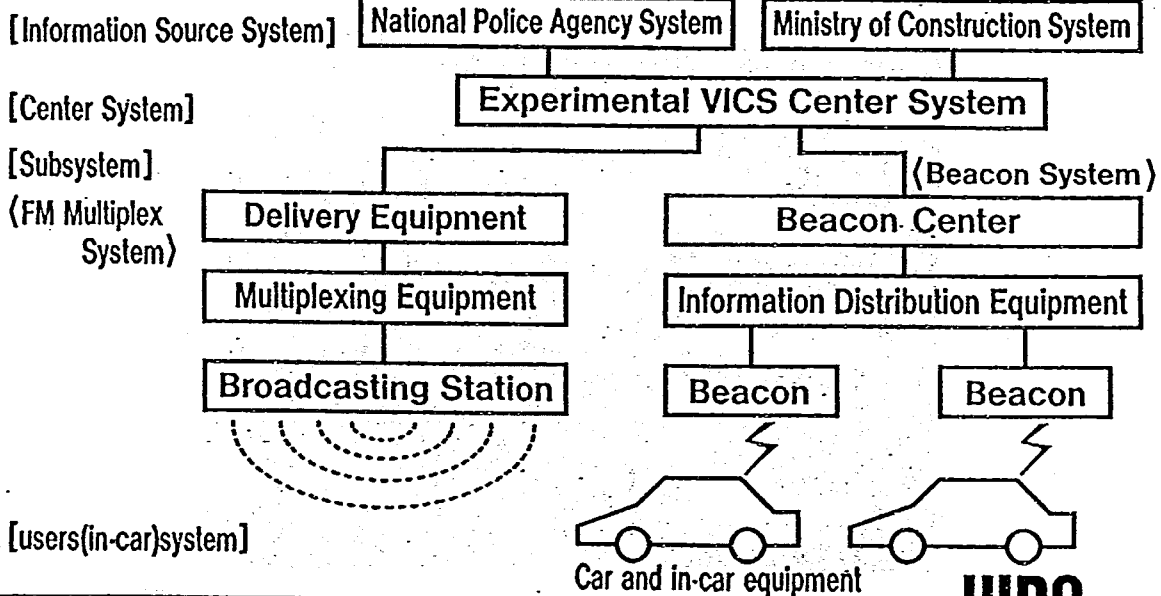
事故 20km/h以下

HIDO

(No.9)

10

Conceptual Diagram of the VICS Demonstration and Testing System



HIDO

(No.10)

5. Records of Presentations

5. 1 Japan side

(2) "Headway and Lateral Control System/Results of Transmission Experiment Using Leakage Coaxial Cable (LCXs) in the Quasi-Microwave Bandwidth"

by Mr. Yohei Hioki/Chief Researcher, Traffic Engineering Division, PWRI
Mr. Yutaka Yamada/General Manager, System Engineering Department, Telecommunication Division, Oki Electric Industry Corporation, Ltd.

I would like to introduce you the results of transmission experiment using Leakage Coaxial Cable in the quasi-microwave bandwidth. This quasi-microwave is going to be applied to the Headway and Lateral Control System for next-generation traffic control system.

(OHP-No.1)

Automobile transportation is totally related to the infrastructure of modern society and also to various environmental problems including road traffic problems and pollution. To solve various social problems while the mobility functions of automobiles sufficiently utilized and extending economic activities, not only is road construction essential but new automobile traffic information technology must be examined. In recent years, advanced technologies have been rapidly applied to these fields (e.g., the provision of information-handling equipment on roads and the application of electronic functions in vehicles). However, the technologies for road construction and for automobiles have been developed separately. To achieve further advancement in these fields, these functions must now be coordinated each other to develop comprehensive intelligent features. With this background, a study on Road Vehicle Communication (RVC) technology has been

conducted as a means to link intelligent road features and intelligent automobile functions.

The Road/Automobile Communication System (RACS) developed through the cooperation of the Public Works Research Institute (PWRI) of the Ministry of Construction of Japan, the Highway Industry Development Organization (HIDO), and private enterprises is one type of RVC systems. RACS communicates with vehicles when a vehicle passes through very small radio communication zones placed at intervals along roads. This system not only supports automobile navigation systems but also offers many other features, and can be installed throughout the nation. So, there has been strong demand to put RACS into practical use. Japan's Ministry of Construction has been researching next-generation road transportation systems since 1989. This research also includes next-generation RVC technology.

(OHP-No.2)

Research organization was established by the Society for next-generation Road Transportation Systems set up in HIDO. Research has been proceeding through cooperation between HIDO (including private enterprises) and PWRI of the Ministry of Construction. The basic aims of the next-generation road transportation system are to support drivers by providing continuous support data along roads and to promote the development of future automatic driving technology. The system is called as "Headway and Lateral Control System". It consists of the three stages of its developments, as informing data and issuing alarm level, driving assistance level, automatic driving level. The informing data and issuing alarm level has been studied at the present stage. The functions example of informing data and issuing alarm level are as follows.

- Inform to the drivers the accidents occurred at the out of sight headway of the vehicle through radio communication.

- Inform to the drivers the abnormal approach of the vehicles behind and abnormal speed reduction of vehicle in front through radio communication.
- Suitable distance between the vehicles in front shall be determined, and in case of abnormal approach, alarm shall be issued or applying brake automatically.

To realize those functions mentioned here, the next-generation RVC system must have a continuous communication link between roads and vehicles. One way to achieve this configuration is to use Leakage Coaxial Cables (LCX). However, there are few examples of using LCX in a quasi-microwave band. So, we conducted an experiment to determine the basic electric wave propagation characteristics.

(OHP-No.3)

The next-generation RVC system must be able to send and receive information at all times between traveling vehicles and the roads. In other words, the system must use real-time communication technology (communication that is available at all times, at high speed, and in local areas). Examples of communication systems using LCX include train radio communications on railway networks and radio communications in road tunnels. In such cases, the frequency band which has been used is 80 MHz though 900 MHz. And voice-based communication is mainly used. RVC system aims at high speed data transmission using quasi-microwave band. Thus no electric wave propagation characteristics have been acquired as basic data for the design of next-generation RVC system. To investigate the possibility of LCX quasi-microwave band communications as a means of RVC for next-generation road transportation system, we installed LCXs along a test course PWRI here. The experiment was designed to measure electrical field strength and the bit error rate.

(OHP-No.4)

Now I explain the configuration of the experimental system. Transmitter output was fed to the LCX cable to emit electric waves along the test course road. Receiving equipment was installed in an experimental vehicle to measure data while the vehicle traveled along. The LCX cables were installed on the straight course of a test track in PWRI.

(OHP-No.5)

The experimental items are electric field strength and bit error rate. We used the following items as experimental parameters.

Frequency: 1.5GHz (1.480) and 2.6GHz (2.685) bands

LCX installation height: At the ground level, about 1.5m, and
about 5m

Power feed method: from a single end of 200m LCX or from the
center of two 100m LCXs

Supplied power: 1W, 0.1W, 0.01W

We measured the received field strength and bit error rate based on a combination of the noted parameters.

(OHP-No.6)

This is the one example of the results at 1.5GHz band. This part shows the receiving level and this part shows the bit error rate. The horizontal axis shows a distance along the LCXs. This is the starting point of LCXs. In this case, the deviation of receiving level is very large and the errors have been occurred so often even the transmission power is 1W.

(OHP-No.7)

This is the results at 2.6GHz band under the same conditions except sending power of 0.01W. At 2.6GHz, the received field strength was low according to the low power, but the deviation of receiving level was small. The errors have not been occurred so often. The

deviation of receiving level became greater at 1.5GHz, which caused the difference in the bit error rate. Since the LCXs used at 2.6GHz was designed in accordance with the experimental frequency, but the LCXs used at 1.5GHz was for wide-frequency band use, we estimate that the noted difference was mainly caused by the difference in the LCXs cable characteristics. We report the following data, mainly on the results obtained at 2.6GHz.

(OHP-No.8)

This shows the results of LCX installation height of 0m under the same conditions as those shown in last screen. The figure shows decreased received level. This result was probably obtained due to the use of an antenna with upward directivity on the roof of the test vehicle. To verify this, we measured received field strength by using an antenna on the side of the vehicle.

(OHP-No.9)

This is the result using an antenna on the side of the test vehicle, showing that the characteristics at a LCX installation height of 0m were improved.

(OHP-No.10)

This is the result showing that the characteristics at a LCX installation height of 5m. Characteristic is also improved more. We conducted the measurement by changing the experimental vehicle traveling speed from slow (10 km/h or less) to about 120 km/h. There were no particular differences in the data obtained. The LCX cable transmission loss was almost constant regardless of the cable installation condition.

(OHP-No.11)

The 200m of LCX cable was fed from a single end. Two pieces of 100m cables were connected using a connector. As shown here,

obtained from the first lane, which had better measurement conditions. We estimate that this error was due to separation between the cables at the connection point. This subject, including the cable installation method, will require further study. We started the experiment with transmission power set at 1W. However, no bit errors were caused at 2.6GHz. We lowered the power to 0.1W and to 0.01W in turn. The transmitter's output requirement is determined by system parameters and differs depending on the system configuration. Our experiment shows that a relatively stable transmission can be obtained even at 0.01W (10mW). When we consider a practical system configuration, a power of 1W or less can make a configuration of about 300 meters of transmission distance without a repeater.

(OHP-No.12)

1. Less variations compared to field strength distribution in a tunnel close to the calculated value.
2. Receiving field is quite stable, preventing the occurrence of errors at low receiving level.
3. Offers the possibility of use in high-speed data communications that is 512kbps or more.
4. LCX installation height does not much affect the cable characteristics. The relationship to the location of the vehicle antenna is important.
5. Changes in communication quality that result from variations in speed require no consideration.
6. Transmitter output is acceptable at a relatively lower level. This raises the possibility of making a practical system with LCXs in quasi-microwave bandwidth.

(OHP-No.13)

If it is assumed that high-speed, continuous data transmission is achieved using LCX cables installed along the road, it can be

considered system configuration as shown here. An LCX communication area extended along the road is separated into blocks and LCX cables in each block are connected to a roadside devices. These roadside devices are then connected to host-processing equipment to configure a network. Since the LCX radio communication area concentrates coverage over the areas along the road, fewer unnecessary electric waves are propagated than those in the case of other radio communication means. The LCX communication system is also advantageous from the viewpoint of electric wave utilization. This configuration allows a variety of data to be sent ranging from wide-area information to area-based local information between vehicles and the road. For example, if a road sensor or traveling vehicle detects danger of slippage in an icy area, such danger can be reported to succeeding vehicles. The Society for the Next Generation Road Transportation System has been conducting research on a headway and lateral control system, which is the basis of the next generation road transportation system, and assessing the possibility of driving support using an RVC system which has a continuous communication link like the one used in the experiment.

This experiment was conducted to acquire the basic data needed for electric wave propagation. In the future, various experiments considered on system design must be conducted including experiments on the shielding and reflection effects caused by large vehicles running alongside each other, the LCX installation method considering road construction, and interference problems encountered when lanes going in opposite directions are located next to each other. We have been conducting such experiments and will report the experiment results when they are ready. Regarding the possibility using the RVC system in the future, which was the initial objective of our experiments, we believe that a communication using LCXs in the quasi-microwave band proved to be

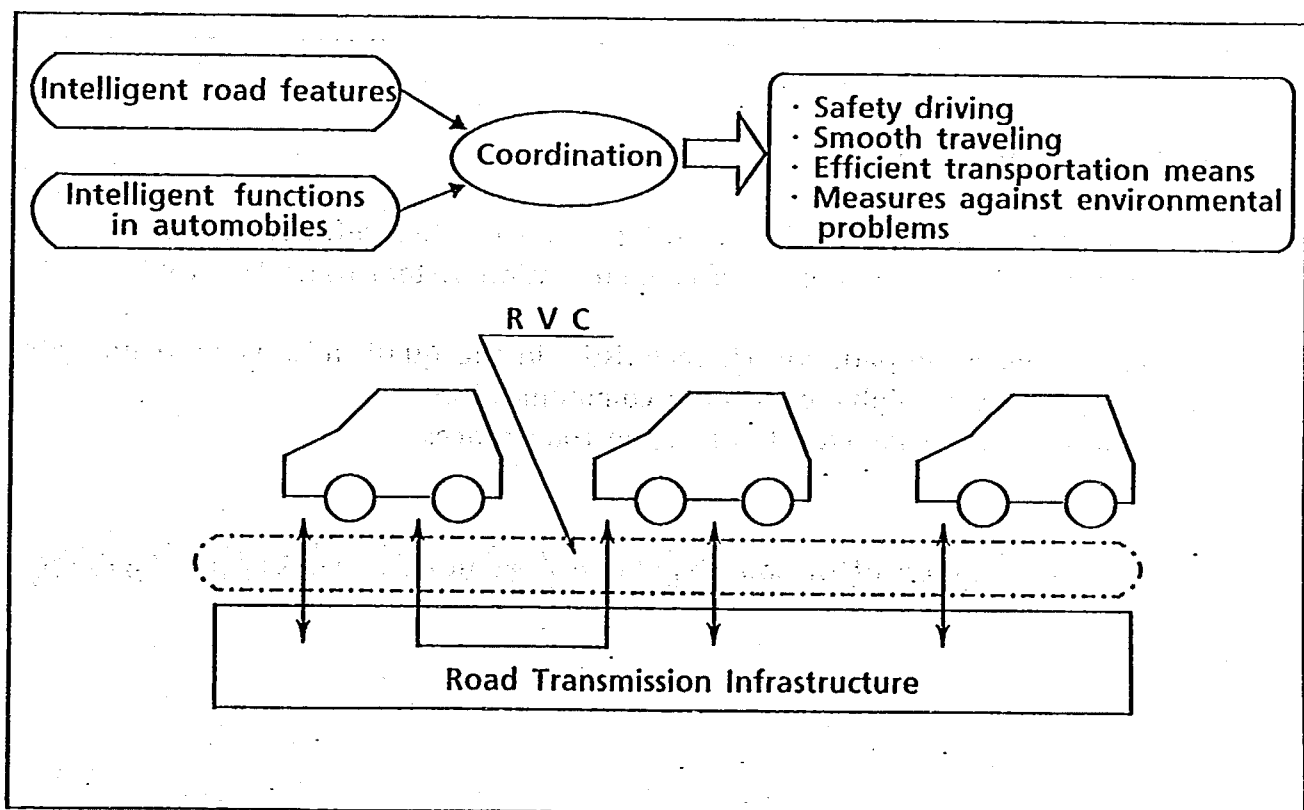
sufficiently effective.

Finally, we would like to express our thanks to the staff of companies involved with the Society for the Next Generation Road Transportation System who assisted us with these experiment and also to the staff of PWRI who gave us considerable suggestions and help to us.

Headway and Lateral Control System / Results of Transmission Experiment Using Leakage Coaxial Cable (LCXs) in the Quasi -Microwave Bandwidth

Youhei Hioki , Yutaka Yamada

1. Background
2. Experimental Objectives
3. Experimental Details
4. Other Considerations

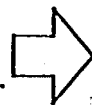


* Next-generation RVC system

This system allows traveling vehicles to send or receive information at all times to or from the road on which they are traveling. The system requires real-time communication technology (communication that is available at all times, high-speed, and localization).

* Communication using LCX cables

- Relatively consistent communication zone along the cables
- Wide-band communication is possible.
- Limited space communication is also possible.



In-tunnel communication
Train communication in railway network
Communication in underground areas

(No.2)

* Experimental Objectives

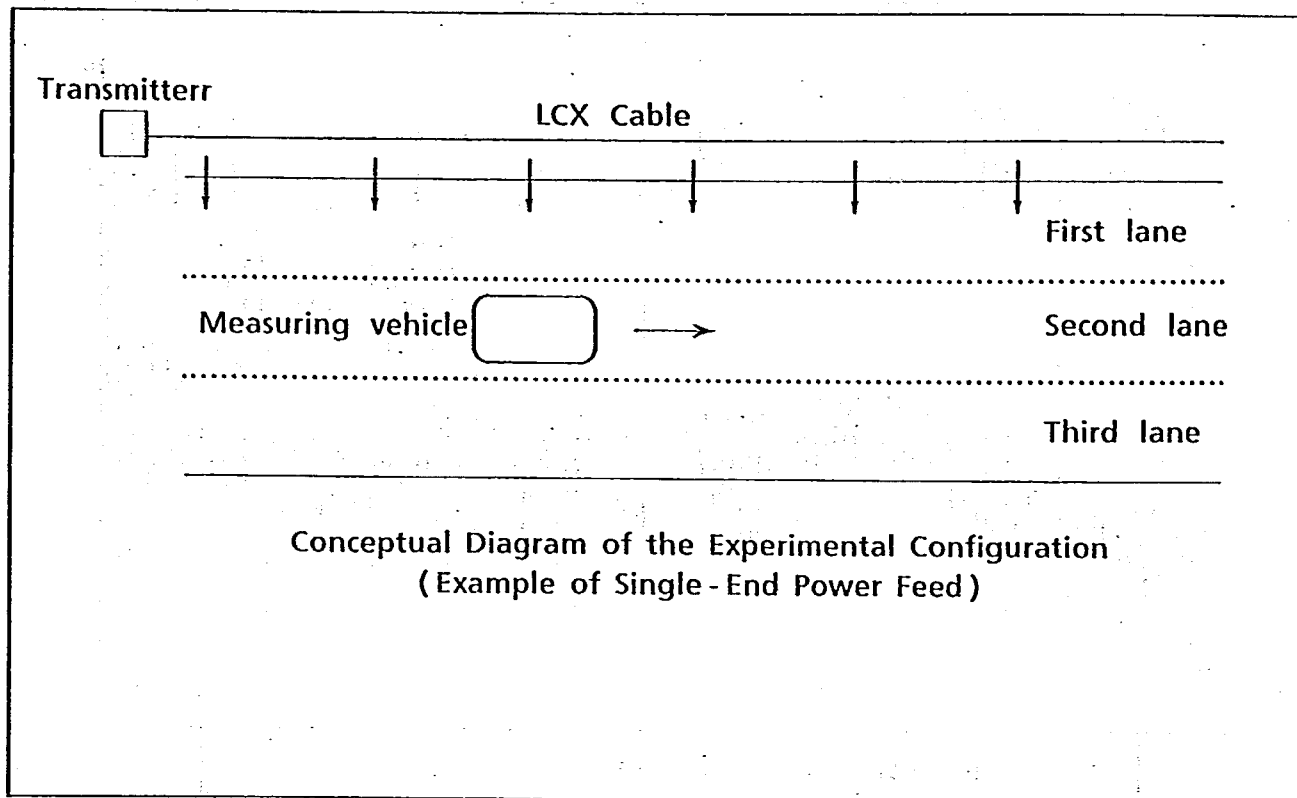
To acquire the basic data of the following characteristics, different from the conventional use, for the radio communication system using LCX cables

- LCX electric wave propagation characteristics in the quasi-microwave bandwidth
- Possibility of use as high-speed data communication
- Wave propagation characteristics in open road spaces



Verification of the possibility of use as next-generation RVC system

(No.3)



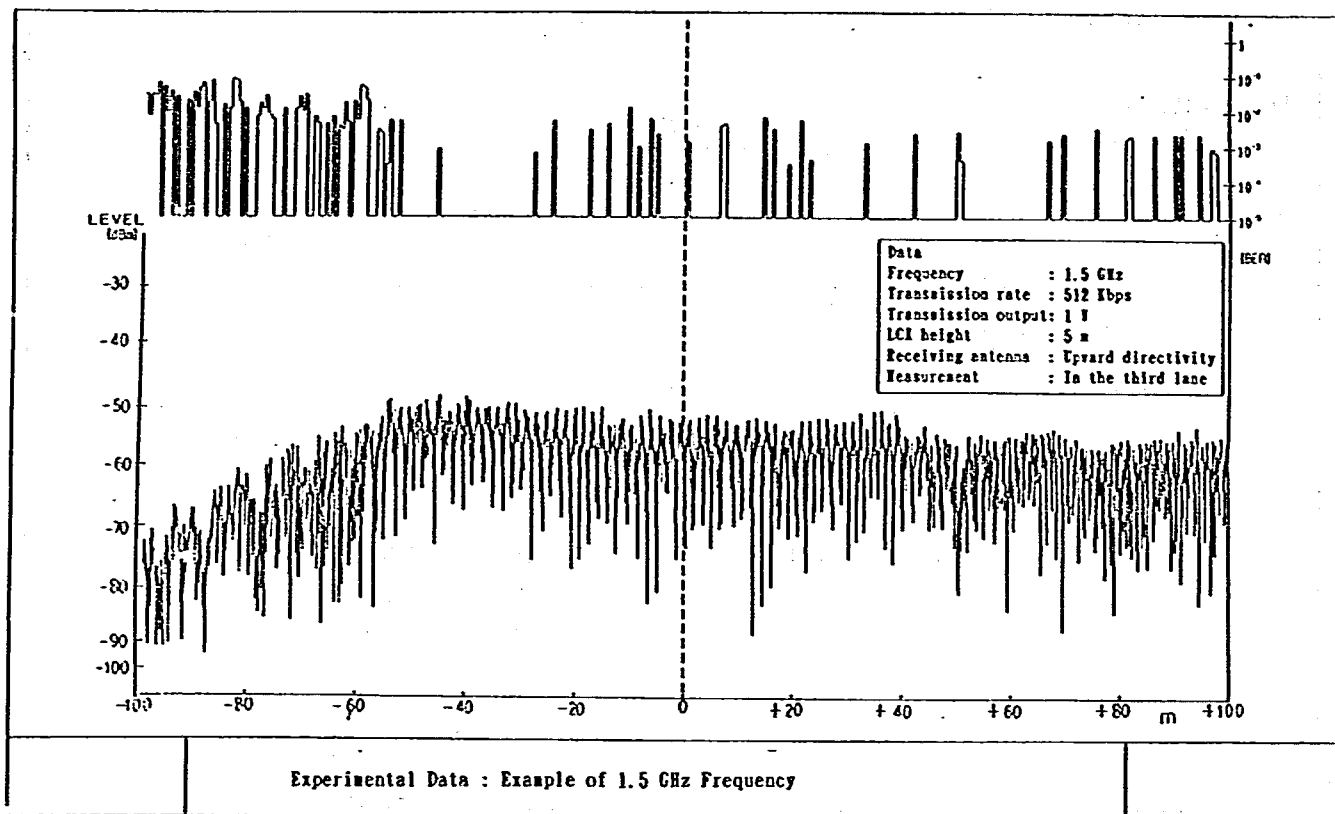
(No.4)

*** Experimental Items**

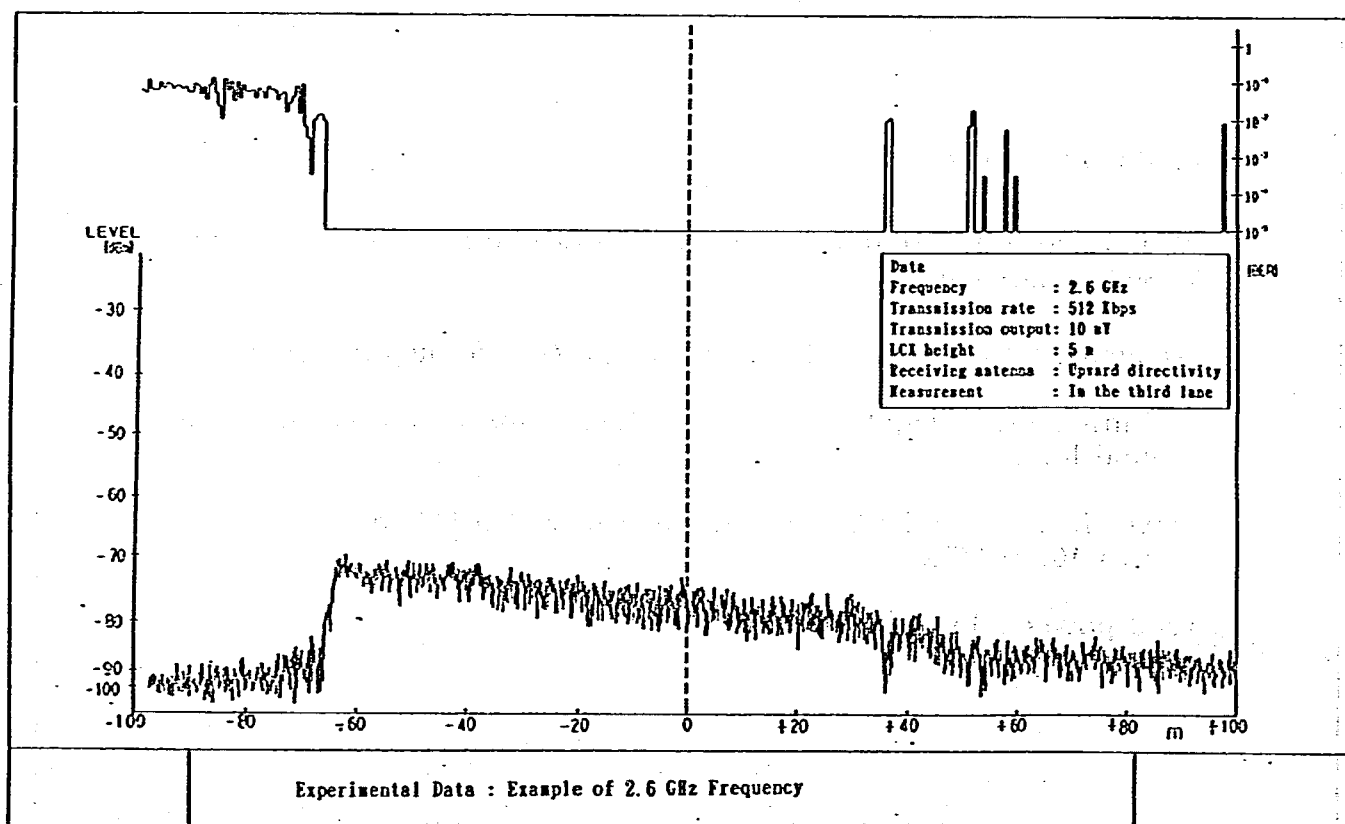
Field strength distribution and bit error rate are measured based on the following parameters.

- Frequency : One each in 1.5 GHz and 2.6 GHz frequency bands
- LCX installation height : 0 m , about 1.5 m , and about 5 m from the ground level
- Power feed method : Via a single end of 200 m LCX or from the center of two 100 m LCXs
- Feed power : 1 W , 0.1 W , and 0.01 W

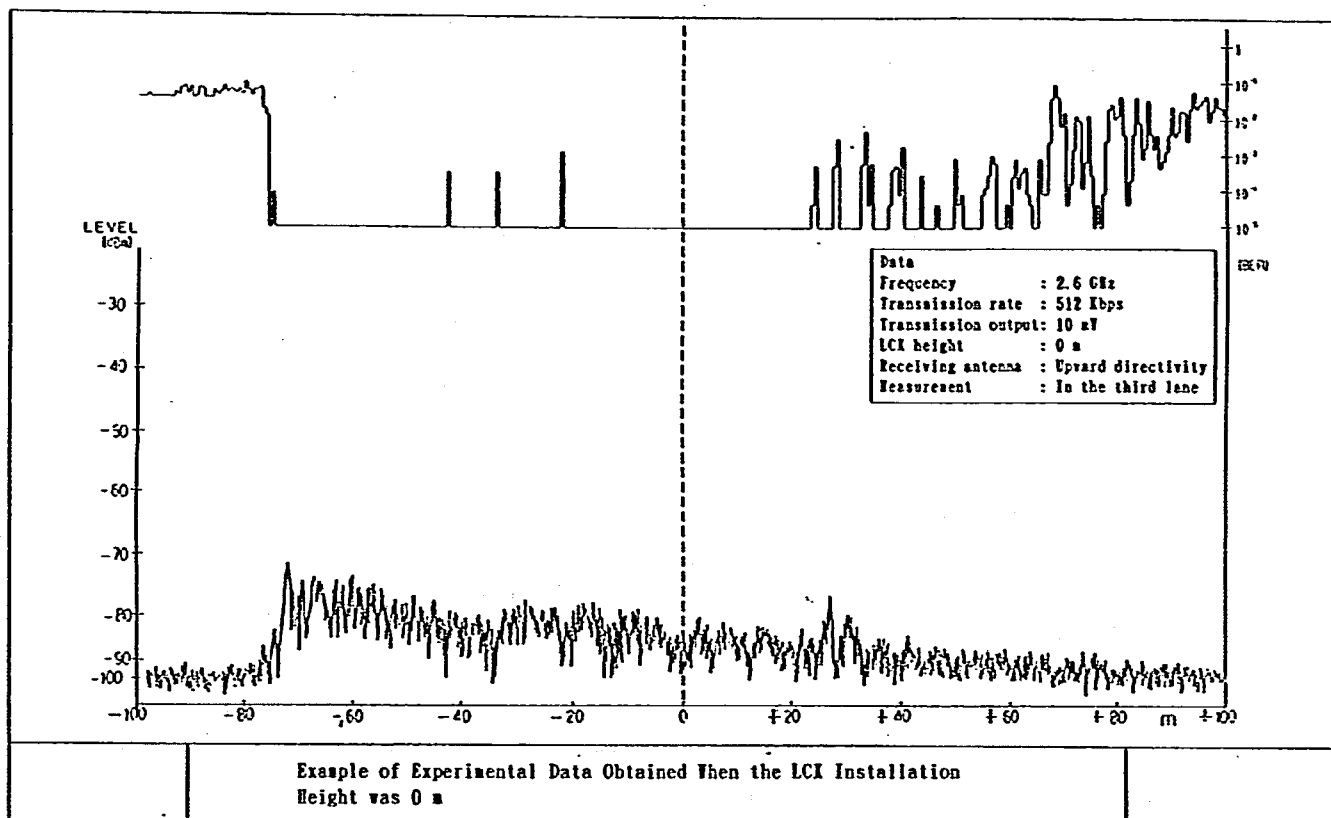
(No.5)



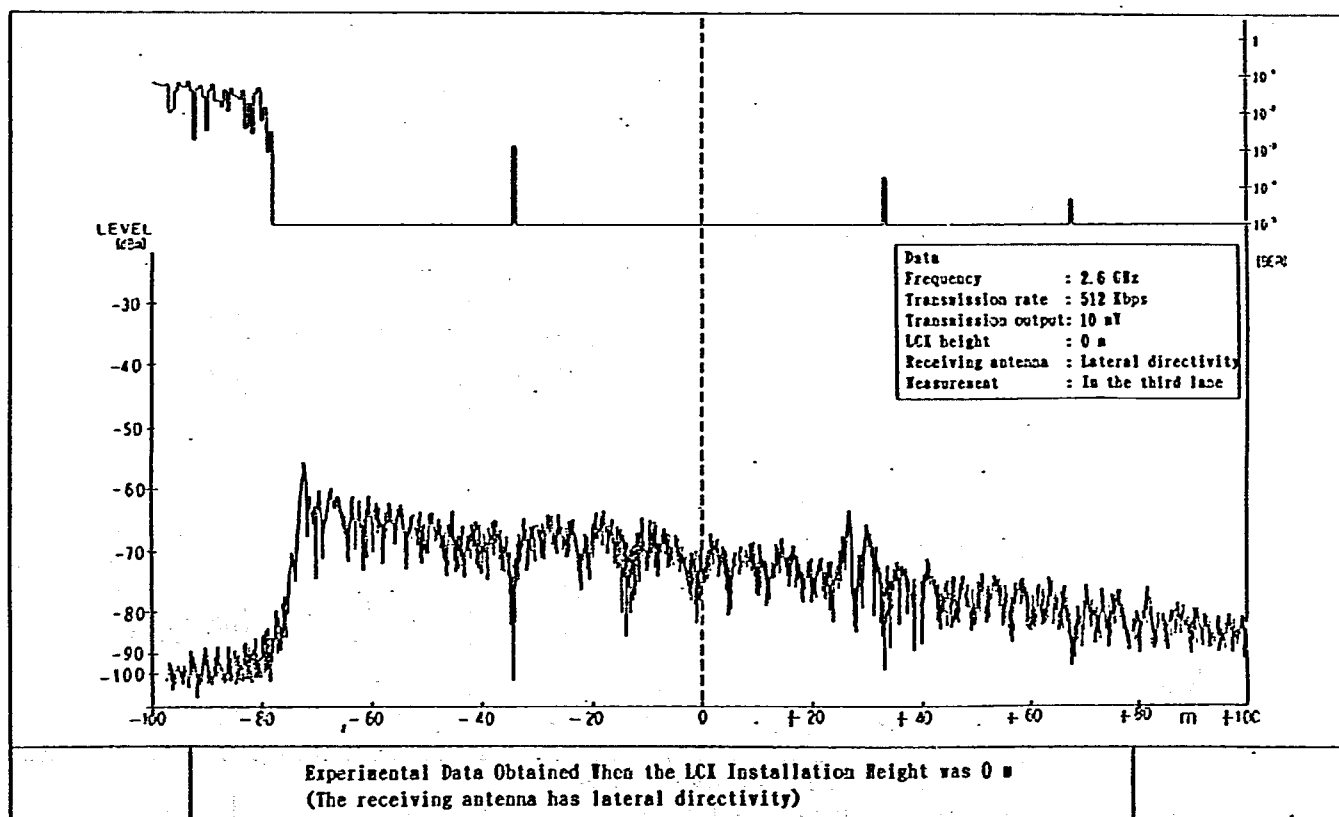
(No.6)



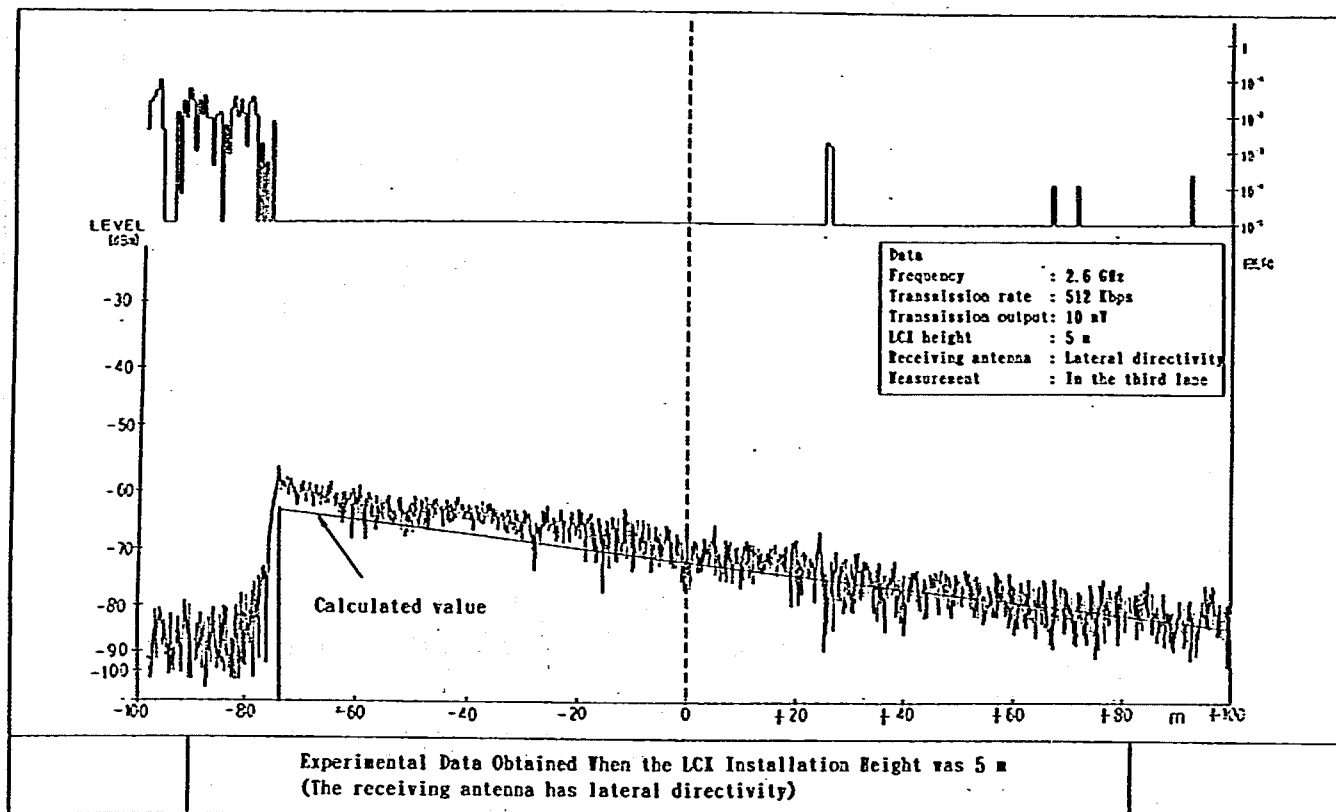
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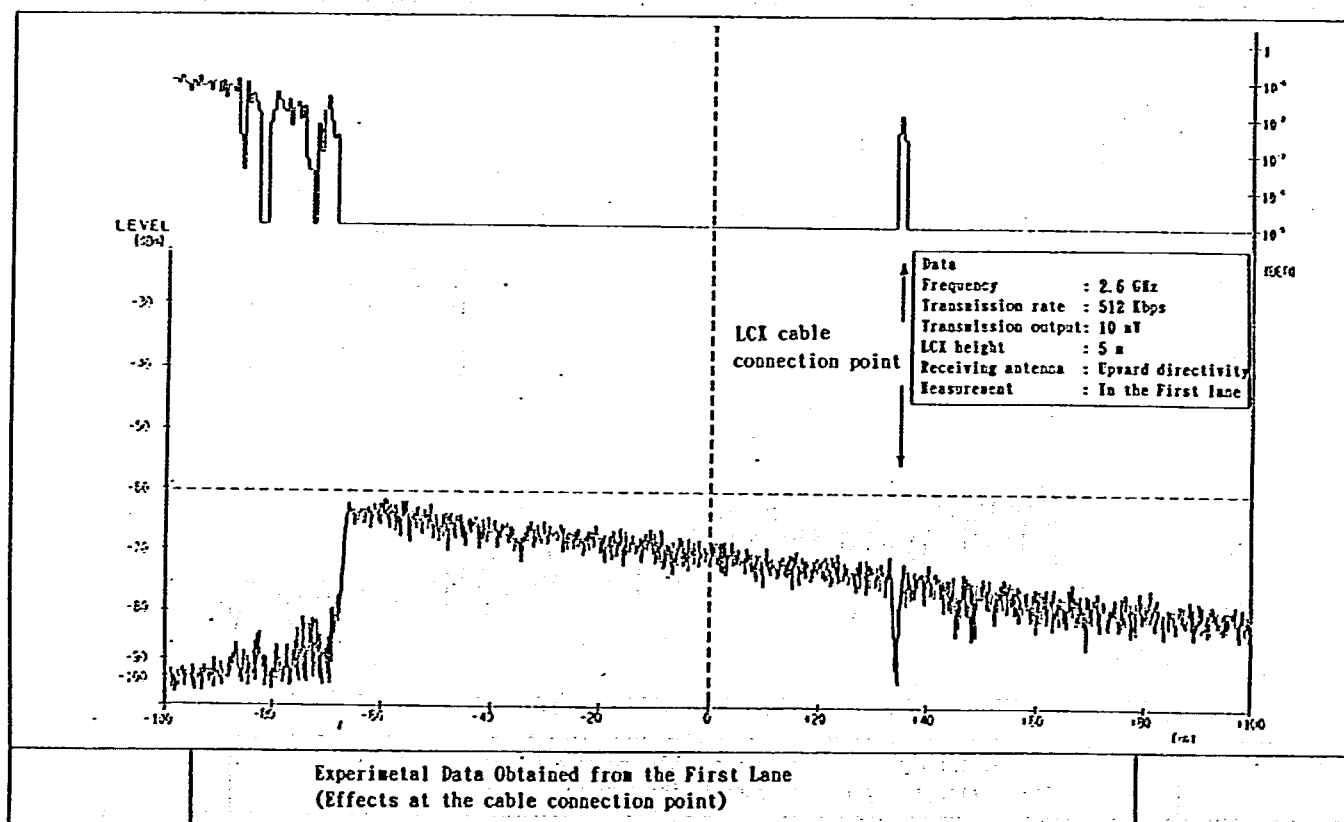
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(No.9)



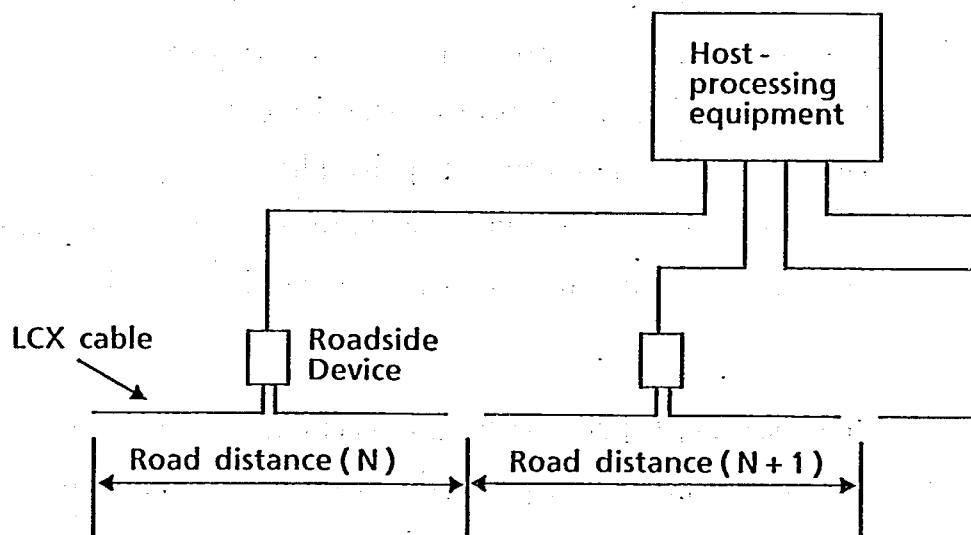
(No.10)



(No.11)

1. Less variations compared to field strength distribution in a tunnel ; close to the calculated value.
2. Receiving field is stable , preventing the occurrence of errors at low receiving level .
3. Offers the possibility of use in high -speed data communications (512 Kbps or more) .
4. LCX installation height does not much affect the cable characteristics. The relationship to the location of the vehicle antenna is important.
5. Changes in communication quality that result from variations in speed require no considerations .
6. Transmitter output is acceptable at a relatively lower level .
This raises the possibility of a making a practicable system with LCXs in the quasi -microwave bandwidth .

(No.12)



Example of RVC System Configuration Using LCX Cables

(No.13)

5. Records of Presentations

5. 1 Japan side

(3) "Preparation and Application of Digital Road Map in Japan" by Mr. Masao Shibata/Executive Director, Japan Digital Road Map Association

(OHP-No.1, No.2, No.3)

I'd like to present several aspects of DRM (digital road map) prepared by JDRMA (Japan Digital Road Map Association); its importance, specification, achievement, applications and future trends. Worldwidely the importance of DRM in navigation is recognized. DRM is necessary to identify the car's position and to find the appropriate route. I'd like to add some additional characteristics in Japanese road system, which multiply the importance of DRM.

We have an address definition system different from other countries. It is based on areas, not on streets. This system is not convenient for automobile transportation. Our cities spread continuously. It is very hard to recognize the boundaries. Because of the size of the aggregation of cities, single map is not sufficient for guiding a driver. Drivers usually carry driving map books with many pages. More than ten map publishing companies publish many driving map books. We use symbolic letters which can be recognized at a glance. Place names can be described with less letters.

Our road network has not kept pace with the tremendous increase in automobile ownership and rapid spread of densely populated area. Many areas are covered by narrow and complicated road network. Let me show an example of such road network. No.3 figure shows the address definition of the same area. Tsuchihashi area is divided into 7 blocks and each area is divided into estate areas. Each house has its number in it.

(OHP-No.4)

Road administrators and manufacturers in the navigation industry share the view that navigation systems and DRM to support it are particularly needed in these circumstances. They established JDRMA in August 1988 as an organization to prepare DRM database. The JDRMA map is the standard map for most DRM applications in Japan. To produce a map acceptable to all parties, JDRMA has been taking painstaking care to create a database that can function as a standard for various applications. Until recently, various companies were producing their independent databases. These companies have switched to the JDRMA database mainly because of economic reasons and considerations for future adaptability to VICS (Vehicle Information and Communication System) development.

(OHP-No.5, No.6)

The characteristics of JDRMA map are as follows;

The road network is divided into two networks; basic road network and all road network. Roads included in the basic road network are those belong to the prefectural level or higher and roads with a width of 5.5m or more. The all road network is composed of basic roads and all other roads with a width of 3.0m or more.

(OHP-No.7, No.8)

Let me explain the two networks by showing an example. This is the original analogue map. Next is the DRM. Blue, red and orange lines show basic road network and green lines show other roads.

(OHP-No.9, No.10)

Next two figures are the displays of a navigation system; first one displays only basic road network and the second one displays all road network.

(OHP-No.11, No.12)

The road network is expressed by the combination of nodes and links. Nodes in the basic road network are assigned numbers between 0001 and 9999 in the secondary mesh. Nodes in the all road network are assigned numbers from 00001 to 99999. A link number is created by combining the numbers of the nodes at the both ends. The x and y coordinates are based on secondary mesh units which are the components of the national code system of geographical information system. The data are divided into several layers; secondary mesh control data file, basic road network data file, all road network data file and background data file which includes information other than roads such as administrative boundaries, railways, facility names and place names.

The main data source is 1/25,000 and 1/50,000 scale analogue maps produced and maintained by Geographical Survey Institute of the Ministry of Construction, which cover all Japan. The other data source is the information from road administrators, which is mainly information of newly constructed roads. There are about 1,000,000 km of roads in Japan and about 30,000 km of roads are constructed or reconstructed every year.

(OHP-No.13)

We started to produce the DRM using 1/50,000 scale maps first and is gradually converting it into DRM from 1/25,000 scale maps, from the densely populated area. In March 1993, 50% of Japan is covered by the 1/25,000 scale maps. 75% of Japan is mountainous and there are not many roads in these areas. The remaining digitalizing work in these areas is not so much as before.

(OHP-No.14)

The data volume of JDRMA database has been increasing year by year. The total data volume of the 1993 database is about 2 gigabytes.

The maintenance of the database is also an important work. JDRMA supplies users with the up-dated edition of DRM of the whole country in March every year. We has developed the data error feedback system which deals error information from the customers and the data registration system which keep track of the additions and deletion of data, to cope with this task.

(OHP-No.15, No.16, No.17)

Car navigation is currently the largest application of DRM. 12 users purchased the original JDRMA database as the basic data and added their own original data for their navigation systems such as hotels, restraunts and resort spots. There are about 130,000 vehicles equipped with the DRM data based on JDRMA map.

(OHP-No.18)

The current navigation systems are independant systems without linkage with outer facilities. VICS is now in the preparation stage. JDRMA is cooperating with VICS organization in developing the VICS link that is necessary to transmit information between vehicles and road information devices.

(OHP-No.19, No.20)

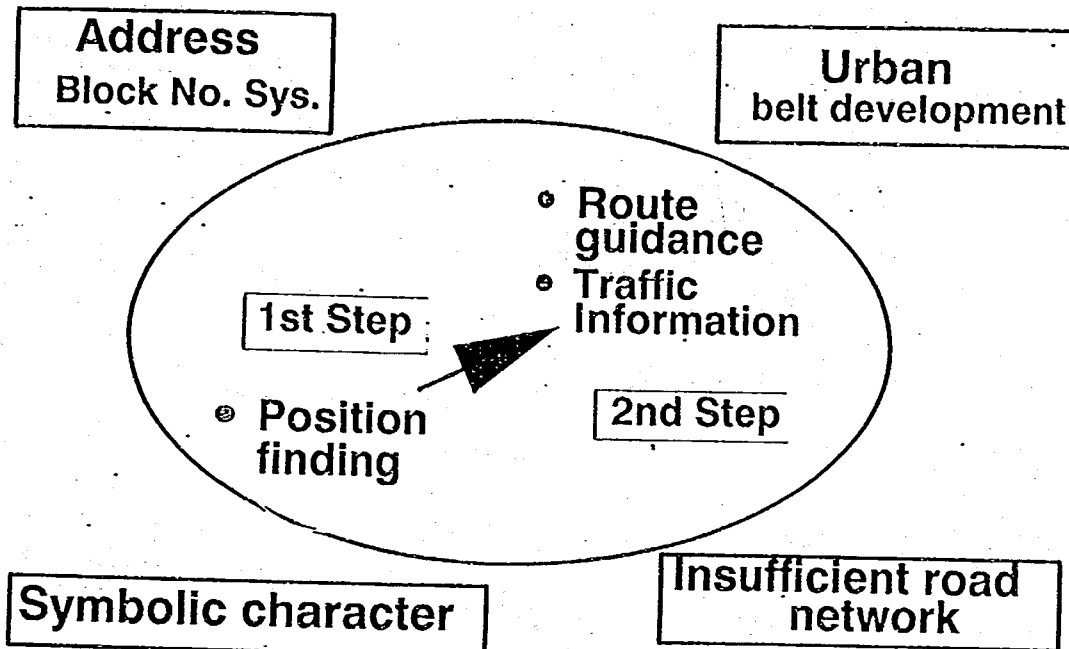
The research to promote traffic safety by establishing road-vehicle system which includes control of vehicles by high level digital road map is undergoing. Location systems using DRM is in service in police, ambulance, fire department and taxi companies. The characteristics of digital data are well suited for emergency systems.

Planning and research fields will be major application of DRM in the future. A road sign checking system, traffic accident analysis system, road census reference system and logistics are now studied. To cope with the development of applications, DRM should progress.

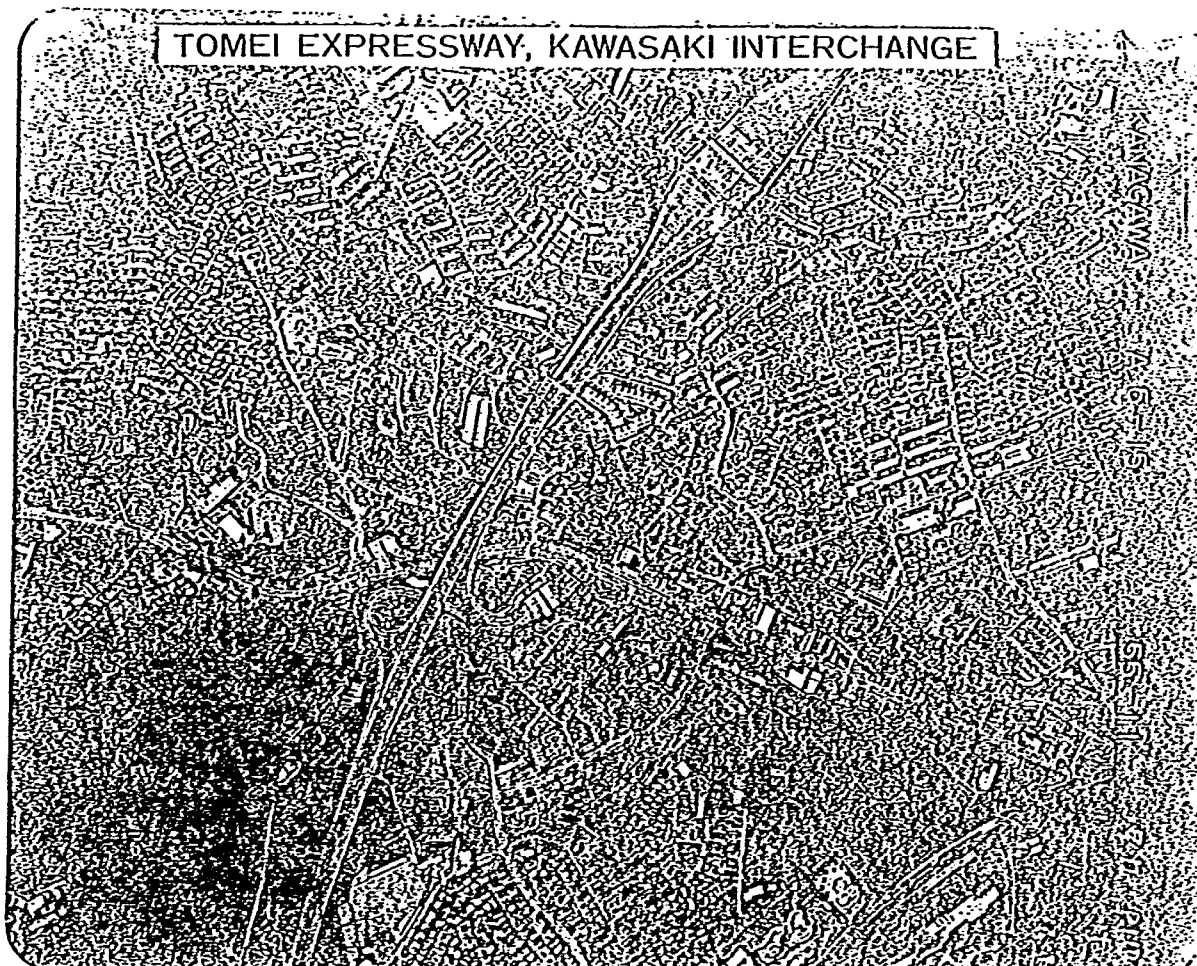
Let me present some directions on this line. Besides road data, information of roadside facilities such as public facilities and recreational spots are requested. Detailed information on intersections and large scale road map in urban area will promote the effort to make navigation more precise and easier. High grade DRM, which includes geometric details of road, will promote the development of advanced traffic safety systems.

DRM is used practically in navigation and some other fields in Japan. But there are wide possibilities to be cultivated in the future. We'd like to continue our efforts with the colleagues of the world.

Why is digital road map important ?

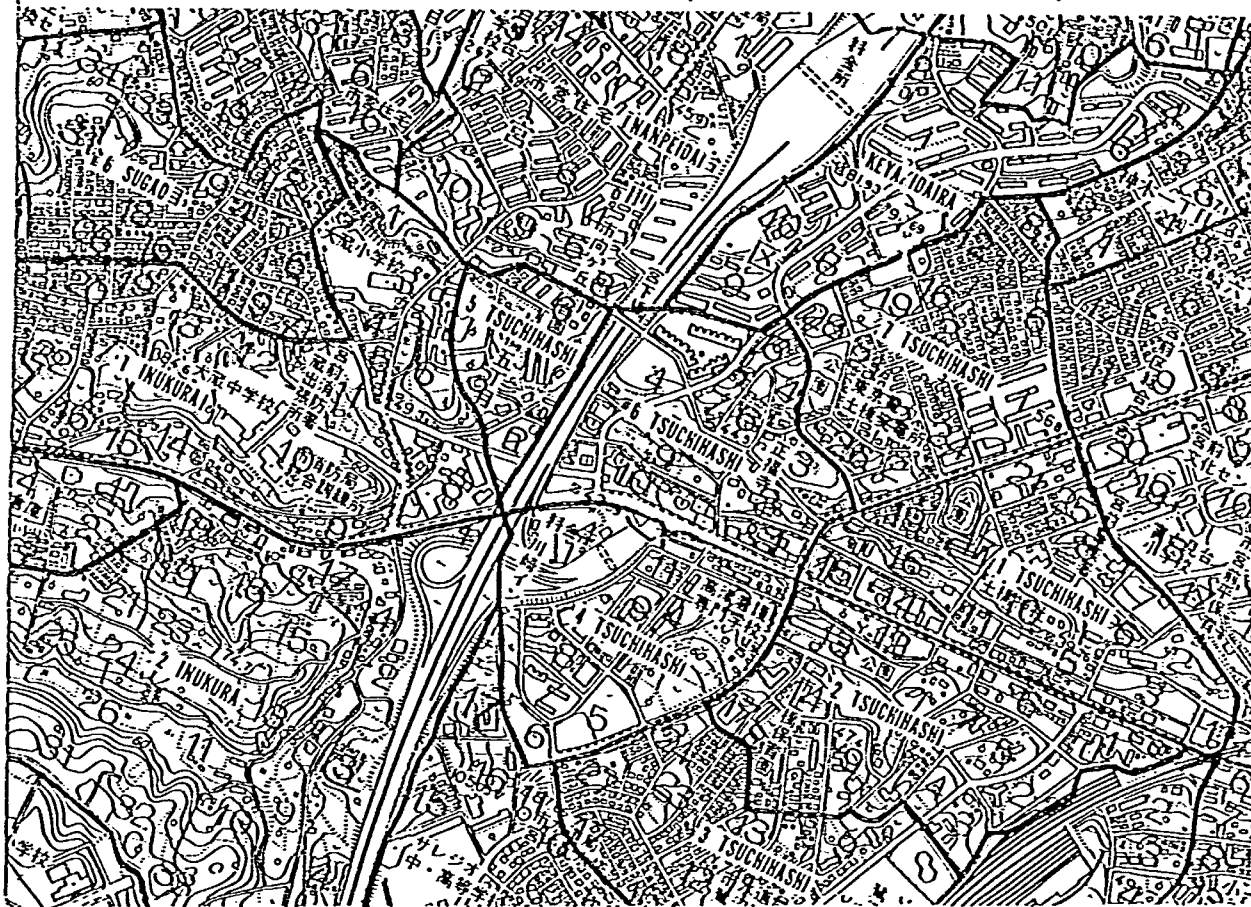


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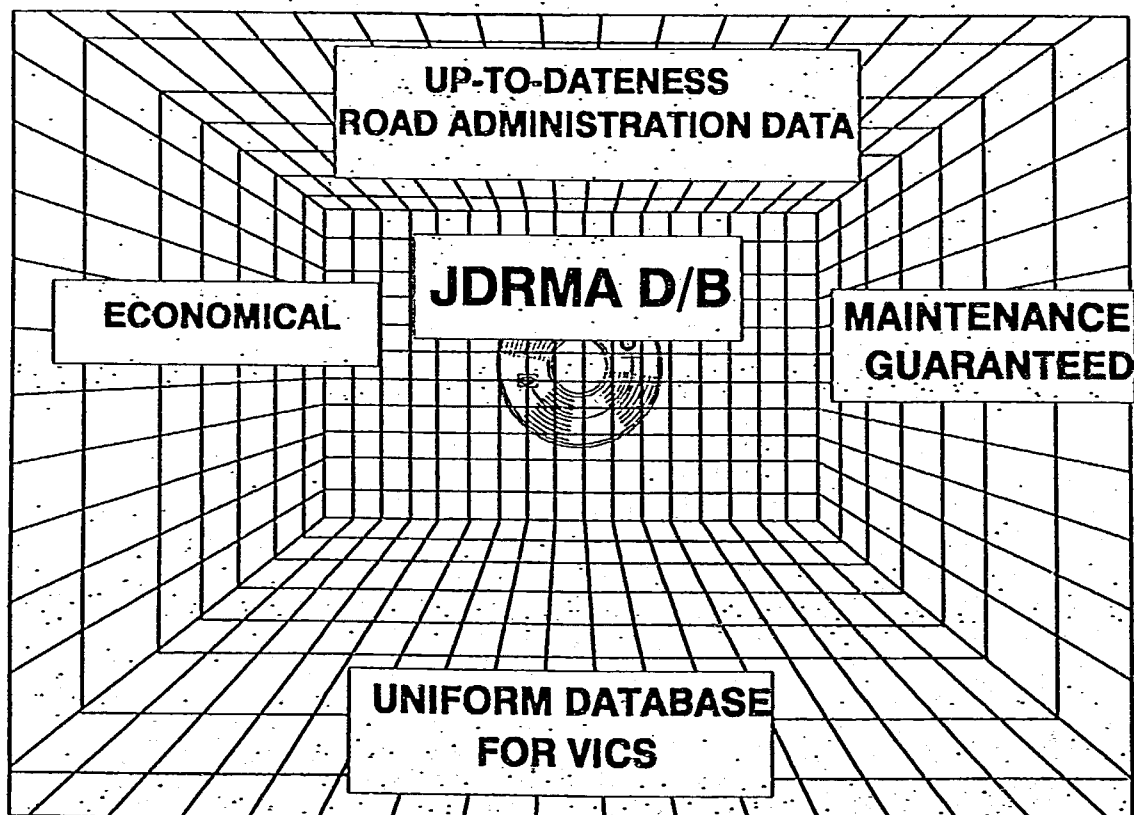


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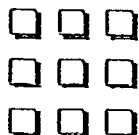
ADDRESS EXPRESSION IN JAPAN



(No. 3)



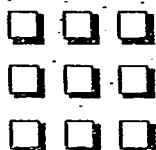
(No. 4)



DATABASE PRODUCTION

- Digital road map database standard
- Road grouping: 1. BASIC ROADS
Nat., pref. roads &
roads, width $> 5.5\text{m}$
2. ALL ROADS
Roads, width $> 3.0\text{m}$
- Road network by nodes and links
- 2° mesh units (approx. $10\text{km} \times 10\text{km}$)
X: 0-10,000 ; Y: 0-10,000

(No.5)

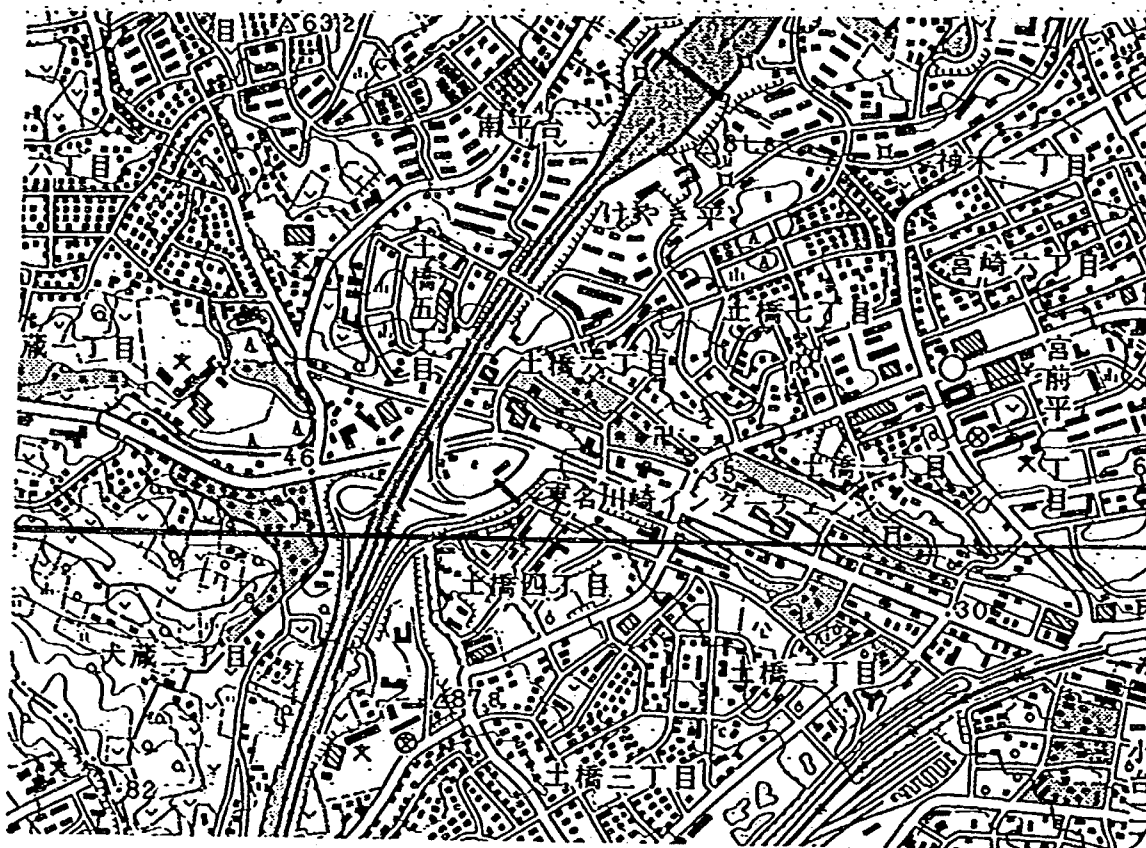


TARGET OF JDRMA DATABASE

- UP-TO-DATENESS
 - New roads, open by Oct. 1st
 - Roads open in near future
- ACCURACY
 - 0.3mm on original map
 - Supplemental data
- COMPLETENESS
 - Based on original map
(except traffic regulation)

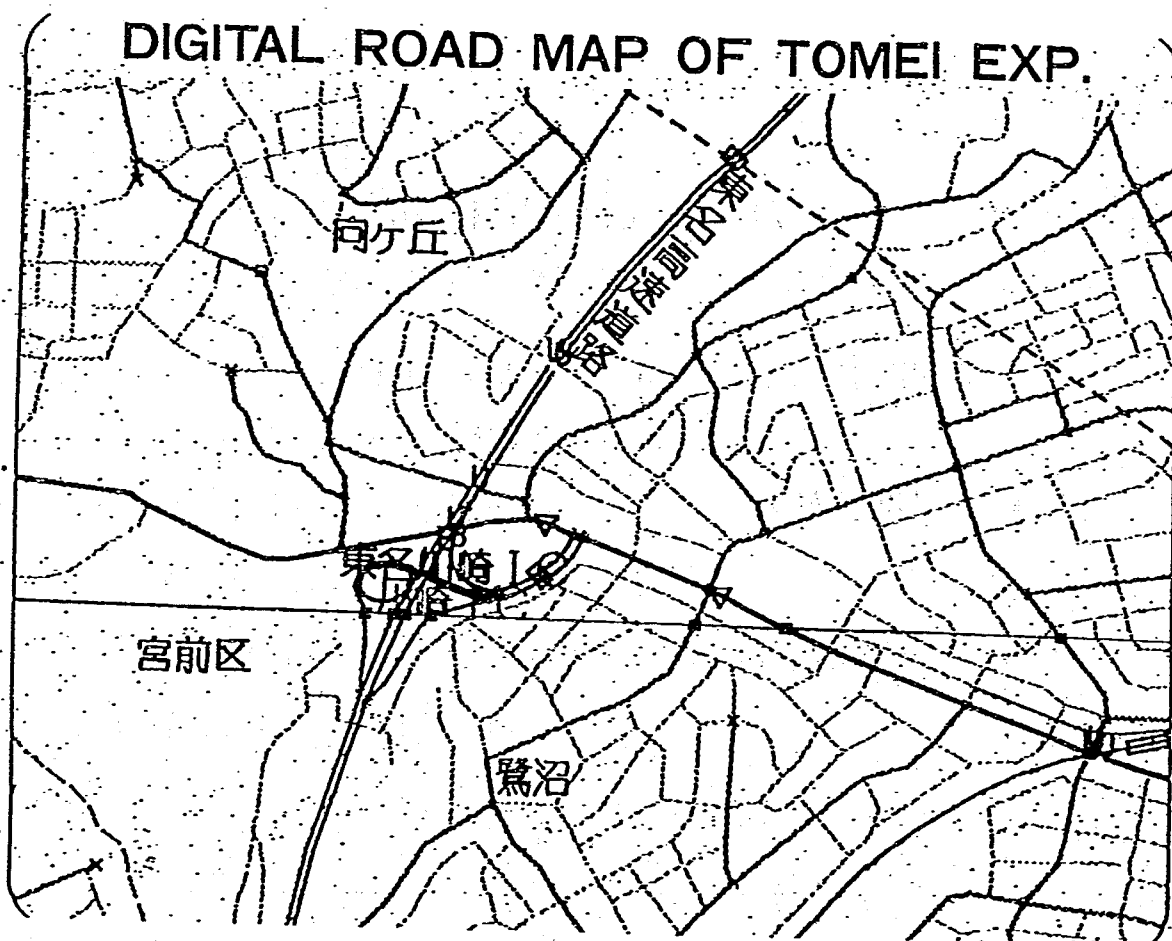
(No.6)

1:25,000 MAP OF TOMEI EXP.

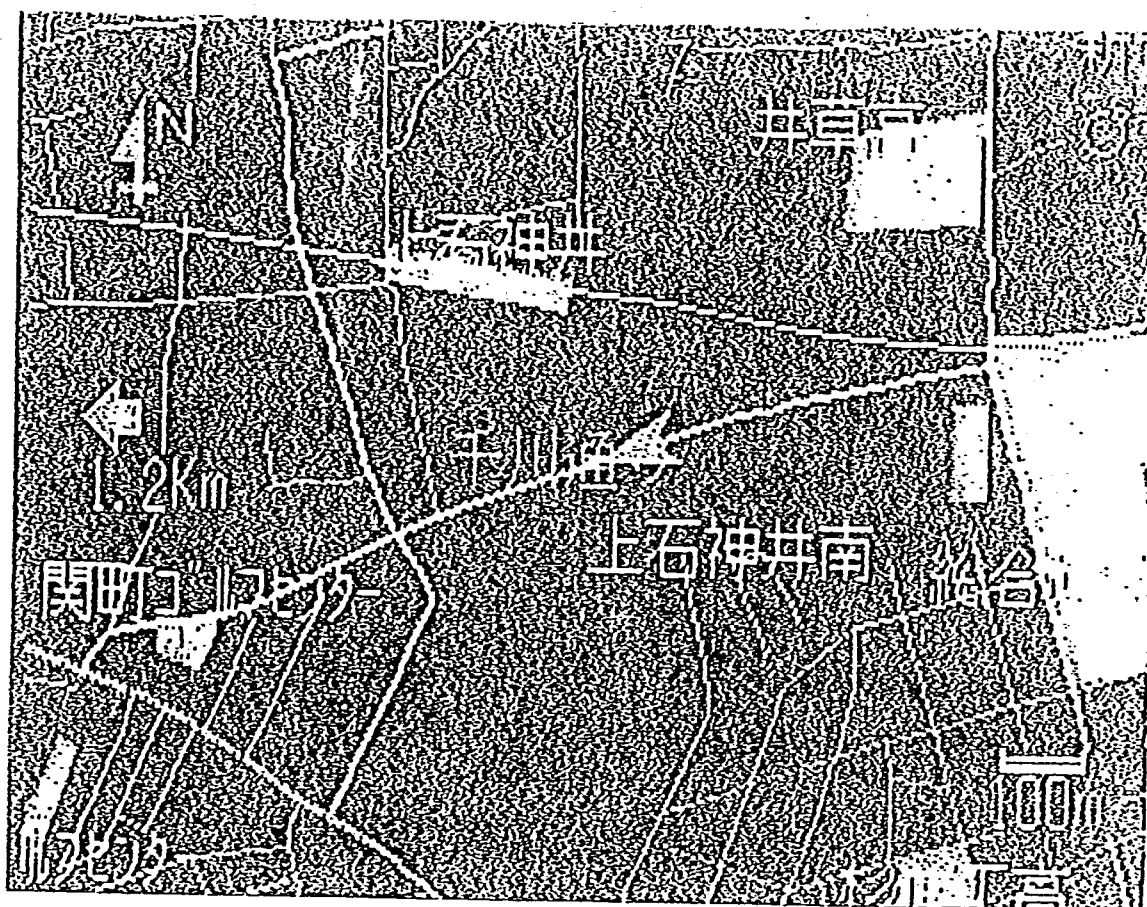


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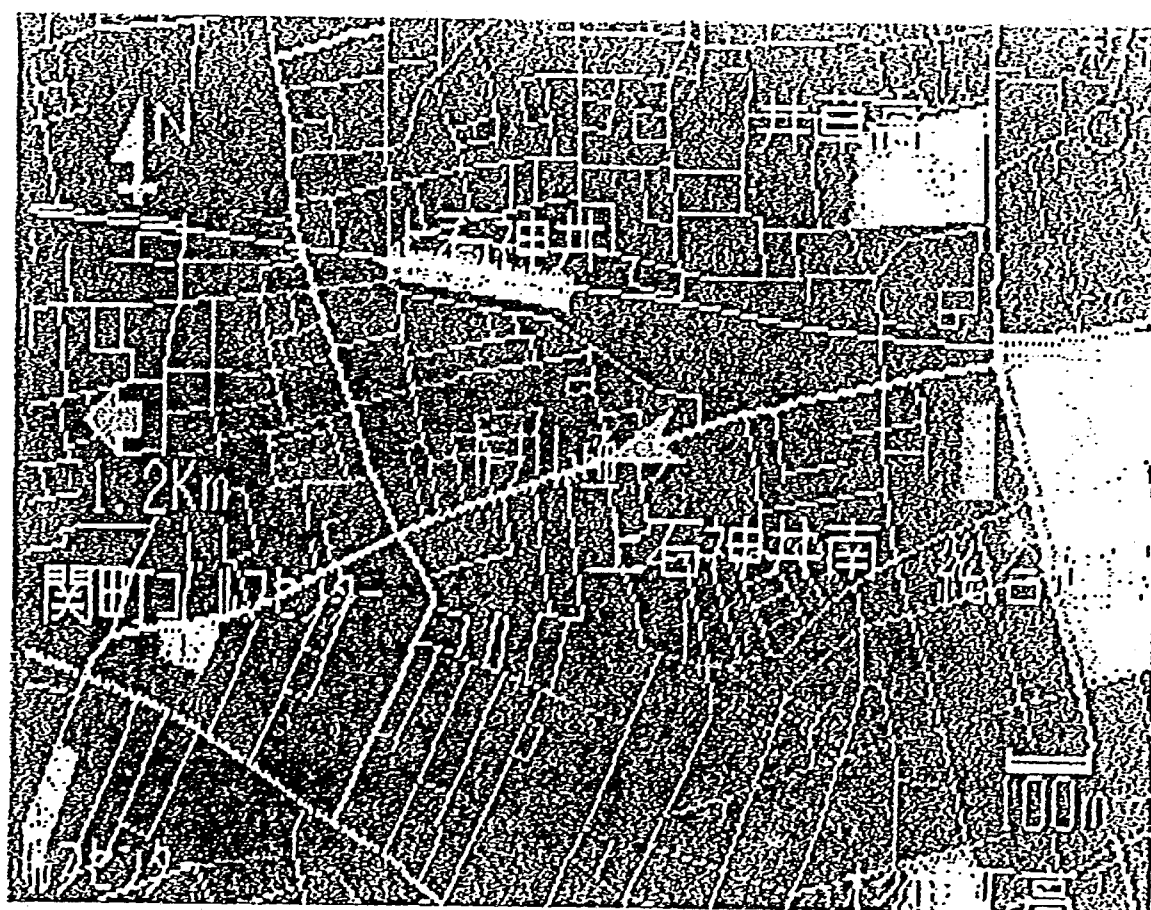
DIGITAL ROAD MAP OF TOMEI EXP.



(No.8)



(No.9)



(No.10)

Standardization of digital road map

- Classification

- Basic road network--for navigation
- All road network-----for display

- Node & link structure

- Regular x,y coodinate on secondary mesh unit

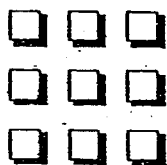
- Layers of database

- Control data
- Basic road data
- All road data
- Background data

- Data source

- 1:25,000, 1:50,000 Scale map
- Road administrators

(No.11)



BASIC APPROACH

■ Digital road map based on:

☐ Topographical maps, 1/25,000 & 1/50,000

☐ Maps & documents from

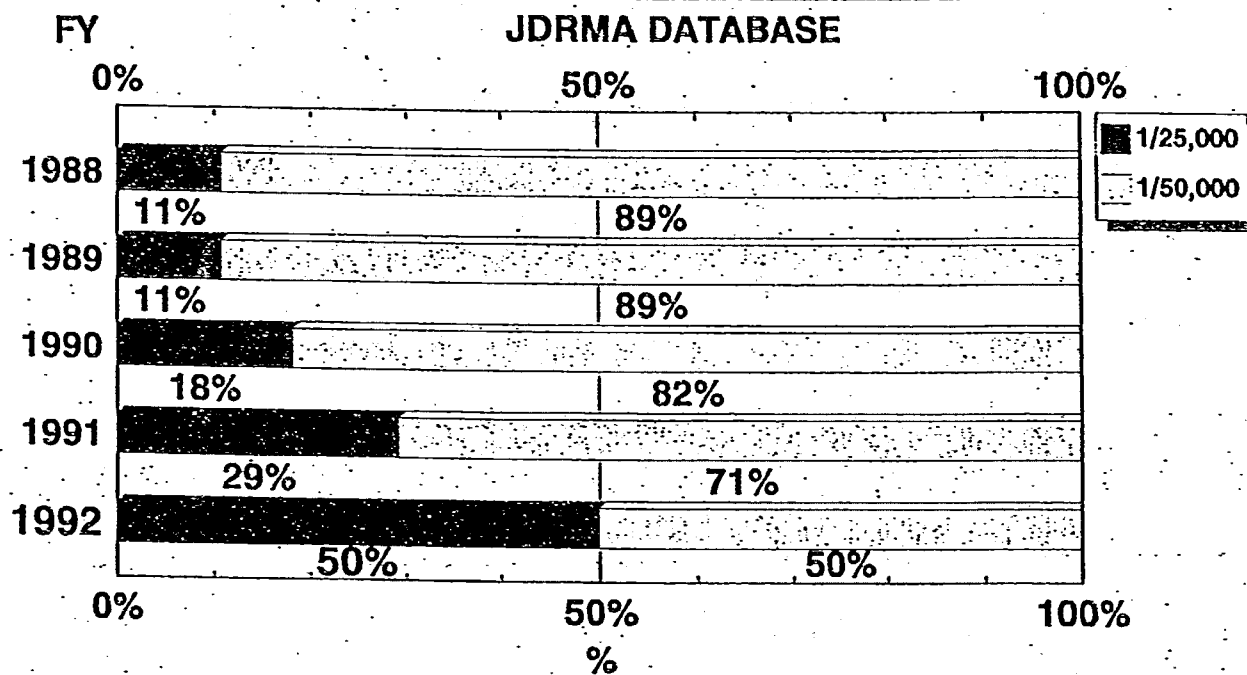
— Ministry of Construction

— Road Administrative Agencies

— Geographical Survey Institute

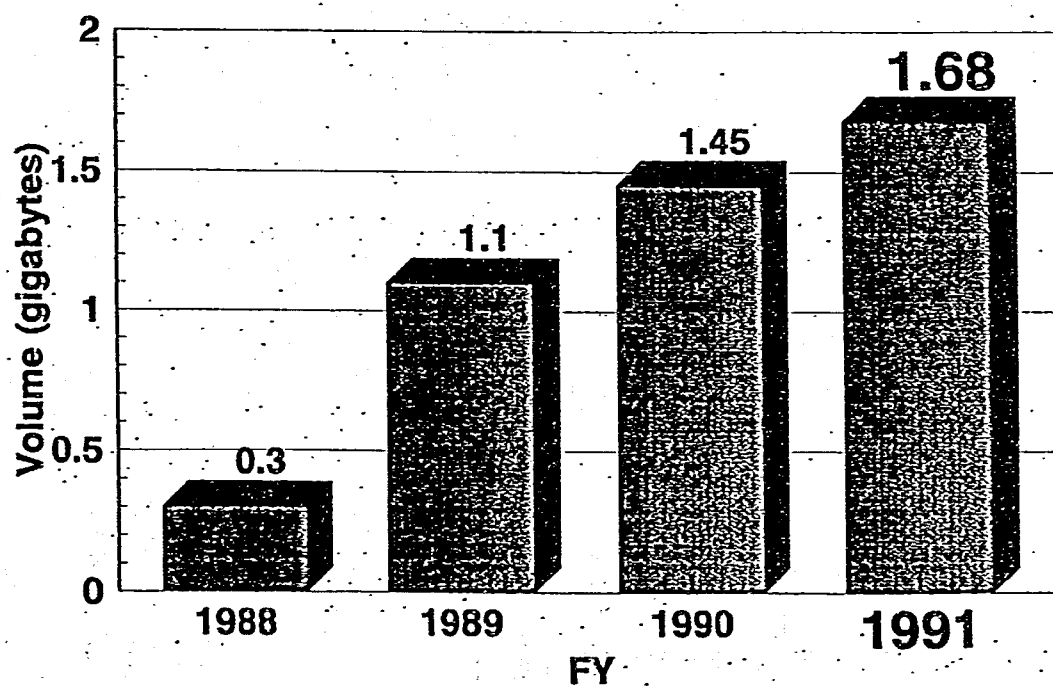
(No.12)

AREA COVERAGE OF JAPAN



(No.13)

DATA VOLUME OF JDRMA DATABASE



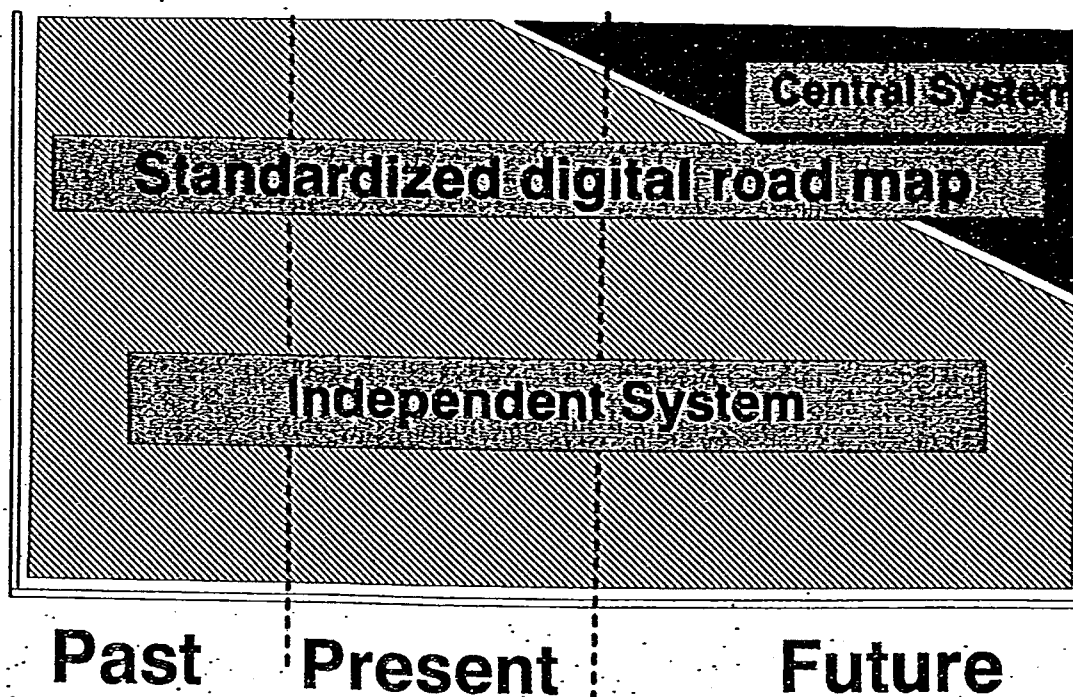
(No.14)

Digital road map for car navigation

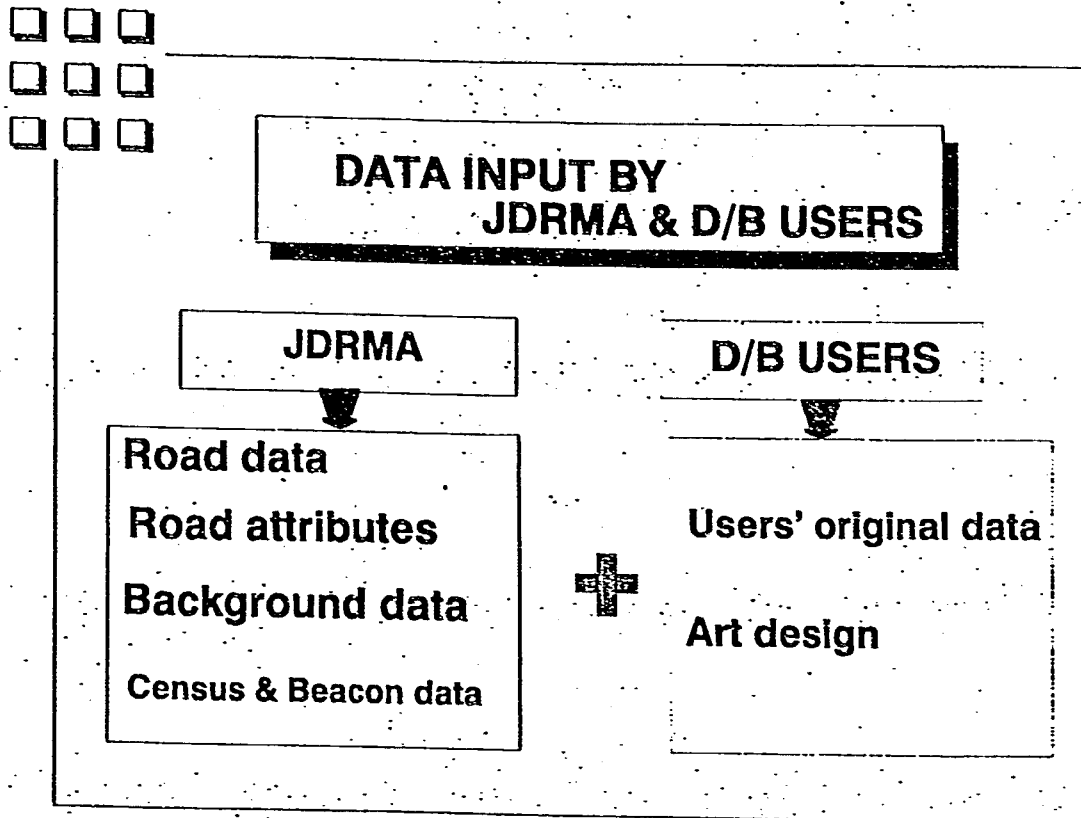
- Why is it important ?
- What kind of digital road map is suited ?
- Achievements
- Applications
- Future trends

(No.15)

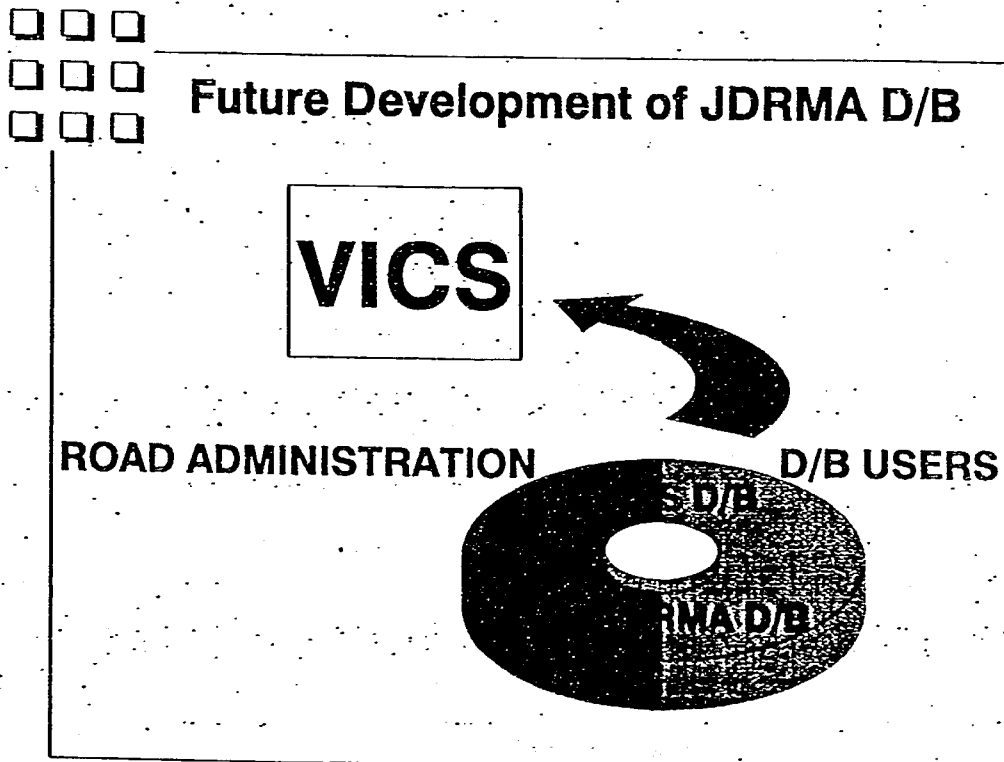
Car navigation system



(No.16)

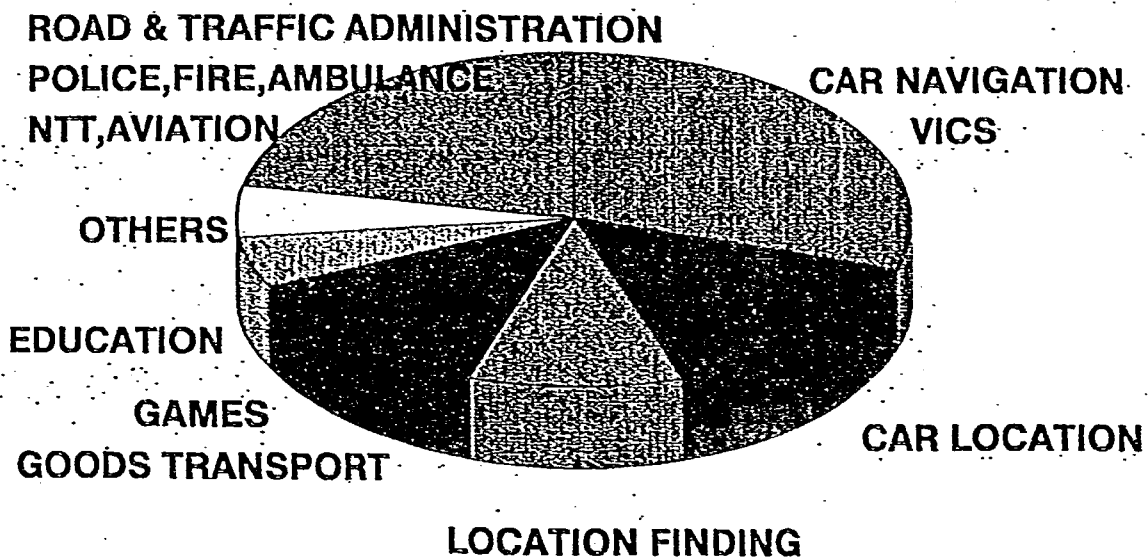


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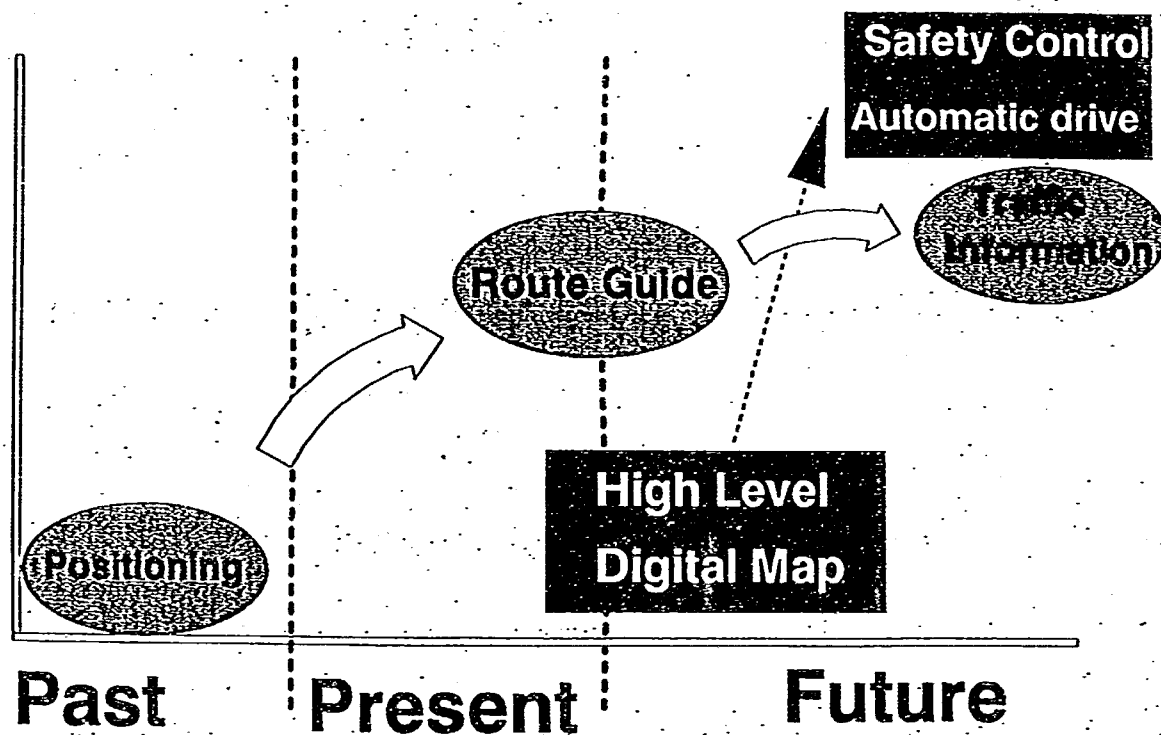
(No.18)

Application of JDRMA database



(No.19)

Car navigation development process



(No.20)

5. Records of Presentations

5. 2 U.S. side

(1) "1993 IVHS Operational Tests"

by Mr. Robert L. Rupert/IVHS Operational Test Team
Leader, Office of Traffic Management & IVHS, FHWA

(OHP-No.1)

The solicitation listed seven technology or program areas that the proposals had to relate to. These areas are: Rural Systems, Advanced Traveler Information Systems, Advanced Traffic Management System Integration, Surveillance and Detection, Advanced Sensor Systems, Commercial Vehicle or Truck Operations, and Advanced Vehicle Control Systems. Basically anything related to IVHS could be proposed. Proposals were received in October.

(OHP-No.2)

We received 102 proposals from all across the country and both public and private agencies and joint ventures. There proposals in total requested 305 million dollars in Federal government funds, and offered 231 million dollars in matching funds. These matching funds included State and local government and private company money and services. Many groups of professionals within the United States Department of Transportation reviewed the proposals, multiple levels of management reviewed the groups' recommendations, and in December 16 projects were selected as Operational Tests. These 16 projects requested 41 million dollars from the Federal government, while offering 49 million dollars in matching funds. We are currently negotiating with these 16 sites to decide exactly what the projects will test and how much they will cost.

(OHP-No.3, No.4)

The next two slides list the 16 selected Operation Tests. I will describe each briefly, and then talk in more detail about three of these.

The SmartDart project in Delaware will test using "smart cards" for automatically charging users of bus systems.

The Denver Real-Time Transit Information project in Colorado will give information about the bus system and the highways to possible users at "park-and-ride" parking lots where people can carpool or take buses into Denver.

The New York Real-Time Transit Information project will provide information to bus riders at bus stops in New York City.

The Bay Area Intermodal Advanced Traveler Information System, or "TravInfo", will collect all kinds of transportation information in the San Francisco Bay area in California. This information will include transit and highway information, and will be offered to private companies for distribution to end-users.

San Antonio, Texas, is installing an expressway traffic control system that will use a communication system very similar to a computer area-wide network. This test will evaluate that communication system for practicality and cost-effectiveness.

The Dynamic Truck Speed Warning in Colorado will use roadway sensors to detect truck speeds, and roadside signs will alert drivers who are traveling too fast.

The On-Board Mileage and State Border Crossing project was shown by Mr. MacGwan earlier. It involves the states of Iowa, Wisconsin and Minnesota, and will let trucks keep track of the miles of roads that they travel over in each state. This travel information will then be used to decide what taxes the trucks should pay.

I will describe the Idaho Storm Warning System later.

The TravLink project in Minnesota will provide transit information to people in their homes through small terminals supplied by the local telephone company.

I will discuss thhe Genesis project, also in Minnesota, later.

The Integrated Ramp Meter and Adaptive Traffic Control System is in Irvine, California, and will test coordinated operations between the freeway control system and an adaptive signal controller.

The Mobile Video Surveillance System will be used in Orange County, California; to test video surveillance as a temporary detection system for construction sites and special events.

The Adaptive Traffic Control System in Anaheim, California, will compare two types of adaptive signal systems.

Because of the large number of call boxes installed in California, the Smart Call Box project in San Diego will test using call boxes for data communication.

The City of Los Angeles will use radios to interconnect some signals as a network near the airport.

And I will describe the surveillance system in Washington D.C. later.

(OHP-No.5)

The Storm Warning System will be installed in Idaho. It will detect when snow storms or fog cause dangerous driving conditions because of limited visibility. Two different sensing systems will be tested. The HANDAR system will use a weather station and infrared sensors to check visibility conditions. The LIDAR system uses a laser to check visibility along the roadway. It is hoped that better detection will help reduce the number of accidents associated with these dangerous conditions.

(OHP-No.6)

The Genesis project in Minnesota will provide traveler information to personal portable devices. There are many public and private organizations involveed. The first phase of the project will send information to paging devices. Later phases will send information

to more complex equipment, such as very small, portable computers. This project will be included into the larger, statewide Minnesota GuideStar program.

(OHP-No.7)

Finally, the Washington, D.C. Area Surveillance project will use cellular telephone technology. Certain vehicles with cellular telephones will be tracked to provide information about the highway network. This project involves many private and public organizations, and will use a fleet of delivery vehicles.

As you can see, we have a very ambitious IVHS Operational Test program. We are very excited about it and about future Operational Tests as we establish our national IVHS program plan.

1993 IVHS OPERATIONAL TESTS

**Presentation to PWRI
21 April 1993**

**Robert Rupert, Team Leader
IVHS Operational Tests Division
Federal Highway Administration**

TECHNOLOGIES OR PROGRAM AREAS

- 1. Rural Systems**
- 2. Advanced Traveler Information System (ATIS)**
- 3. Advanced Traffic Management Systems (ATMS) Integration**
- 4. Surveillance and Detection**
- 5. Sensor Systems**
- 6. Commercial Vehicle Operations**
- 7. Advanced Vehicle Control Systems (AVCS)**

RESPONSE TO SOLICITATION

- 102 Offers Received
- \$305 Million in Federal Funding Requested
- \$231 Million other Funding

-
- 16 Sites Selected for Operational Tests
 - \$41 Million in Federal Funding Requested
 - \$49 Million other Funding

(No.2)

SELECTED PROPOSALS	
Name of Proposal	Source
SMARTDART	Delaware DOT
Denver Real-Time Transit Information	Regional Transportation District
New York Real-Time Transit Information	New York Metro Trans. Authority
Bay Area Intermodal ATIS (TravInfo)	S.F. Bay Area Ad Hoc IVHS
San Antonio TCS Comm. Eval.	Texas DOT
Dynamic Truck Speed Warning	Colorado DOT
On-Board Mileage/State Crossing	Iowa DOT
Storm Warning System	Idaho DOT

(No.3)

SELECTED PROPOSALS

Name of Proposal	Source
TRAVLINK	Minnesota DOT
ATIS Personal Comm. Devices (Genesis)	Minnesota DOT
Integrated Ramp Meter/Adaptive TCS	California DOT
Mobile Video Surveillance System	California DOT
Adaptive Traffic Control System	California DOT
Smart Call Box	Ad Hoc Call Box Committee
R.F. Networking for Advanced TCS	City of Los Angeles
Washington D.C. Area Surveillance	Maryland SHA

(No. 4)

STORM WARNING SYSTEM

- Submitted by Idaho Department of Transportation
- Propose to Install Visibility and Weather Sensors
 - HANDAR System: Weather Station (wind, precipitation); Near-Infrared Visibility Sensor
 - LIDAR System: Laser Visibility Sensor
- Evaluate Reduction of Visibility-Caused Multiple Accidents

(No. 5)

GENESIS

- Submitted by Minnesota GuideStar Program
- Partners: Minnesota DOT
Motorola, Inc.
Univ. of Minnesota Center for Trans. Studies
FHWA
- Provide Traveler Information to Personal Communication Devices
- Personal Pagers
- Personal Digital Assistant (Palmtop Computer)
- Plan to Incorporate into other GuideStar Programs

(No.6)

WASHINGTON DC AREA SURVEILLANCE

- Submitted by Maryland State Highway Administration
- Partners: Bell Atlantic Mobile Systems
Engineering Research Associates
Farradyne Systems, Inc.
Maryland State Highway Administration
Virginia Department of Transportation
- Propose Passive Cellular Geolocation for Traffic Flow Information (Probe Data)
- Cellular Data Transmission of Traveler Information
- Fleet of Delivery Vehicles

(No.7)

5. Records of Presentations

5. 2 U.S. side

(2) "Design Features of a Subcarrier based Traffic Information Channel (STIC)"

by Mr. Frank J. Mammano/ATIS & Communications Research
Chief, IVHS Research Division, Turner-Fairbank
Highway Research Center, FHWA

A Preliminary Design and Field Test Results for a System to Distribute Digital Traffic Data Using FM Broadcast Station Subcarriers

D.J. Chadwick, V.M. Patel, J.W. Marshall and J.R. Hamalainen
The MITRE Corporation
and
L.G. Saxton and F.J. Mammano
Federal Highway Administration

Abstract

IVHS development is at a crossroads. In order to support the early implementation of useful IVHS systems for public use, a means must be provided to distribute the traffic data collected and processed by new Advanced Traffic Management Systems to vehicles, that can be used, in turn, to drive a wide variety of Advanced Traveler Information System (ATIS) products. Such a system must have two principal attributes. First, it must be readily implemented at relatively low cost; and second, it must have sufficient capacity to support IVHS traffic data needs for several years until "permanent" or adjunct solutions can be developed.

The FM Broadcast infrastructure in North America fits the first criterion, because it provides nearly universal coverage in the areas where IVHS will be implemented, and because it already has provisions for the use of subcarriers (SCA) for the transmission of subsidiary material that is independent of the main entertainment channel. The second criterion, capacity, has been lacking until recently because these subcarriers have historically been used for the distribution of analog information at relatively low data rates.

This paper describes the derivation of the concept, the selection of modulation and coding techniques through detailed simulation, and the prototyping and field testing of an inexpensive, high-speed, FMISCA-based system for wide-area traffic data distribution. The methodology used to arrive at the optimal compromise among data rate, entertainment-channel interference and channel robustness is described. The effects of multipath and fading are examined and the limits these phenomena place on usable system capacity are defined. Extension of the basic communications characteristics of the system to TV aural subcarriers, with an accompanying increase in capacity, is also discussed.

The results of limited field tests in an urban environment will be given during the oral presentation at the conference, since the tests were being conducted at the time this paper was due for publication.

Introduction

The IVHS program must begin to provide useful capabilities for the traveling public within a very few years if it is to survive in the current fiscal climate. Central to the early implementation of many IVHS services is the availability of traffic congestion data over large geographical areas. Without this information, in-vehicle equipment and software development for Advanced Traveler Information Systems (ATIS) will be significantly slowed and the definition of more effective traffic management strategies, a critical part of Advanced Traffic Management Systems (ATMS), will be delayed.

The requirement for traffic data has two major components. First, the capacity of the delivery system must be adequate to support real-time updates of large numbers of links. Second, because this data is needed to support other activities, little or no time is available to design, engineer, acquire and install a large communications infrastructure.

The Federal Highway Administration, working with the MITRE Corporation, examined several alternatives for providing this data. After looking at alternatives in light of the aforementioned requirements, a decision was made to investigate the use of FM Broadcast subcarriers for digital traffic data distribution. Certainly, the second requirement is met; almost all of the United States is covered by FM broadcast signals so the communications infrastructure is already in place. The first requirement, capacity, was still unknown, however.

The FHWA decided to have MITRE do an analysis to select the best modulation and coding techniques

and subcarrier frequency, build a laboratory simulation of the system using actual radio frequencies, and then build and test a prototype system using actual FM stations. If the experiment is a success, the technology will be no-cost licensed to industry to refine the design and build hardware.

FM Broadcast Station Characteristics

In the United States, FM Broadcasting operations are carried out in the frequency band between 88 and 108 MHz. Each station is allocated a 200 kHz channel in which to transmit FM signals using a maximum carrier deviation of 75 kHz. Most stations broadcast in stereo, using a compatible stereo system standard that employs a subcarrier to support the two independent analog sound channels. The *baseband* frequency distribution of the FM signal is shown in Figure 1.

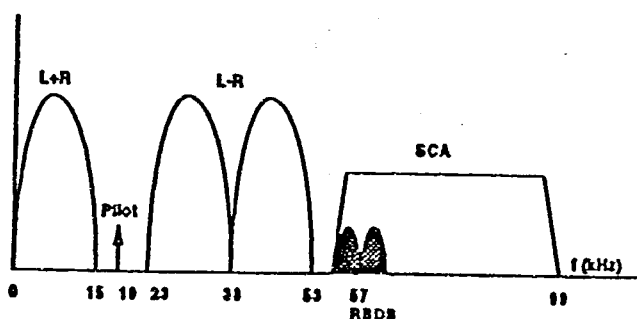


Figure 1. FM Baseband Signal Distribution

At the broadcast station, the left and right stereo channels are added (L+R) and subtracted (L-R). The L+R signal, which carries the entire program for compatibility with monaural receivers, is confined to the region from 20 Hz to 15 kHz. At a frequency of 19 kHz, a pilot carrier is added to simplify detection of the L-R signal. The L-R audio signal is used to modulate a 38 kHz subcarrier (twice the pilot frequency). Double-sideband suppressed carrier modulation is used to improve the robustness of the signals, and it can be synchronously detected in the receiver because the pilot is just doubled in frequency and used to reconstitute the carrier. The L-R spectrum ranges between 23 kHz and 53 kHz.

The baseband spectrum between 53 kHz and the edge of the channel (100 kHz) is not used for the "main" entertainment channel, and is thus available for the transmission of auxiliary program material.

FM stations have the authority (called a "Subsidiary Communications Authority", or "SCA") under their license to broadcast such material without further permission from the Federal Communications Commission (FCC).

Since the early 1960s, FM stations have used this SCA space in their signal format to transmit *analog* material like background music, stock quotes and paging tones. Over the years, standard subcarrier frequencies at 67 and 92 kHz evolved. Stations that did not broadcast in stereo also used 42 kHz. Recently, the Radio Broadcast Data System (RBDS) has been targeted to use a 57 kHz subcarrier to transmit very low-rate (under 1.2 kbps) data using bi-phase, phase-shift keying (BPSK) modulation and covering a bandwidth from 53.5 to 60.5 kHz. Several companies also make modem-based "data" systems that operate on 67 kHz subcarriers and support data rates up to 4.8 kbps.

If a station is not using any subcarriers in the SCA area, then about 45 kHz of bandwidth is theoretically available for broadcasting *true digital* signals. In practice, considering the fact that most stations will adopt RBDS, if for no other reason than to take advantage of the program type selection feature, and that many will want to operate at least one subcarrier at 92 kHz as another revenue source, the traffic data signal must fit within a baseband range between about 62 and 86 kHz, or about half the theoretical value. Still, if the right modulation technique is used, channel data rates in the 18 kbps range can be easily supported.

IVHS Traffic Data Requirements

In a recent study¹, MITRE determined that a large city will need to update enough roadway links (road segments such as between exits on a freeway) to require a basic user data rate of about 6 kbps, if near-real-time notice of incidents is to be accomplished. It would also be advantageous to the development of other IVHS service, if additional data such as differential GPS corrections could be broadcast in the same channel. Overall, a basic user data rate near 8 kbps will serve the needs of IVHS for an extended period. Considering the fact that the error correction coding usually about doubles the user rate, a channel rate of 18 kbps will meet the IVHS requirements if it can be achieved. To simplify references to this channel, we have named it the "Subcarrier Traffic Information Channel", or STIC.

The Technical Issues

Broadcasters make their "living" by providing a good-quality radio signal to the largest possible number of listeners. Anything that either reduces signal quality or coverage area is not likely to be considered for implementation. As a result this experiment had to be designed to provide the highest possible data rate while not noticeably degrading the quality of the main entertainment program material. At the same time, interference from the entertainment portion of the baseband had to be controlled to avoid a reduction in digital signal error rates. Finally, the data system had to allow stations to broadcast RBDS and 92 kHz SCA subcarriers.

Another factor that enters into the choice of a subcarrier frequency is intermodulation. Even though the 76 kHz fourth harmonic and the 19 kHz pilot are not coherent (see next section), use of subcarrier frequencies near pilot harmonics but not on them will result in intermodulation products that are audible tones. As a result, 76 kHz was chosen as the best compromise among baseband noise levels, available bandwidth on either side, and intermodulation.

The last critical system parameter is cost. Unlike many other large programs such as the Air traffic Control System, *IVHS is a consumer electronics system*. Although some state and local government infrastructure will be involved, by far the largest total investment will be by individuals for in-vehicle equipment and software. A broadcast data system must therefore be inexpensive. It also has to function more-or-less automatically without any intervention from the user. These factors somewhat constrain the range of solutions.

Design Strategy

The experiment that was conducted is a proof-of-concept. It was not meant to produce a highly refined design-to-manufacture system. However, it was important to ensure that any potential "show-stopping" technical issues were identified and examined. Time was the other constraint, since this system is meant to support early implementation of IVHS.

Through its defense work, MITRE acquired two powerful system development tools, the Signal Processing Workstation (SPW) and the Arbitrary Waveform Synthesizer (AWS). SPW allows an analyst to quickly configure a variety of electronic

functions to produce a simulation of any modulator, demodulator, transmitter, receiver or filter, and to view the resulting waveforms. With SPW, we were able to quickly examine a range of modulation techniques and to assess their suitability for use in this application. Then, AWS was used to generate the actual radio-frequency (RF) waveforms, just as if we had gone through the laborious process of building hardware.

Using this technique, several modulation schemes were evaluated for their ability to support high data rates in a fading environment while confining their spectra to the bandwidth available in the SCA area. Candidate modulation techniques included quadrature phase shift keying (QPSK), $\pi/4$ offset DQPSK ($\pi/4$ DQPSK), minimum-shift keying (MSK), gaussian-filtered MSK (GMSK), and trellis code modulation (TCM).

All of these schemes seemed worthy of analysis given their relative BER performance and bandwidth efficiency. $\pi/4$ DQPSK was considered to be attractive due to its high bandwidth efficiency (2 b/s/Hz, based on single-sided null bandwidth), and due to its nearly constant envelope (as opposed to QPSK), which results in it having a smaller peak modulation for a given symbol energy. MSK was also a choice that was initially attractive. Although not as bandwidth efficient as DQPSK (or, equivalently QPSK) in terms of null-to-null bandwidth, its fractional out-of-band power performance is considerably better, and it has a constant envelope.

The poor fractional out-of-band power performance of DQPSK can be significantly improved by raised-cosine filtering the two arms of the baseband signal (or placing square-root raised cosine filters in both the transmitter and receiver). This type of filtering greatly reduces out-of-band power while also eliminating inter-symbol interference (ISI). Likewise, an MSK-modulated signal must also have its spectrum manipulated with a pre-modulation low-pass filter in order to meet the high performance demands of this application in terms of out-of-band suppression. After initial analyses were carried out, the modulation scheme decision was narrowed to two choices: raised-cosine filtered $\pi/4$ DQPSK (RC-DQPSK) and GMSK.

The early assumption made for both of these modulation schemes was that coherent demodulation would be used. The most practical method for doing this seemed, at the time, to be to use the fourth harmonic of the pilot subcarrier (76 kHz) as the

STIC subcarrier and to use this harmonic of the received pilot for coherent demodulation. However, after the successful modeling of the Rayleigh fading channel on SPW, it was found that coherence did not exist between the pilot and its fourth harmonic. The coherence bandwidth is small enough to rule out using the fourth harmonic of the received pilot for the purpose of coherently demodulating data that uses this harmonic as a subcarrier. Therefore, a modulation-demodulation scheme that employs discriminator-based detection or differential detection is necessary. Reference 2 contains a complete discussion of these results.

Laboratory Results

After successfully modeling the subsystems described above, simulation analyses were used to comparatively evaluate the RC-DQPSK and GMSK waveforms, to determine how these waveforms perform under fading conditions, to determine the impact of the STIC, RBDS and audio channels on each other, and, in general, determine how the STIC signal would perform in a real system.

Modulation Scheme Comparisons

The first method of comparing the two modulation schemes is in looking at their respective emission bandwidths. Not only is it necessary for the signal to have a narrow bandwidth for transmission over the fading channel, but also it is very important to limit the amount of STIC signal energy in the RBDS and audio spectral regions. The criterion mentioned earlier states that the STIC signal should be 60 dB down from the audio and RBDS signals. Although these are two fundamentally different modulation schemes, much care was taken to compare them on as fair a basis as possible. Figure 2 shows the spectra of the two modulation formats.

The plots show that at 60 kHz (the upper edge of the RBDS channel), the RC-DQPSK spectrum is down around 65 dB, while the GMSK spectrum, which is much noisier around this frequency, is down around 45 dB. Moreover, at a frequency of 53 kHz (upper edge of the stereophonic channel), the RC-DQPSK spectrum is down about 75 dB, whereas the GMSK is down about 65 dB. Clearly, it appears from the spectra of both waveforms that they will not interfere with the audio signal; however, RBDS may be more strongly affected by the GMSK waveform than the RC-DQPSK waveform. Changing the roll-off factor of the raised-cosine filters greatly changes

the 3 dB bandwidth, but has little effect on the 60 dB bandwidth.

Fading Channel Performance

One important characteristic of the fading channel that needed to be studied with the help of computer simulation was the coherence bandwidth. In order to demonstrate the effects of coherence bandwidth, several snapshots in time of the Fourier transform (FFT) of the impulse response of the fading channel were found and plotted together in a three-dimensional plot (Figure 3). The plot shows the time-variant characteristic of the fading channel, in addition to revealing how the channel will affect the STIC signal in the frequency domain. In the frequency range of interest (60 to 76 kHz), the FFT of the various channel impulse responses reveals that the magnitude of the response can vary as much as 10 dB. These results again show the need for using as small a STIC transmission bandwidth as possible.

Expansion to Other Outlets

FM SCA was selected for initial implementation of these techniques because of the wide coverage of FM broadcast stations, and also because SCA receivers are a mature technology available from several manufacturers. As system capacity needs grow, however, the same signal formats can be easily ported to other media, including subcarriers on TV aural transmitters and the vertical blanking interval (VBI) data channels in the TV video signal.

TV aural subcarriers use the same technology as FM SCA, but the bandwidth available is much greater, yielding a higher data rate. Receivers for TV aural channels are not widely available, however, as independent units.

The VBI channel presents interesting possibilities as well. Of the 21 "lines" available for data transmission in each picture field (2 fields per frame or complete TV picture), several have already been assigned to functions such as closed-captioning. Still, if a system that combines the capacity of the unassigned lines is used (and such systems are in production), then channel rates in the neighborhood of 56 kbps can be readily achieved. As is the case with TV aural, independent VBI receivers are still not widely available.

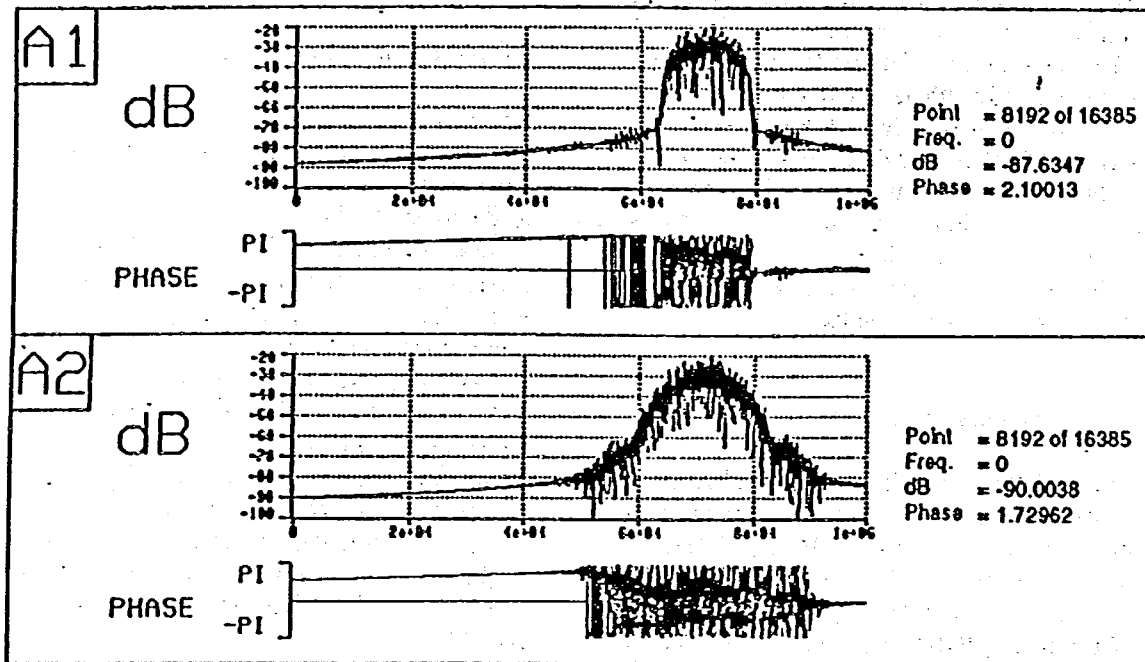


Figure 2. Emission Spectra for RC-DQPSK (top) and GMSK (bottom)

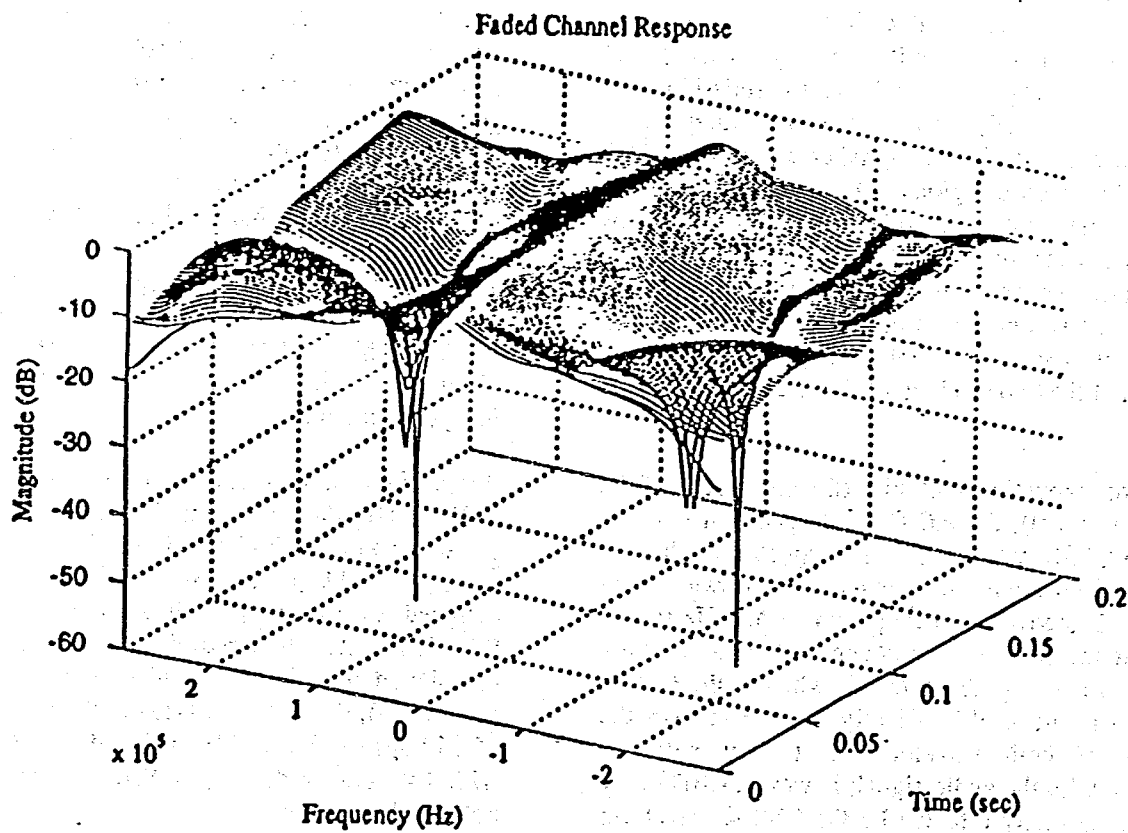


Figure 3. Impulse Response of Fading Channel

Laboratory Performance Tests

In the laboratory, the AWS-generated STIC and analog main program signals were fed into commercial broadcast equipment (stereo generator and exciter) and the output RF signal was fed to two different FM receivers to check for mutual interference between STIC and the entertainment channels. Compact Disk music was used as the main program source, and the STIC signal was modulated with digital patterns typical of actual traffic data in a 5-second repeating sequence.

Two radio receivers were used in the tests. The first was a "high-end" component system receiver, while the second was an inexpensive home receiver. In both cases, when the music was adjusted to normal listening levels, a group of listeners including an FM station chief engineer could not discern any degradation of the entertainment signal by the STIC waveform, even with 20% subcarrier injection. With the main channel idle (no music at all) and 20% injection, the STIC signal crosstalk into the main channel is heard (stereo headphones) as a barely perceptible rise in the background noise level ("hiss"), containing no irritating tone or buzz features. At a more typical 12% injection (station also operating RBDS and a 92 kHz subcarrier), there is no perceptible change at all.

Prototype Hardware

Once the system parameters for the selected modulation were refined, MITRE built a prototype modulator, subcarrier generator and receiver, using off-the-shelf programmable signal processing chip sets. These chip sets, though not economical for actual systems, have the advantage that the SPW generates the firmware for them directly, eliminating the need for the extra programming step in the process. In a production system, custom chips, like are used for the Radio Data System (RDS) in Europe, would be used to gain an economy of scale.

Field Tests

FHWA and MITRE decided on a two-step field test strategy. In the first phase, the prototypes were taken to Fayetteville, NC and the modulator/subcarrier generator was installed at WQSM-FM. This station was selected for four reasons. First, the management was willing to donate the subcarrier time to the project, and were

very interested in the technical nature of the experiment. Second, the Chief Engineer was willing to let us experiment with injection levels (up to FCC limits), and to activate a 92 kHz subcarrier for compatibility studies. Third, WQSM is in a more rural area, where fringe reception is important, so we could evaluate STIC performance and compatibility in less than optimal conditions. Last, the station operates a 57 kHz paging network that uses the RBDS modulation, so we could also check STIC for mutual compatibility with that system.

In the first phase, the emphasis is on compatibility with the FM station's entertainment signal, other subcarriers and RBDS. It will include limited subjective tests with a range of standard receiver types (inexpensive, low performance models through high-end systems) to be sure that receiver characteristics do not result in crosstalk between the STIC signal and entertainment material. Most of the tests are being conducted to fixed locations, although some moving-vehicle measurements are being made.

The first-phase tests are being run as this paper is being written. Results will be discussed during the Conference presentation.

The second phase of the test program will be conducted in the Washington, DC area using the facilities of radio station WPGC-FM. These tests will concentrate on communications with vehicles moving at various speeds, and on multipath and fading issues. The system will be available for demonstrations during the IVHS AMERICA Annual Meeting.

References

1. Cheslow, M., G. Hatcher and V. Hsin, "Communications, Storage and Processing Load Requirements of Alternative IVHS Architectures", MITRE Technical Report # 93W018, 1993.
2. Chadwick, D.J., J.W. Marshall, B.L. Hinton, V.M. Patel and H.W. Lam; "Communications Concepts to Support Early Implementation of IVHS in North America", *IVHS Journal*, Volume 1, April 1992.

5. Records of Presentations

5. 2 U.S. side

(3) "In-Vehicle Safety Advisory Warning Systems (IVSAWS)"

by Dr. Gregory L. Mayhew/Project Technical Director,
Hughes Aircraft Corporation

Hughes is involved in all aspects of IVHS. Four examples are Los Angeles traffic control, vehicle roadside communications, public transportation communications, and IVSAWS. The Los Angeles traffic control uses spread spectrum radios to communicate commands from an operations center to individual traffic lights. The operations center coordinates traffic lights to optimize traffic flow.

Installing radios is very inexpensive compared to digging trenches and installing cables from the operations center to the lights.

Spread spectrum radios can also be used to determine the locations of trains along the tracks in tunnels where GPS does not work.

Accurate positions are necessary so that distances between trains can be safely minimized and existing systems can be used more efficiently.

IVSAWS - In Vehicle Safety Advisory and Warning System - is similar in concept to VICS in Japan. The difference is that IVSAWS provides safety information rather than traffic congestion information. You have received a packet with lots of details. I will summarize some key ideas.

(OHP-No.1)

The purpose of IVSAWS is to provide motorists with advance warning of dangerous conditions in their immediate environment. To be the most effective, the warning must be about 10 seconds prior to the hazard. This is similar to the studies in Japan which have shown that one and a half seconds warning is sufficient to prevent 90% of accidents because drivers can take the appropriate action.

Notifying the driver in the vehicle is important because drivers, particularly older drivers, can fail to notice signs along roadside. This project is a cooperative effort between, Hughes Aircraft Company, the University of Michigan, a consulting company which specializes in federal government regulations about frequency usage, and the Federal Highway Administration.

(OHP-No.2)

The initial concept was that warning transmitters would be placed at the locations of the roadway hazards. This placement could be temporary or permanent. Temporary ones could be stationary or mobile. Examples of mobile situations are ambulances moving through traffic or children existing from a school bus on a two lane road. Examples of permanent situations are railroad crossings, frequent accident sites such as sharp curves in road, or areas with low visibility weather. Those warning transmitters would broadcast their message to all vehicles in the immediate area. The system in the vehicle determines if the warning applies to that vehicle and notifies the drivers if appropriate. This project is to refine this concept and develop a system that consumers can purchase.

(OHP-No.3)

Three major engineering studies were performed on this project. The first study identified and prioritized the situations in which safety could be improved with advance warning. The second study determined the method for presenting the alert to the driver. The third study considered alternatives for communicating these alerts from the transmitters to the appropriate vehicles. These studies raised many questions about what drivers rather than engineers consider appropriate. Because the United States IVHS deployment strategy is ultimately funded by consumer purchases, we decided to answer these questions by conducting surveys of motorists and local agencies, such as police, who would use this system.

(OHP-No.4)

Young, middle aged, and older drivers were presented warnings using several different methods. These methods included display on the dashboard, a flashing display, a display with a tone, and a display with a tone at the start followed by a brief voice message. The different methods were evaluated for recognition, appropriateness, comprehensibility, and effectiveness. The preferred method by all age groups is a simple hazard symbol, a tone to indicate reception of a message and get the drivers attention, and then a short voice message providing the details. In this way, drivers do not need to remove their eyes from the roadway. Overall, the test subjects agreed that IVSAWS would be a significant help to drivers.

(OHP-No.5)

For maximum effectiveness, the warning should be no earlier than 10 seconds prior to arrival at the hazard situation. As this table shows, the distance from the hazard that the driver should be notified depends on the traveling speed of the vehicle and the action required by the driver. For example stopping completely requires more distance than just changing lanes. With a simple broadcast approach, a driver could receive the alert too early, create confusion, and possibly cause an accident instead of preventing an accident. Rather, IVSAWS should determine the distance between the vehicle location and hazard location. However, this is more capability than originally expected.

(OHP-No.6)

Many other situations can be identified which require increasing levels of capability in the system in order to prevent drivers from receiving irrelevant alerts. Here we have an example of an accident on a two lane road. This two lane road does not intersect the expressway. In an ideal system, alerts about the accident are given to drivers on the two lanes road but not the expressway.

(OHP-No.7)

As we progressed in the engineering studies, many questions arose concerning which functions the driver could perform and which functions the system should perform. Could we expect the drivers to determine whether or not an alert applied to them? Would drivers become very irritated with a low capability system? Or should the system set up geographic warning zones? Drivers would only be notified when their vehicle entered that zone. These warning zones could have various shapes and signs depending on the situation and the relationship between the various roadways. Should drivers be able to summoned help in the event of an accident? Should the vehicle electronics assume the vehicle is in an accident if the air bag has been activated and therefore summoned help automatically? All these capabilities are possible but result in a cost which consumers may refuse to pay.

(OHP-No.8)

To answer these questions, we performed driver and agency surveys. First I will present some of the results from the driver surveys and then some of the results from the agency surveys. 39 drivers from a rural city in California were interviewed and 46 drivers from an urban city in California were interviewed. The purpose of the interviews was to determine if the drivers liked the IVSAWS concept, determine what system capabilities the drivers expected, and determine what cost was acceptable to the drivers.

(OHP-No.9)

58% of the drivers interviewed liked the IVSAWS concept. Of those that were interested, 75% wanted IVSAWS in their current vehicle. This means that after market installation will be important to the successful deployment of IVSAWS. IVSAWS cannot assume the vehicle will have display systems or navigation systems. However, if the vehicle has such systems, the IVSAWS design should be modular so

that IVSAWS can be compatible with these other IVHS systems.

(OHP-No.10)

A very significant result from the interviews is that drivers will not tolerate listening to alerts which do not apply to them. No more than one irrelevant alert per month was deemed acceptable. Otherwise the drivers would lose confidence in the system. A simple broadcast system does not provide the resolution and distinctions that consumers want. Drivers want a high capability system. Thus, the IVSAWS design must include a geographic location capability and a warning zone capability. In this way, the system can distinguish which drivers to notify and which drivers not to notify. Of those drivers who are notified, the system should determine the proper time and location.

(OHP-No.11)

If IVSAWS notifies drivers of roadway alerts, but only those alerts that are relevant to that driver, then consumers are willing to pay 350 dollars for such a safety advisory and hazard warning system.

(OHP-No.12)

This next portion presents some of the results from the agency surveys. The agencies are responsible for detecting hazardous conditions and taking steps to increase motorists safety. In this way, IVSAWS is an extension of their normal duties and provides the agencies with another method for communicating with drivers.

Personnel from various agencies were interviewed to determine if they liked the IVSAWS concept and to determine how IVSAWS should operate from their perspective. Agencies such as police departments and fire departments were selected from across the United States. Three interview approaches were used - questionnaires, one on one tallies, and a group workshop. In total, 155 members from various agencies were interviewed.

(OHP-No.13)

This table shows the number from each agency that were interviewed either by questionnaire, direct tallies, or the group workshop. Responses were obtained from agencies that deal with all aspects of motorist safety: police, law enforcement, fire departments, paramedics, road construction, railroads, IVHS system developers, state departments of transportation and university's department of transportation.

(OHP-No.14, No.15)

The agency personnel were presented with three operational concepts. The operational concepts differed in whether the professional at the scene or an operator at other control centers would establish the warning zones. All agencies overwhelmingly agreed that impact on emergency crews at an accident scene must be minimized. Hence, the preferred concept is as follows.

Personnel at the scene provide alert information to their communications center using standard procedures. An operator at these agency communication centers relay their alerts to a regional IVSAWS operation center. The IVSAWS regional center determines the appropriate warning zones and transmits this information to motorists vehicles.

IN-VEHICLE SAFETY ADVISORY AND WARNING SYSTEM (IVSAWS)

DR. GREGORY MAYHEW

IN-VEHICLE SAFETY ADVISORY AND WARNING SYSTEM (IVSAWS) PROGRAM

PROGRAM OBJECTIVES:

- IDENTIFY CANDIDATE ADVISORY, SAFETY, AND HAZARD SITUATION ALERT SYSTEM FOR MOTORISTS ON URBAN, RURAL, AND SECONDARY ROADS.
- AMELIORATE HAZARDOUS SCENARIOS WHICH HAVE REMAINED HAZARDOUS DESPITE APPLICATION OF TRADITIONAL CRASH REDUCTION TREATMENTS.

CUSTOMER:

- FEDERAL HIGHWAY ADMINISTRATION

CONTRACT:

- FUNDING LEVEL: \$ 906 K
- TYPE OF CONTRACT: COST REIMBURSEMENT PLUS FIXED FEE
- CONTRACT DURATION: SEP 90 - SEP 93

TEAM MEMBERS:

- HUGHES AIRCRAFT DIVISION 1A (SYSTEMS ENGINEERING)
- HUGHES AIRCRAFT DIVISION 1L (HUMAN FACTORS)
- UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE (UMTRI)
- TELECOMMUNICATIONS CONSULTING

(No. 1)

WARNING UNIT DEPLOYMENTS

MOBILE:

EMERGENCY VEHICLES

POLICE

AMBULANCE

FIRE

RESCUE

SLOW MOVING VEHICLES

SCHOOL BUS

FARM VEHICLE

POSTAL DELIVERY

WIDE LOADS

CONSTRUCTION EQUIPMENT

MOBILE HOME TRANSPORT

TEMPORARY:

ROAD MAINTENANCE

ROAD CONSTRUCTION

ACCIDENT (SPILLAGE)

FIXED:

RAILROAD CROSSINGS

ONE LANE BRIDGE

BLIND ENTRANCE

FREQUENT ACCIDENT SITE

ICY BRIDGE / ROADWAY

FOG AREA

DUST STORM AREA

(No.2)

FUNCTIONAL DEFINITION STUDIES

ENGINEERING STUDIES

(1) SITUATION IDENTIFICATION AND PRIORITIZATION

(2) DRIVER ALERT WARNING SYSTEM DESIGN

(3) COMMUNICATION SUBSYSTEM ARCHITECTURE TRADEOFFS

USER MARKET RESEARCH STUDIES

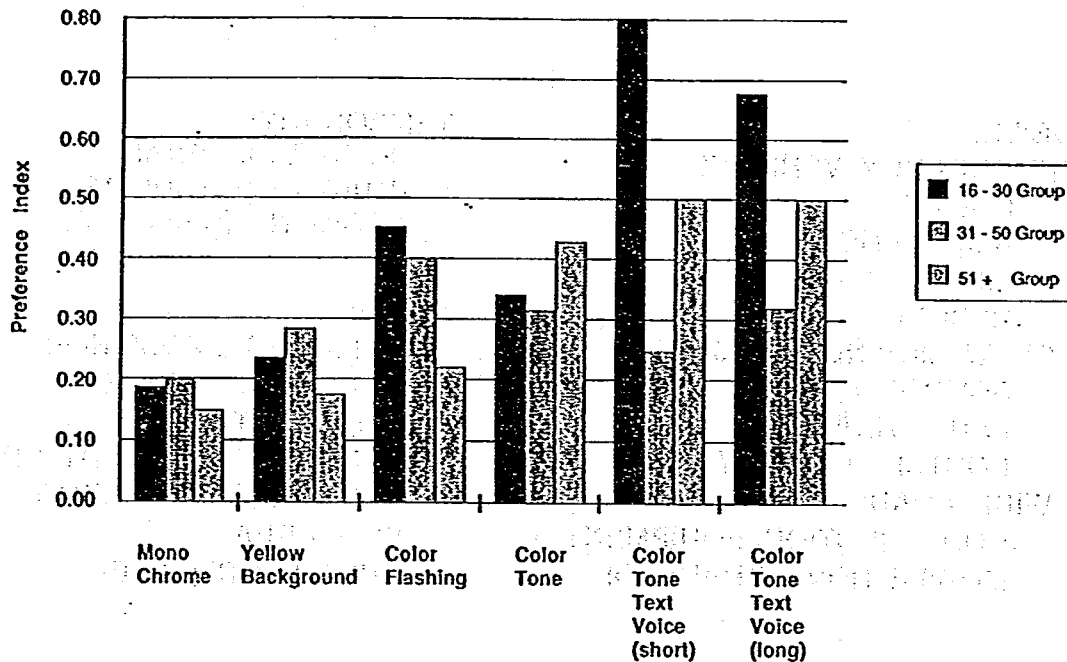
(4) MARKET POTENTIAL ASSESSMENT

(5) CONCEPT WORKSHOP

(6) DEPLOYMENT COMMUNITY INTERVIEWS

(No.3)

SIGNALLING CODE PREFERENCES BY AGE GROUP



(No. 4)

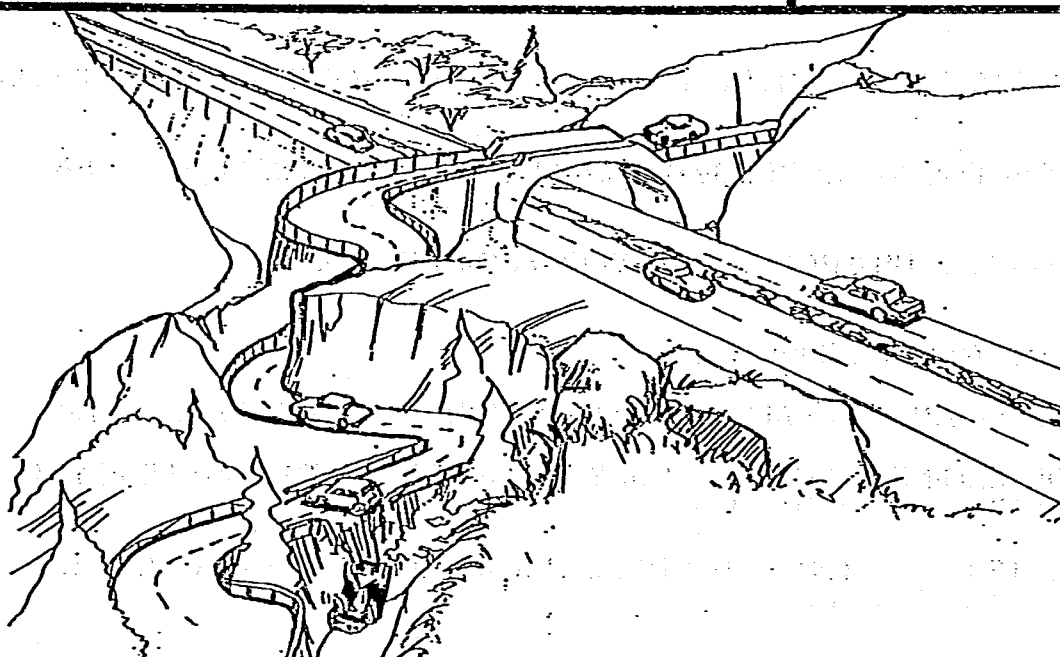
DRIVER ALERT DISTANCES

- AUDIO MESSAGE GENERATION 5.0 sec
 - WARNING PERCEPTION / RESPONSE 2.5 sec
 - WARNING EFFECTIVENESS PERIOD 6.0 sec
 - HAZARD DETECTION / RECOGNITION 2.5 sec
 - HAZARD AVOIDANCE MANEUVER variable
- (bald tires, wet pavement, etc.)
- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

Vehicle speed (mph)	DRIVER ALERT DISTANCE (feet)			
	Increased Attention	Lane Change	Full Stop	
			Car	Heavy Truck
40	940	1200	1160	1320
50	1170	1470	1550	1815
60	1410	1750	2030	2400
70	1660	2040	2600	3070
80	1880	2300	3150	3770

(No. 5)

ACCIDENT CROSSING (NON INTERSECTING) ROAD



(No.6)

SCENARIO ISSUES

OTHER SCENARIOS IVSAWS SHOULD / COULD SUPPORT SYSTEM FEATURES NECESSARY TO SUPPORT FUNCTIONALITY

- DIRECTIONALITY
- FILTERING TO REJECT IRRELEVANT ALERTS
- VARIABLE WARNING DISTANCES
- QUEUE DETECTION
- IRREGULARLY SHAPED COVERAGE AREAS
- MAP MATCHING
- MINIMIZED WORKLOAD FOR EMERGENCY PERSONNEL
- FREE TEXT MESSAGES
- INTERFACE WITH INFRASTRUCTURE SYSTEMS
- REMOTE ACTIVATION OF WARNING UNITS
- AUTOMATIC AND MANUAL MOTORIST'S MAYDAY

SUBJECTIVE AND OBJECTIVE BENEFITS OF IVSAWS

RELATIONSHIP TO OTHER IVHS CONCEPTS

(No.7)

TWO FOCUS GROUPS WERE HELD WITH RURAL AND URBAN DRIVERS

FOCUS GROUPS CONDUCTED BY: TRADE-OFF MARKETING SERVICES, INC.

RURAL FOCUS GROUP: 39 DRIVERS FROM THE PALMDALE, CA AREA

URBAN FOCUS GROUP: 46 DRIVERS FROM ENCINO, CA

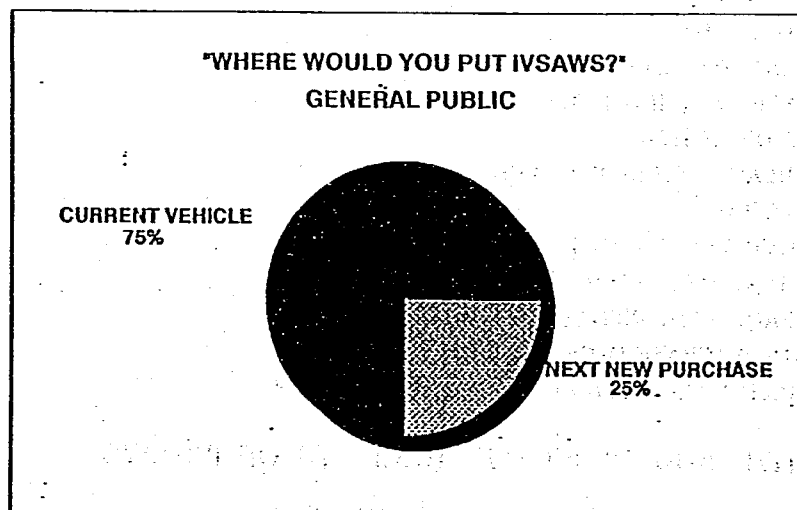
FOCUS GROUP OBJECTIVES:

- DETERMINE OVERALL DRIVER REACTION TO THE IVSAWS CONCEPT
- DETERMINE FEATURES, ISSUES, AND PRICE POINTS MOST LIKELY TO STIMULATE PURCHASE
- DETERMINE THOSE SITUATIONS IN WHICH THE DRIVER WOULD FIND IVSAWS MOST USEFUL

(No.8)

IVSAWS INSTALLATION PREFERENCE

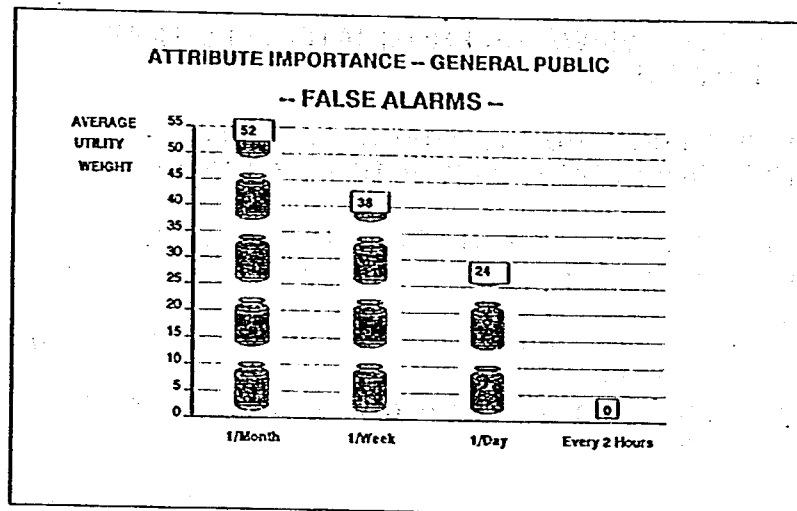
- THREE-FOURTHS OF THE GENERAL PUBLIC WANT IVSAWS INSTALLED IN THEIR CURRENT VEHICLE RATHER THAN WAIT TO PURCHASE THEIR NEXT NEW VEHICLE
- A FEW PEOPLE, ESPECIALLY URBAN DRIVERS, WOULD LIKE A PORTABLE SYSTEM SO THEY CAN SWITCH FROM ONE VEHICLE TO ANOTHER



(No.9)

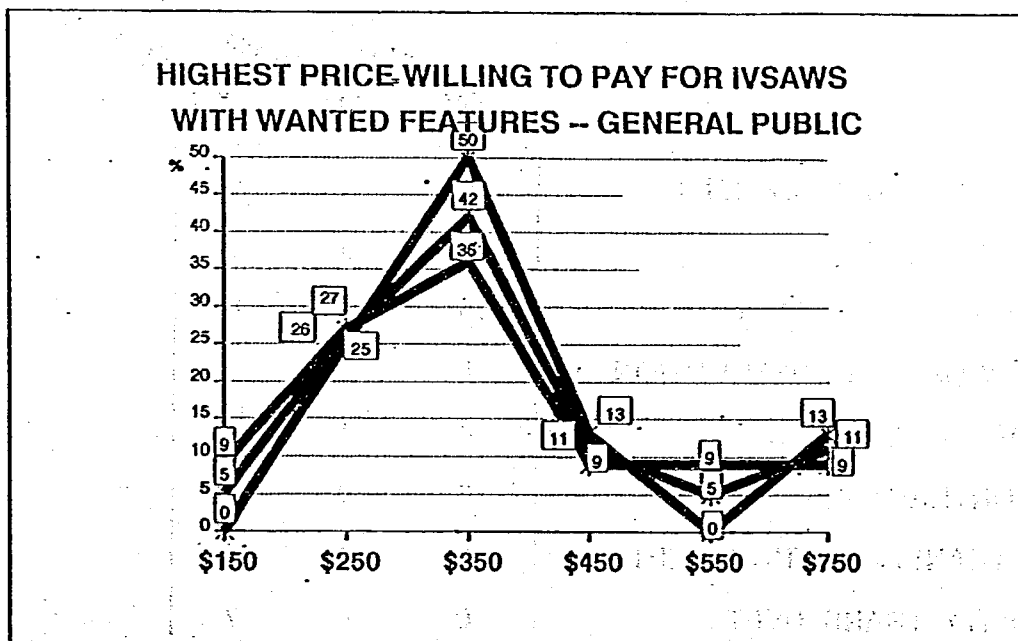
RELATIVE IMPORTANCE OF FALSE ALARMS

- WHILE HARDLY MENTIONED IN EITHER FOCUS GROUP, THIS ISSUE EMERGED AS A VERY IMPORTANT TOPIC IN THE CONJOINT SURVEY
- THE HIGH UTILITY WEIGHTS MEAN THE GENERAL PUBLIC DOES NOT EXPECT, NOR WILL THEY TOLERATE, MANY FALSE ALARMS



(No.10)

MOST DRIVERS WOULD SPEND \$250-\$350 FOR AN IVSAWS



(No.11)

DEPLOYMENT COMMUNITY INTERVIEWS

75 COMPUTER SURVEYS CONDUCTED BY TRADE-OFF
MARKETING SERVICES

44 DETAILED INTERVIEWS (APPROXIMATELY 1.5 HOURS)
CONDUCTED BY HUGHES

36 RESPONSES FROM RURAL TRANSPORTATION
CONFERENCE WORKSHOP CONDUCTED BY HUGHES

DEPLOYMENT COMMUNITY INTERVIEW OBJECTIVES

- assess deployment practicality of various operational concepts
- determine overall deployment representative reaction to the IVSAWS concepts
- assess critical scenarios from deployment perspective
- assess system cost limits

(No.12)

DEPLOYMENT COMMUNITY AGENCY BREAKDOWN

	COMPUTER SURVEYS	DETAILED INTERVIEWS	RURAL WORKSHOP
POLICE / LAW ENFORCEMENT	25	16	0
FIRE DEPARTMENTS	16	5	0
PARAMEDIC / AMBULANCE	15	2	0
PUBLIC WORKS / CONSTRUCTION	8	7	1
RAILROAD COMPANIES	4	1	0
IVHS CONTRACTORS	0	0	12
STATE TRANSPORTATION DEPT	5	13	16
UNIVERSITY TRANS DEPT	0	0	7

(No.13)

OPERATIONAL CONCEPT PREFERENCE

1. PERSONNEL "AT SCENE" PROVIDE HAZARD INFORMATION TO THEIR COMMUNICATIONS CENTER.

COMMUNICATIONS CENTER RELAYS HAZARD INFORMATION TO IVSAWS OPERATIONS CENTER.

IVSAWS OPERATIONS CENTER INITIATES ELECTRONIC WARNING ZONE (exception: mobile hazards).

2. PERSONNEL "AT SCENE" PROVIDE HAZARD INFORMATION DIRECTLY TO IVSAWS OPERATIONS CENTER.

IVSAWS OPERATIONS CENTER INITIATES ELECTRONIC WARNING ZONE (exception: mobile hazards).

3. PERSONNEL "AT SCENE" INITIATE ELECTRONIC WARNING ZONE DIRECTLY.

(No.14)

SUMMARY

- PURPOSE IS TO PROVIDE MOTORISTS WITH ADVANCE WARNING (~ 10 sec) OF IMPENDING HAZARDS TO MITIGATE THEIR SEVERITY.
- IDENTIFIED MOBILE, TEMPORARY, AND FIXED HAZARDS.
- INITIAL OPERATIONAL CONCEPT:
INDEPENDENTLY OPERATED TRANSMISSION NODES PERFORMING LOCAL AREA BROADCASTS.
- RESOLVED SYSTEM CAPABILITY ISSUES (over design) BY PERFORMING MARKET RESEARCH TO DETERMINE DEPLOYMENT COMMUNITY REQUIREMENTS AND COMSUMER PREFERENCES.
- GEOLOCATION AND ELECTRONIC WARNING ZONE CAPABILITY IS NECESSARY TO PREVENT IRRELEVANT ALERTS TO MOTORISTS AND MAXIMIZE WARNING EFFECTIVENESS (window vs ATIS).
- OPERATIONAL IMPACT ON EMERGENCY AND DEPLOYMENT PERSONNEL "AT HAZARD SCENE" MUST BE MINIMIZED.
- CURRENT OPERATIONAL CONCEPT:
REGIONAL IVSAWS OPERATIONS CENTER RECEIVES REPORTS. PERFORMS REGIONAL BROADCASTS FOR FIXED AND TEMPORARY. MOBILE TRANSMITTERS ARE DEPLOYMENT COMMUNITY ONLY.

(No.15)

5. Records of Presentations

5. 2 U.S. side

(4) "TravTek Evaluation Overview"

by Dr. Joseph I. Peters/Assistant Vice President and
Director Human Performance Technology Department,
Science Applications International Corporation

(OHP-No.1)

Today, I will talk about three things:

- I will briefly describe the TravTek system.
- I will discuss our evaluation approach.
- and, I will give some preliminary results.

(OHP-No.2)

The TravTek operational field test is the product of the relationship between government and industry; FHWA, the City of Orlando and the Florida Department of Transportation are TravTek government partners; AAA and GM represent industry.

(OHP-No.3)

The TravTek system is made up of three major components. The Traffic Management Center accumulates and disseminates information from the traffic monitoring system (cameras, loop detectors and data received from TravTek vehicles). The TravTek Information and Service Center is run by AAA as a 24 hours service to users to answer questions and provide emergency road services. GM built the 1992 Oldsmobile Torinados and converted them into TravTek vehicles.

(OHP-No.4)

GM built 100 TravTek vehicles for this operational test. Each car was programmable to provide any of three levels of information to the driver: a "Services" or, control condition, a "Navigation" condition, and a "Navigation +" condition. The following charts

describe the building block approach.

(OHP-No.5, No.6, No.7, No.8, No.9)

The "Services" conditions provided information only while the car was in "park" as shown on the chart. Here is an example of CRT display screen news available in this condition. The "Navigation" condition provided all the same information as included in the Services condition plus its distance listed on the chart.

This chart shows screens available to drivers in the "Navigation" - configured vehicle. When the "down" (↓) arrow is pushed, the box moves down. When the box highlights the desired information, the driver presses the "Done" button. In this case, after the driver has entered the desired intersection, the driver selects a routing method: fastest; avoid interstates; avoid tolls.

This chart shows the 2 route guidance displays available to the driver as soon as they enter the assigned route paths. The left display we call the "Route Map" - it is a moving map display with a magenta line depicting the assigned route and an arrow showing the vehicle. Although not shown here, a star (☆) appears at the destination. This map always operates in a "Heading Up" Mode. The display on the right is what we call a "Guidance Display". This is a simplified turn-by-turn display giving the driver; Miles to destination, minutes to destination, tenths of miles to next turn, current road being travelled, target road upon which turn will be made. The car symbol progressively eliminates hush marks until it arrives at the intersection.

This chart shows information in the ultimate, "Navigation +" condition, whereby drivers receive all of the information provided by both the "Services" and the "Navigation" modes, as well as real-time information about city events, weather, parking lot condition, incidents and most importantly, routing that is dynamically

responsive to traffic conditions. If traffic exceeds a threshold within the car, the system advises the driver (by voice and display) that a better route is available. The driver has the option to select the "O.K. New Route" button.

(OHP-No.10)

There are a total of 12 separate yet integrated TravTek Evaluation studies being performed in the 7 areas shown on this chart. Time will allow me to discuss only a small subset of studies and results. Nearly 3,000 drivers were recruited by AAA to rent a TravTek car in Orlando.

These drivers participated in what we call the "Rented Users Study". AAA assigned some of them to the "Services" condition; some to the "Navigation" condition; and some to the "Navigation +" condition. I have a copy, that I will leave here, of training procedures and video tapes that were sent in advance to the vacationers or business travellers. Please note that separate tapes and brochures were developed that talked about only the conditions to which individuals were assigned (i.e. "Services", "Navigation", "Navigation +"). Each driver was given a diary upon arriving. After renting was completed (average of 4-7 days), each driver was asked to mail back a questionnaire, also computer files in each car recorded driver trip information. At least 1 GByte of evaluation data have been collected. In addition to renters, there were 53 high mileage drivers given cars for 2 months each. In addition, nearly 500 tourists were recruited to participate in controlled experiments. Now for some results. I will present only results for which remaining time is available.

(OHP-No.11)

In this chart showing percent of all trips where drivers used TravTek features, a trip is defined as anytime from turning the

ignition on to turning it off. "Use" is defined as any driver-initiated activation of a TravTek function, no matter how simple or complicated. The data show much higher usage by those who received the more powerful capabilities of TravTek. It also points out the importance of a "control" condition whereby the benefits of the "Navigation" and "Navigation +" conditions can be composed.

(OHP-No.12)

Many charts, following this one, will use this format for displaying questionnaire results. Although a neutral rating was not allowed for in the questionnaire, an average across ratings of 3.5 is the statistically neutral point. This chart shows that drivers firmly agreed the TravTek system was easy to learn and disagreed that it interfered with driving.

(OHP-No.13)

As expected, this chart shows that those in "Services" mildly disagreed that the system helped them find their way, while those in "Navigation +" and "Navigation" firmly agreed. Likewise, "Navigation +" and "Navigation" drivers mildly agreed that TravTek helped them pay attention, while those in the "Services" condition mildly disagreed.

(OHP-No.14)

Also, as expected, time savings were noted by "Navigation +" and "Navigation" drivers and not by "Services" drivers. Because these are only preliminary data, we are still investigating why "Navigation +" drivers did not perceive significantly greater time savings.

(OHP-No.15)

This chart shows that "Navigation +" and "Navigation" drivers showed mild agreement that TravTek helped with safer driving.

Those in "Services" said it did not help. Again, these results confirm many peoples expectancies, but rejects. People who believe TravTek displays are "perceived" as unsafe.

(OHP-No.16)

Although the guidance display format was the default display, this chart shows that while drivers were on their assigned routes, they changed switch to the route map which stayed display 16% of the time.

(OHP-No.17)

This chart shows that overall, all drivers thought TravTek displays were "Easy to Read the Text", drivers could understand the information, they liked the screen colors and strongly disagreed that the screen was distracting at night.

(OHP-No.18)

This chart shows that although "voice guidance" was the default mode, only 5% of driving time did drivers turn the system off.

(OHP-No.19)

All drivers agreed the voice tone was clear and the message was understandable, even though synthesized speech (instead of digital voice) was used. Sunthesized speech allowed very specific road names and intersections to be called out.

(OHP-No.20)

This chart shows that nearly 70% of drivers used the "Repeat Voice" button, but that it was used on only less than 10% of trips. We are investigating if most drivers used this in their first trips; hereby reflecting a learning or accomodation phenomenon.

(OHP-No.21)

This chart shows that all display modes were liked, but that there

is a clear preference for combined voice and visually displayed information.

(OHP-No.22)

Next I will present results of one of the three experiments using paid volunteer drivers. In this study, drivers were trained for 1 hour and 40 minutes in the car before being tested. Each driver drove 3 origin/destination pairs. In 1 pair, they could only use the guidance map. In another, drivers only used the route map. In another, they used only a paper map. Half of these drivers had voice; half did not. Half drove in non-rush daylight. Half drove in non-rush night conditions.

(OHP-No.23)

The left chart shows that TravTek functiones considerably helped in trip planning time. The left bar is the control condition with no voice and using a paper map. These drivers took 7 minutes to plan their trips compared to only 1 minute with TravTek. The right chart shows considerable travel time saving as well.

(OHP-No.24)

Our wrong turn analysis shows that the route map display without voice had significantly more wrong turns than even the control condition. Those data are preliminary and we are just beginning to look into this further.

(OHP-No.25)

In summary of naturalistic field studies, drivers show a preference for display modes with voice included. Usage and preference data both indicate that voice and displays should both be included in IVHS designs. Overall, TravTek is rated by drivers as saving time, aiding in navigation and helping to drive more safely. Conclusions from one field experiment show that TravTek reduced trip planning

time by 81% and travel time by 20%. Although results are not calculated for our camera car study, we do have an S-VHS tape of one of our drivers. If we have time now or later, I will be glad to show this. The tape shows the four views from each camera: a lane tracking view, an over-the-shoulder view, a view of the driver's face and a view of the road ahead.

This chart summarizes the overall evaluation effort. The interview and questionnaire study yields driver perceptions data. The field studies and field experiments yield driver behavior data and the safety study integrates driver perception data, driver behaviour data and driver crash data to yield an overall safety assessment. All empirical studies yield data to two other analytical studies. The "traffic modelling study" takes data from 100 cars to estimate effects of wider market penetration. The "architecture evaluation" evaluates TravTek's decentralized system performance in comparison to alternative architectures. These studies therefore yield estimates of overall system performance. Finally, the global evaluation assesses implication of TravTek for other IVHS field tests. Finally, please remember that these results are only preliminary. Data collection ended less than one month ago. As of now, it is clear that opinions about TravTek are good, and the synthesis of data among our multi-study approach is just now beginning.



TRAVTEK Evaluation Overview

Joseph I. Peters
Science Applications International Corporation

Frank J. Mammano
Federal Highway Administration

First U.S. – Japan IVHS Meeting
Public Works Research Institute
22 April 1993

3



Overview

- System Description
- Evaluation Approach
- Some Preliminary Results

7154



The TRAVTEK Partnership



American
Automobile Association



Department of
Transportation



General Motors



City of Orlando



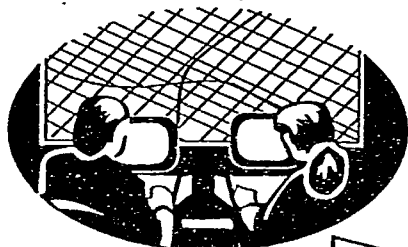
Florida Department of
Transportation

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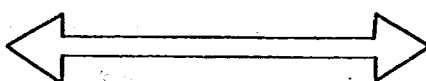
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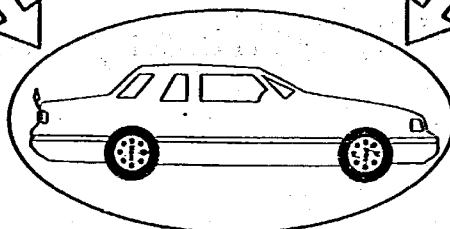
The TRAVTEK System



Traffic
Management
Center



TRAVTEK
Information
and Services
Center



In-Vehicle Computers and
Navigation Systems



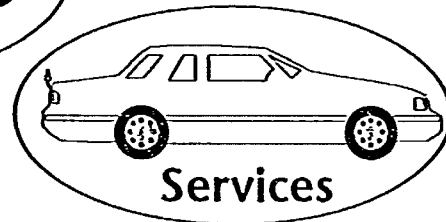
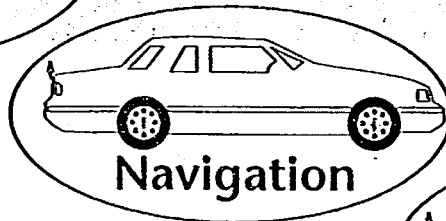
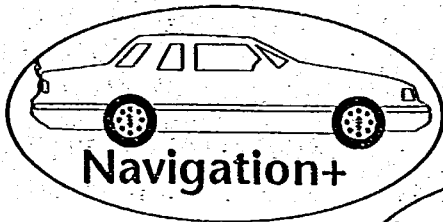
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(No. 3)



In-Vehicle Computers and Navigation Systems

Three Vehicle Configurations:



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(No. 4)

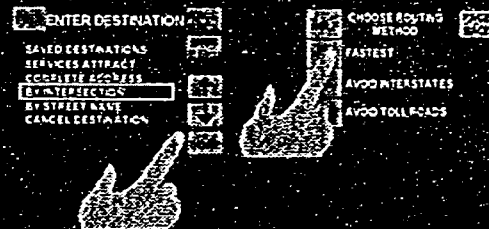


TravTek In-Vehicle System

- Route Selection and Planning
- Route Guidance
- Real-Time Traffic Information
- Help Desk Telephone Assistance

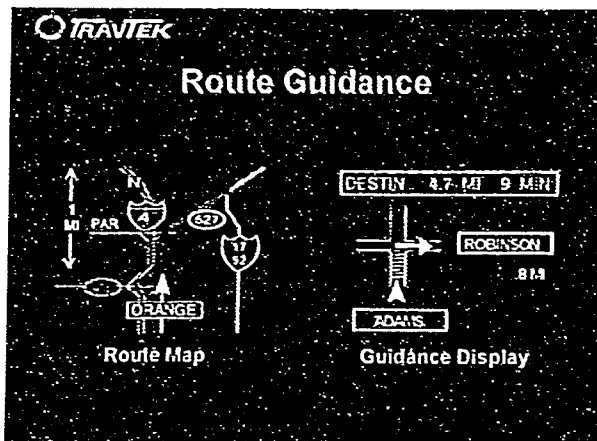


Route Selection and Route Planning



Page 2

(No. 5)

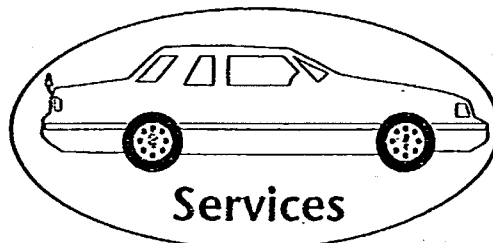


Page 3

(No. 6)



"Services" Features



- Location Information on Area Restaurants, Hotels, Attractions, etc.
- Free Cellular Telephone Access to TRAVTEK Information and Services Center & 911 Emergency*
- Pre-Drive Map Display with Zoom-In-Zoom-Out Feature

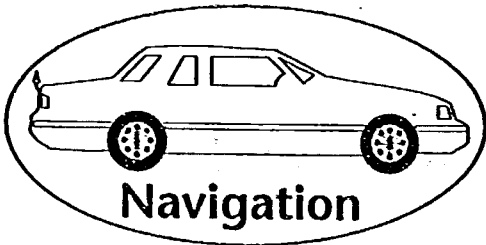
*Commercial Call Access via Credit Card

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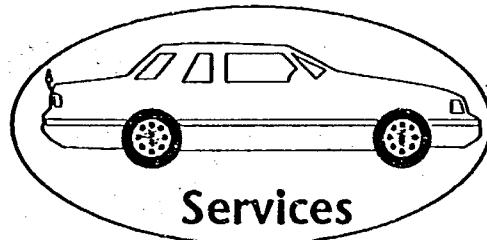
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"Navigation" Features



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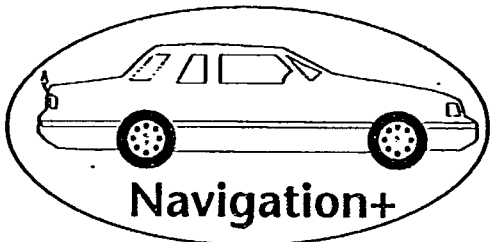
- + Computer Route Planning (Fastest Route; Avoid Interstates; Avoid Tolls) to Destination
- + Highlighted Route Path on Moving Map Display
- + Turn-by-Turn Route Guidance Display and Voice Instructions

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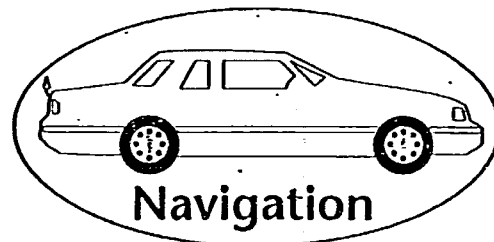
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"Navigation+" Features



=



- + Real-Time Traffic and City Information
- + Real-Time Re-routing Option to Avoid Congestion/Incidents

7155

(No. 9)



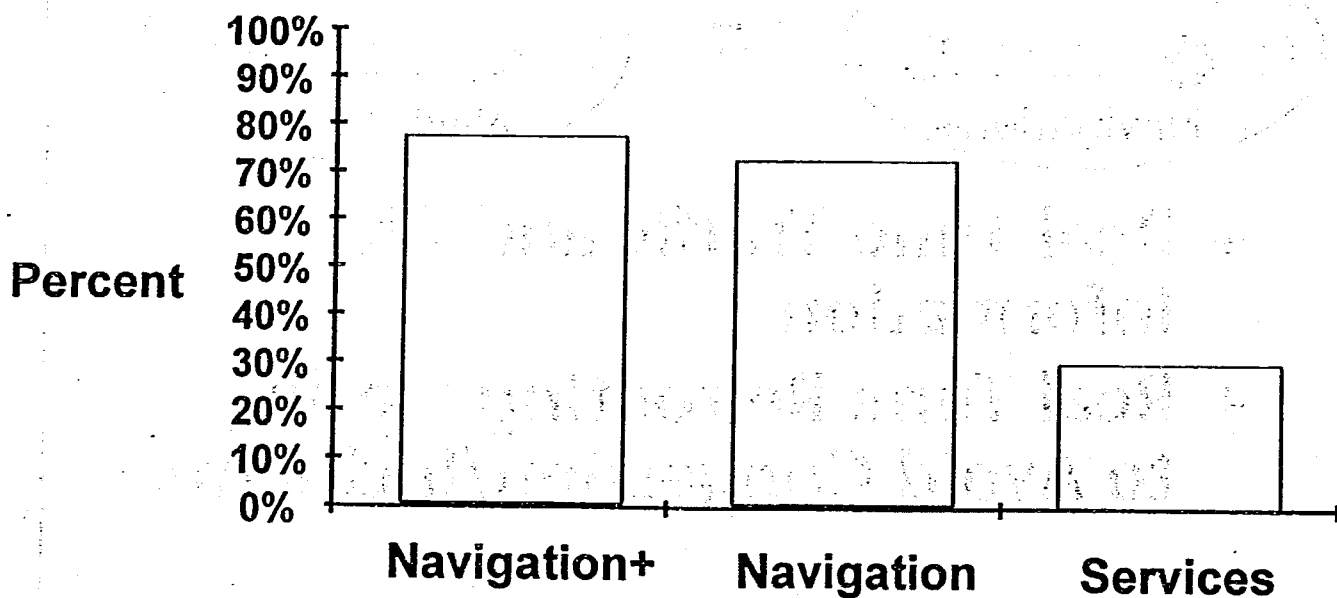
Multiple Integrated Studies

- User Field Studies
- Design and Effectiveness Field Experiments
- Interview and Questionnaire Studies
- Safety Study
- Traffic Modeling Study
- Architecture Evaluation Study
- Global Evaluation

2154

(No. 10)

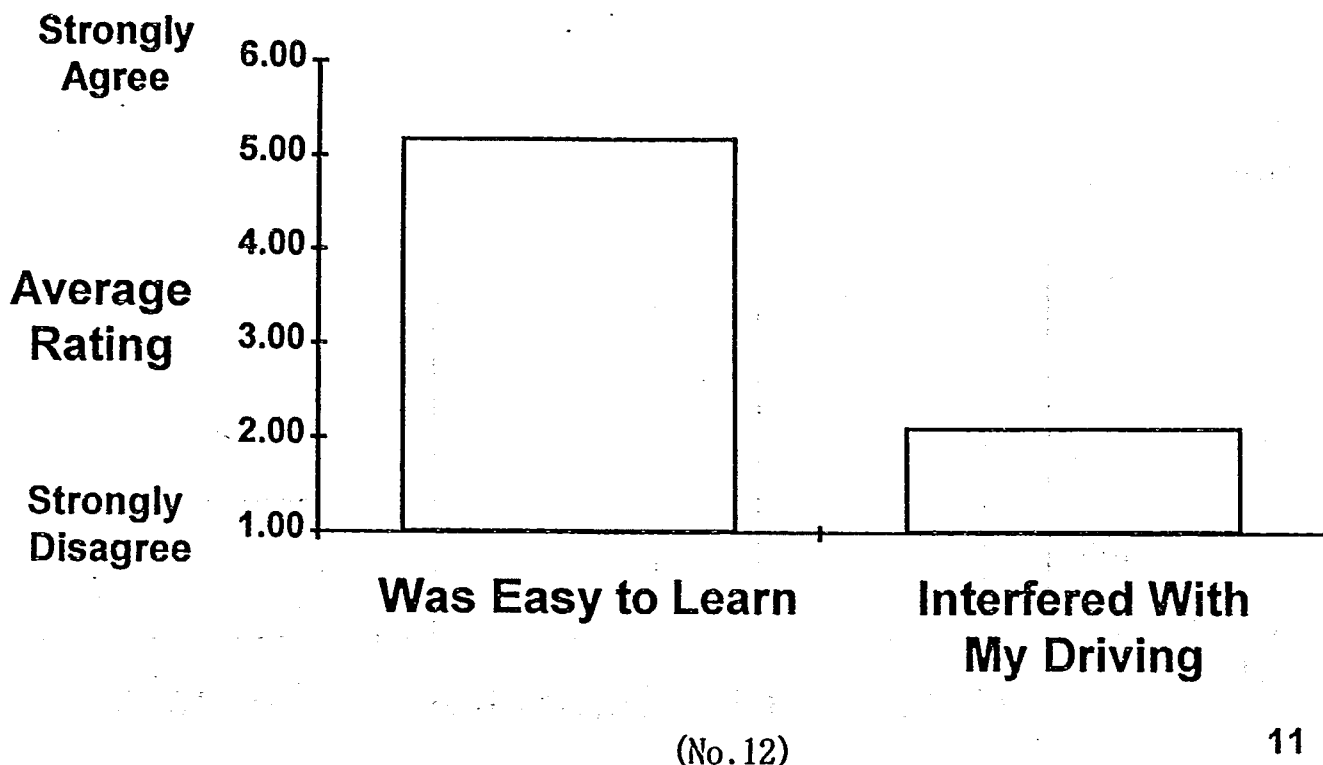
Percent Of All Trips Where Drivers Used TravTek Features



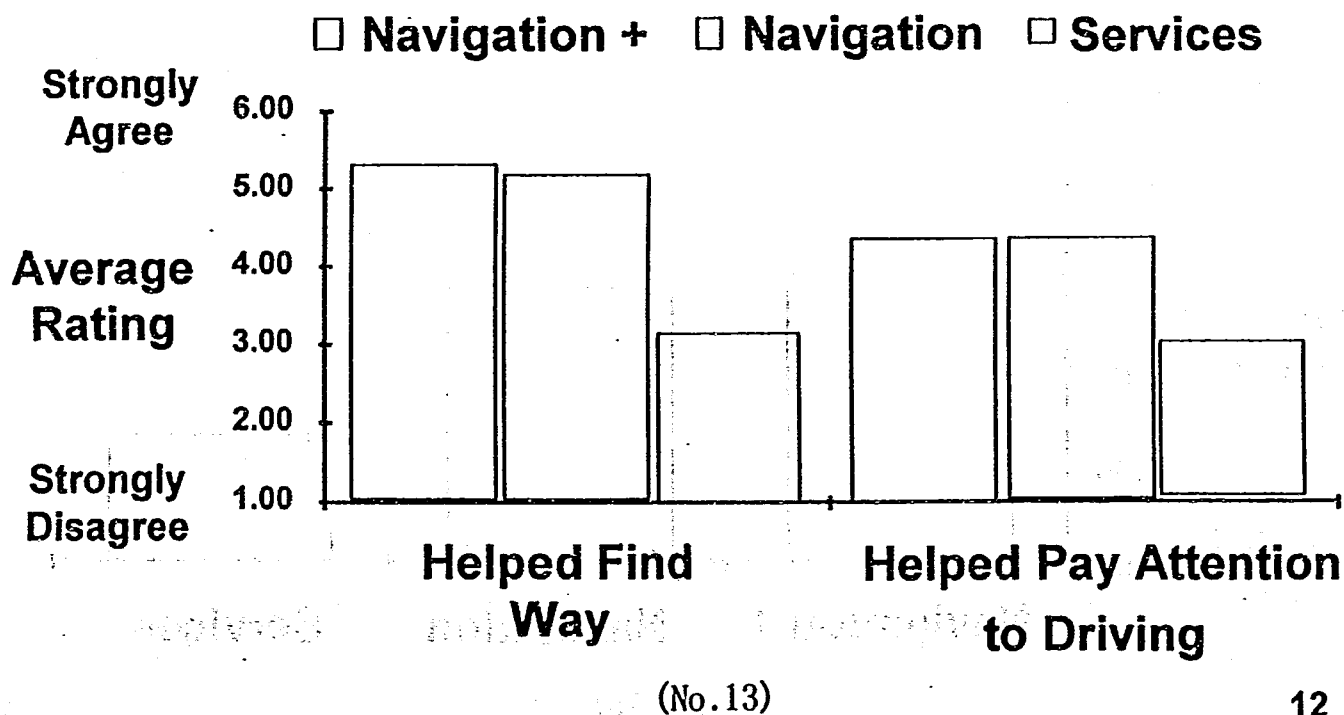
(No. 11)

10

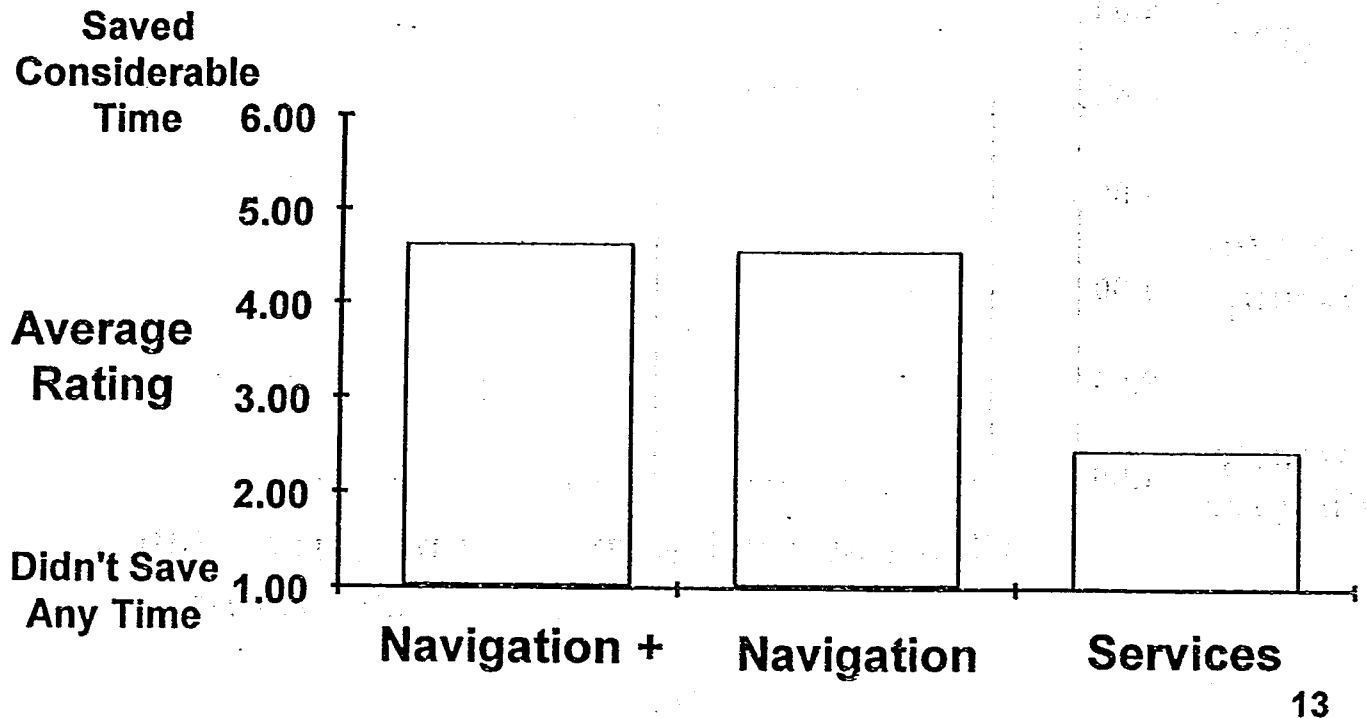
Drivers' Overall Ratings Of TravTek



Drivers' Overall Ratings Of TravTek

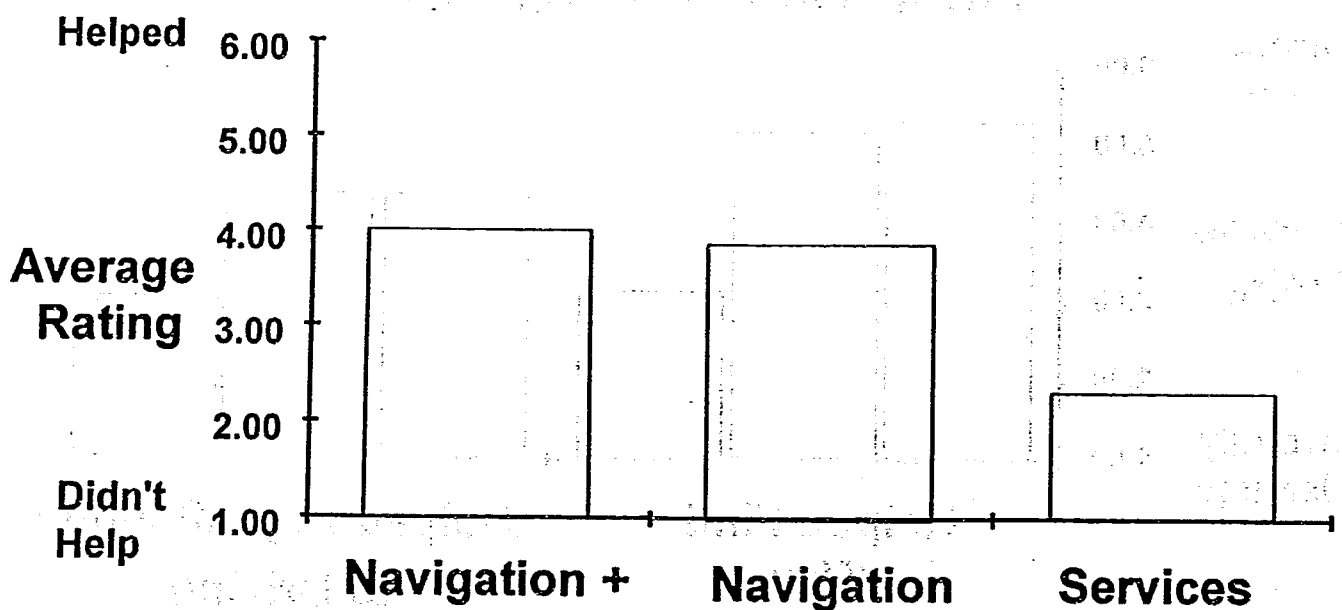


TravTek Helped Me Save Time In Reaching Destinations



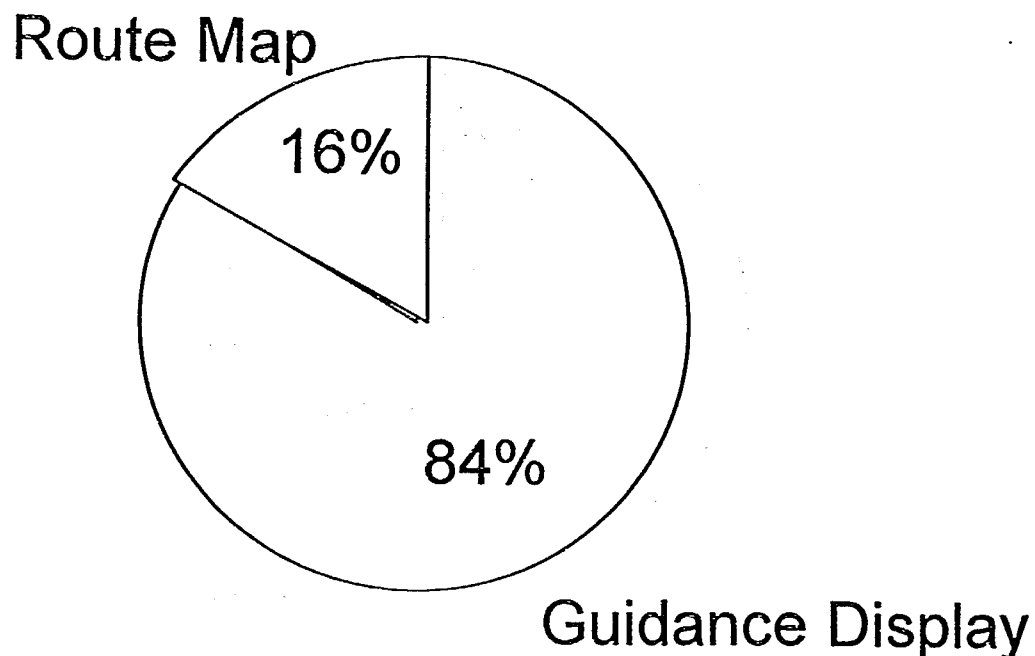
(No. 14)

TravTek Helped Me To Drive More Safely In Orlando



(No. 15)

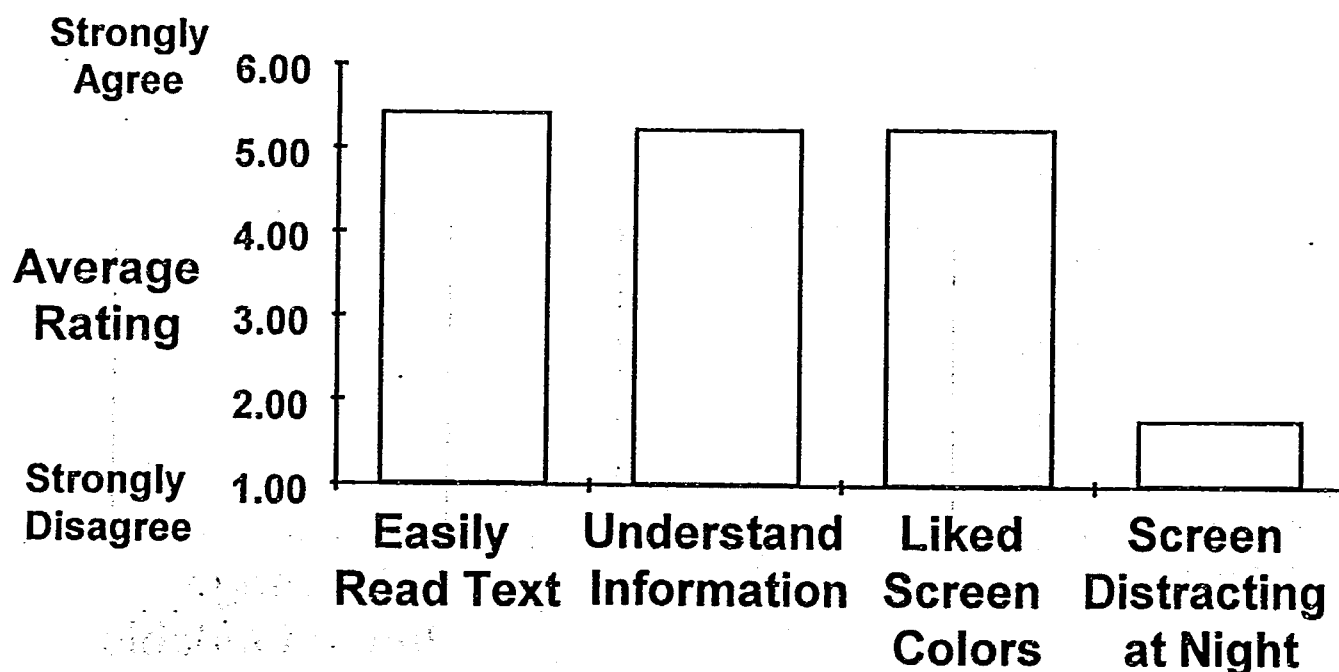
Percent of Time Guidance & Route Map Displays Present (Cars on-route)



(No. 16)

16

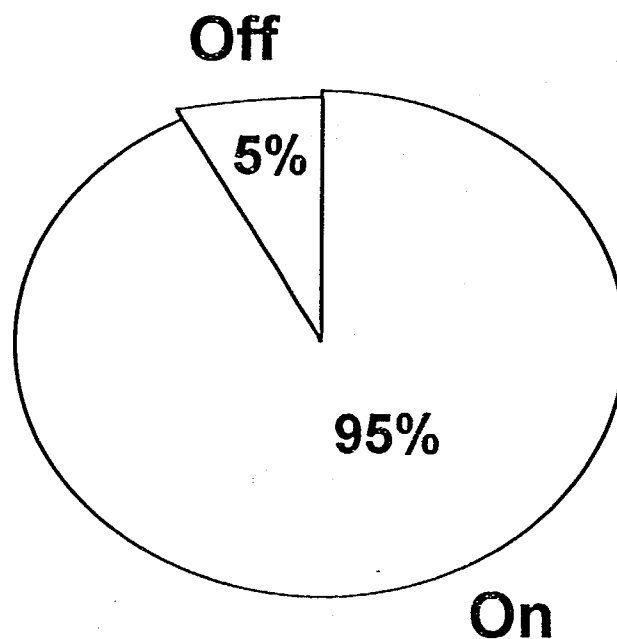
Overall Ratings Of TravTek Visual Displays



(No. 17)

17

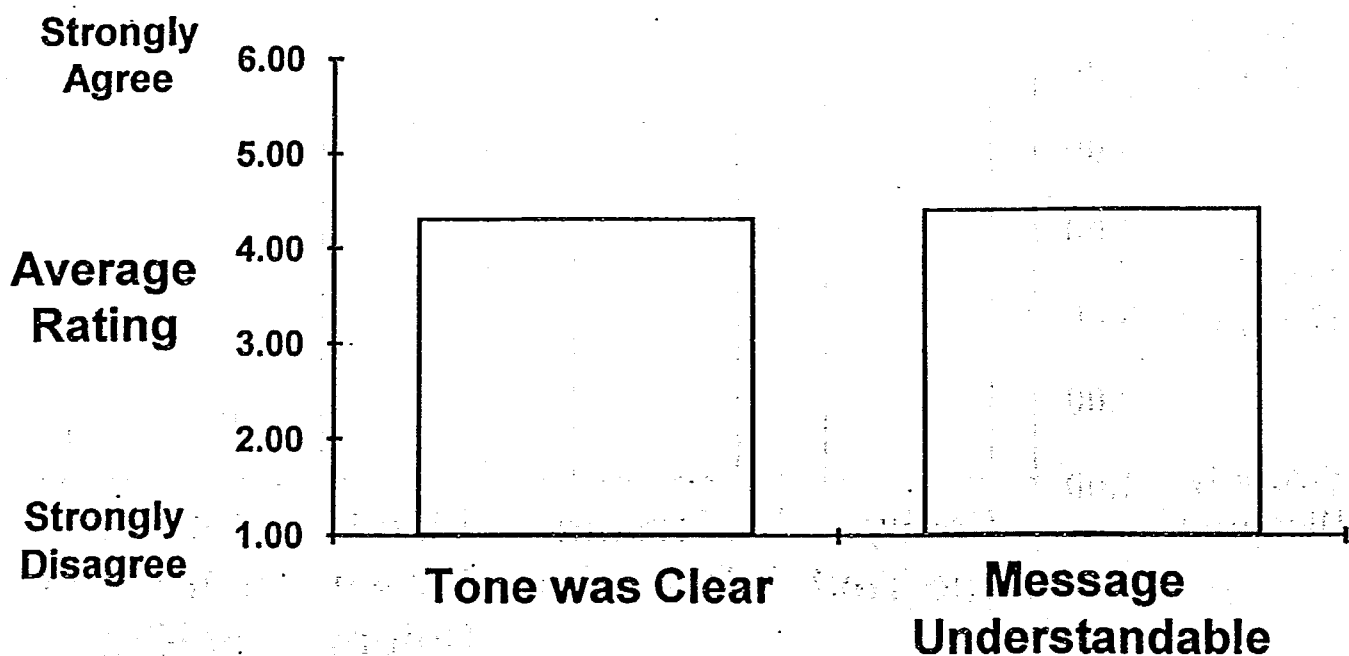
Percent of Time Voice Guidance Was On/Off (Car On-Route)



(No. 18)

19

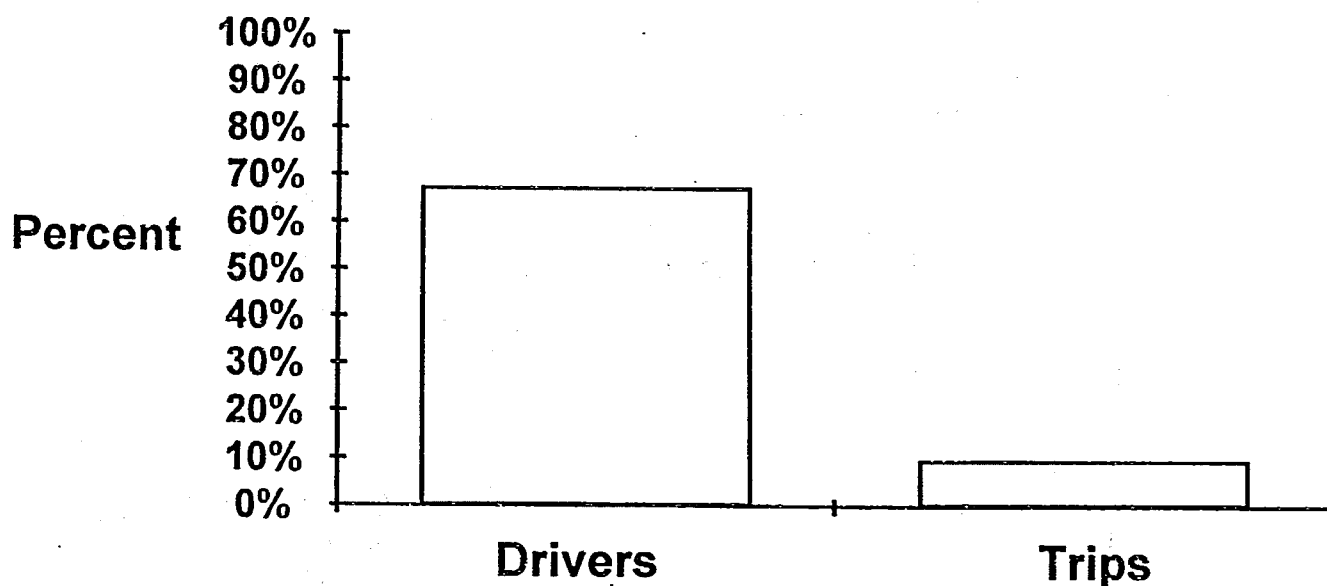
Overall Ratings Of TravTek Voice Presentation



(No. 19)

20

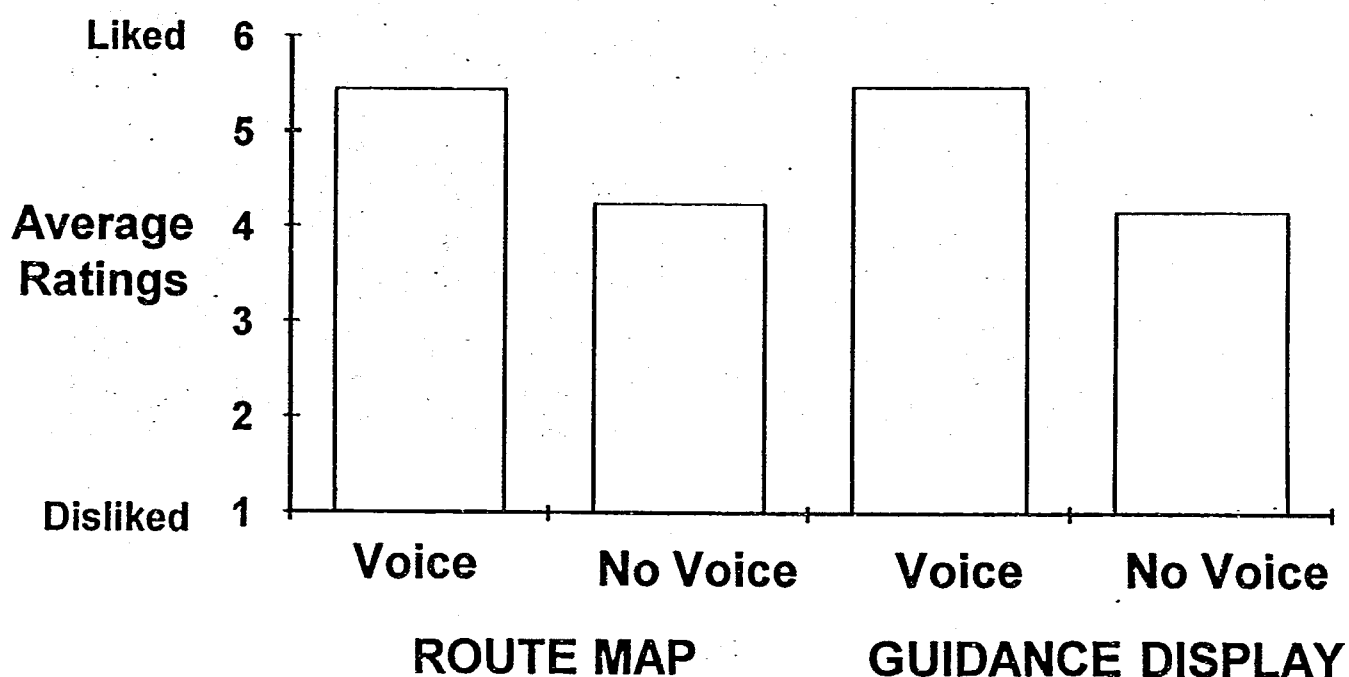
Percent of Repeat Voice Key Presses As A Function Of Drivers/Trips



(No.20)

21

Drivers' Ratings Of Alternate Display Modes



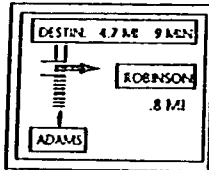
(No.21)

23

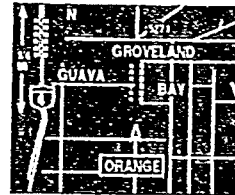


Orlando Test Network Study

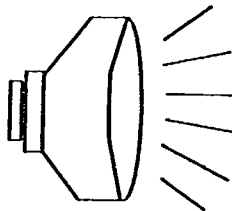
- Evaluate the Effectiveness of Operational Aspects of TRAVTEK/ Driver Interface Features



Guidance Map

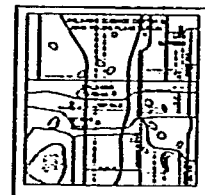


Route Map



Voice Guide

"Turn right on Robinson in nine-tenths of a mile"



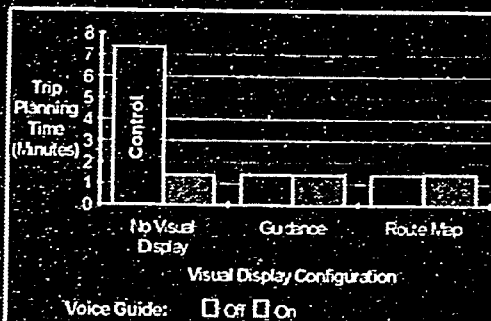
Paper Map

2154

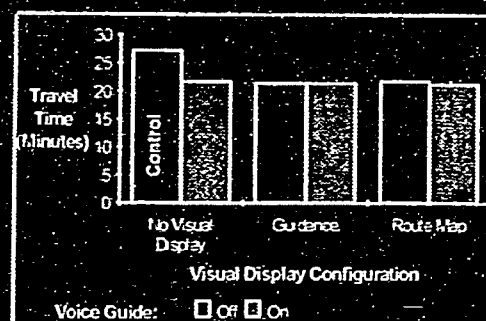
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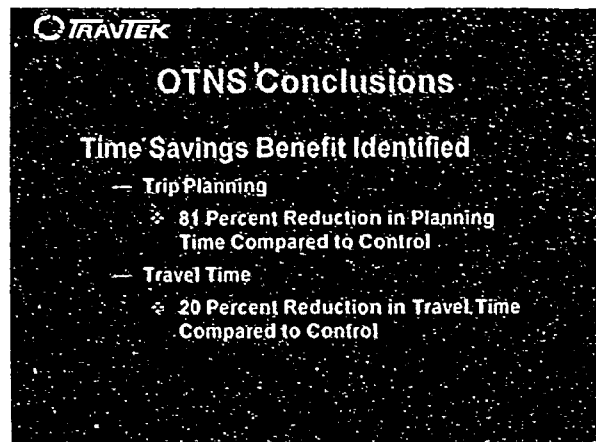
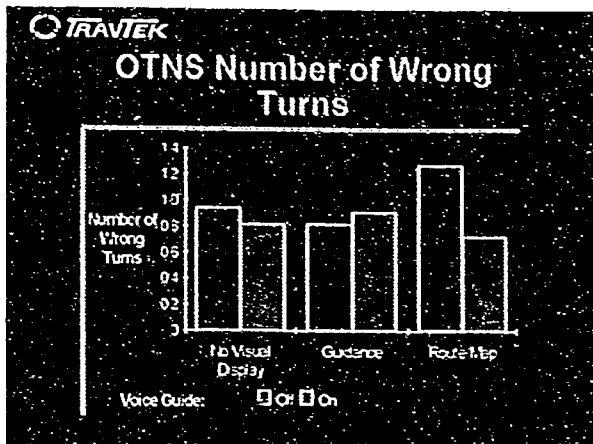


OTNS Trip Planning Time



OTNS Travel Time





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Conclusions

- Results Are Preliminary Only
- Data Collection Ended 31 March 1993
- Overall Opinions About TRAVTEK Are Good
- Synthesis of Multi-Study Data Just Beginning

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(No.25)

6. Discussion on U.S.-Japan Cooperative Effort

Attendees:

Japan - Mr. Kanzaki/Director, Road Department, PWRI, MOC

Mr. Matsumura/Research Coordinator for Traffic Safety,
Road Department, PWRI, MOC

Mr. Nakamura/Chief, Traffic Engineering Division, Road
Department, PWRI, MOC

Mr. Tanaka/Researcher, Traffic Engineering Division, Road
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Mr. Iwatate/Deputy Director, Road Traffic Control Division,
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Mr. Tanimura/Chief of the Road Traffic Information Unit,
Road Traffic Control Division, Road Bureau,
MOC

Mr. Tsunomachi/Executive Director, Highway Industry
Development Organization

Mr. Shibata/Executive Director, Japan Digital Road Map
Association

and others.

U.S. - Mr. MacGowan/Chief, IVHS Research Division, Turner-
Fairbank Highway Research Center, FHWA

Mr. Mammano/ATIS & Communications Research Chief, IVHS
Research Division, Turner-Fairbank Highway
Research Center, FHWA

Dr. Peters/Assistant Vice President and Director Human
Performance Technology Department, Science
Applications International Corporation

Dr. Mayhew/Project Technical Director, Hughes Aircraft
Corporation

(1) Cooperative Research on IVHS

Various topics discussed included: Man Machine Interface, Data Collection (surveillance in networks & freeways, rural area traffic monitoring, automatic vehicle identification (AVI), evaluation studies), General Review of IVHS Accomplishments, Operational Tests Results, Cost and Benefits Measures of Different IVHS. These topics will be examined as possible areas which should be the focus of the next meeting. Also, AVI and Map Date Bases are initial areas of immediate information exchange. It was agreed that the agenda and date of the next meeting will be finalized by correspondence (mail and/or Fax).

Personnel/manpower interchanges are important for both government and industry. An open invitation to both the public and private sector to visit their respective organizations was discussed. The FHWA expressed that there has been good cooperation between the FHWA and PWRI and encourages continued cooperation and welcomes visitors to their facilities. The private sector representation also expressed their willingness for exchanging visitors.

(2) Exchange of Personnel

There were basically three methods for exchanging personnel discussed e.g., 1. sender pays all; 2. sender pays only airfare; 3. receiver pays all. Any of these are possible for Japan. However, the method selected would affect the number of people sent. If the first method is selected Japan can send one a year. This will have various requirements and conditions. This means only one per year can be sent and the individual is selected from all the areas of PWRI. At that rate PWRI would probably be able to send to FHWA every several years. Also there would be age limitations. PWRI prefers sender pays only airfare and receiver pays all expenses. FHWA said they would be able to send a bridge engineer on a sender pays only but would be willing to explore other methods such as the National Science Foundation, or foreign exchange through the State

Department. In addition, there are three issues concerning the exchange of personnel e.g., 1. when someone comes to the PWRI bridge department he or she has to be doing the same activity in their respective department; 2. PWRI does not do research on actual construction aspects only on design; 3. PWRI will comment after they have reviewed the U.S. material in more detail. Mr. Tri Mai of the Office of International Programs is the FHWA contact.

(3) Next Group Meeting

The U.S. proposed the next Group meeting to be at the FHWA Turner-Fairbank Highway Research Center in McLean Virginia, for the week of April 25, 1994. It was determined that April is not a good month for PWRI because of the fiscal year. It was agreed that the coordinators will discuss schedules and items at a later time. It was agreed that the proceedings of this meeting can be in English only.

(4) The Second U.S.-Japan Workshop on the Advanced Technology in Highway Engineering

A tentative agenda was proposed by the U.S. group. It appears that the agenda is acceptable. However, the dates of the workshop are too close to the Japan Road Conference which is October 25-29 and preparations have to be made before the conference. This conference is equivalent to the U.S. Transportation Research Board Meetings. Therefore, the FHWA office of International Programs will be in contact with the Japan coordinator with an agreed date. Also, the U.S. will pay for 9 delegation members. The question was asked if additional members could come. It was agreed that additional members could come and the cost would be handled by Japan. The details would be handled by the respective coordinators.

7. Study tours

(1) PWRI

The U.S. members went on a study tour to the IVHS facilities of PWRI on April 20. The guidelight system, the highway driving simulator, the LCX communication experiment and other road traffic related facilities were introduced.

The guidelight system aims to inform drivers of other cars approach at the blind corner and intersection with poor geometry. The highway driving simulator they experienced is used for the evaluation of man-machine interface of IVHS in-car units. The LCX communication experiment they surveyed is performed in the test track to establish and confirm the continuous road-vehicle communication technologies.

(2) Tokyo

The U.S. members also went to Tokyo using the IVHS experimental car on April 23. There they visited the VICS experimental site on the Metropolitan Expressway and Traffic Control Center of the Tokyo First Management Office, Metropolitan Expressway Public Corporation.

Real time road traffic information is provided from the communication units (beacons) on Shibuya Line of the Metropolitan Expressway. The demonstration that the information was presented on the display mounted in the IVHS experimental car was performed.

They had knowledge about the Metropolitan Expressway through the introduction video, and studied management works using graphic panel to monitor and control traffic condition and operational works of the Highway Advisory Radio System.

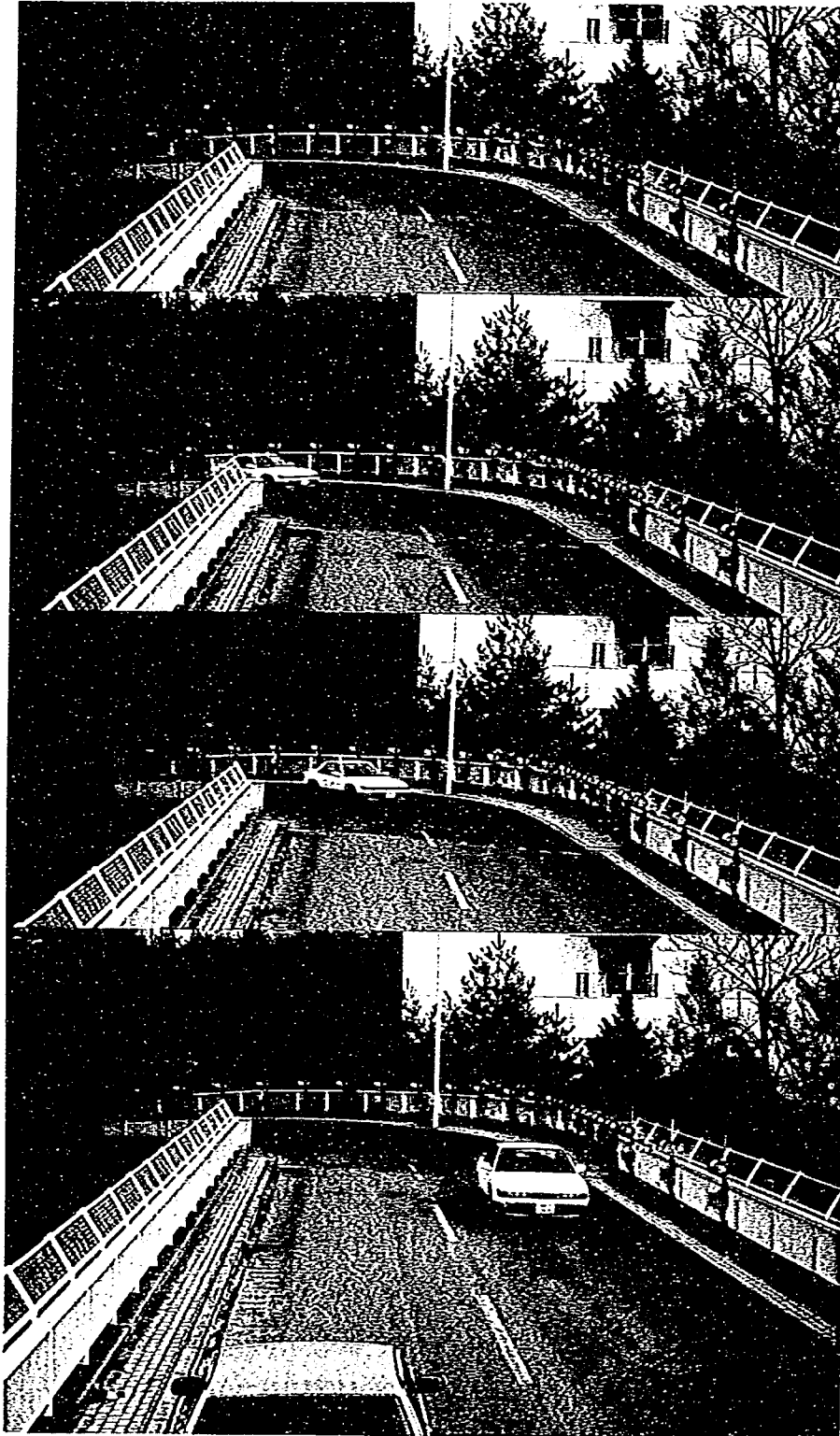


Photo 1. Opposite Lane Traffic Warning & Road Alignment
Indicating Function of Guidelight System

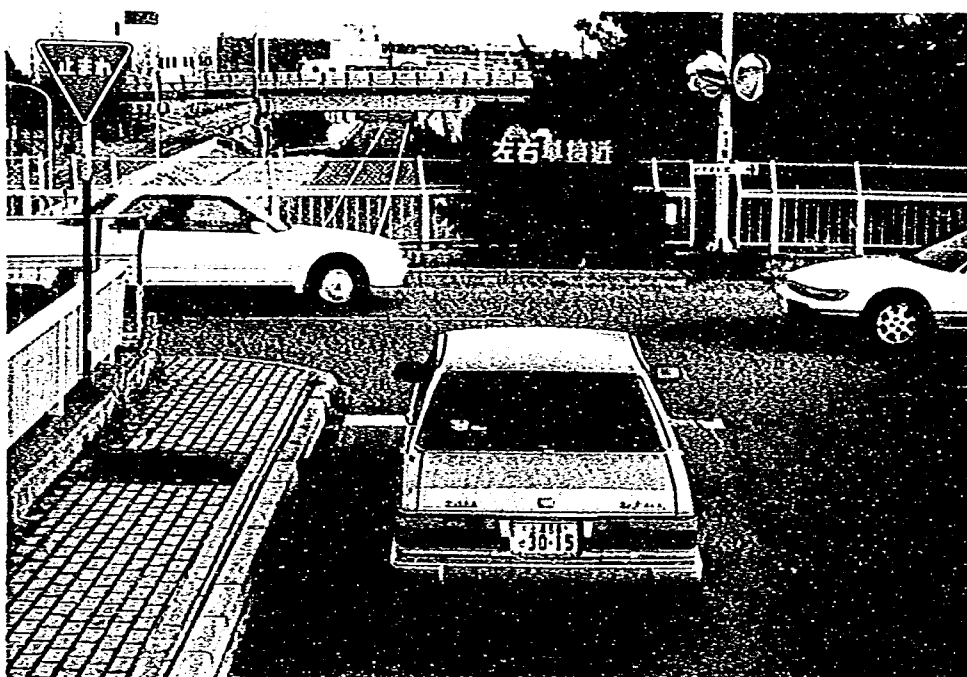


Photo 2. Intersection Warning Function of Guidelight System

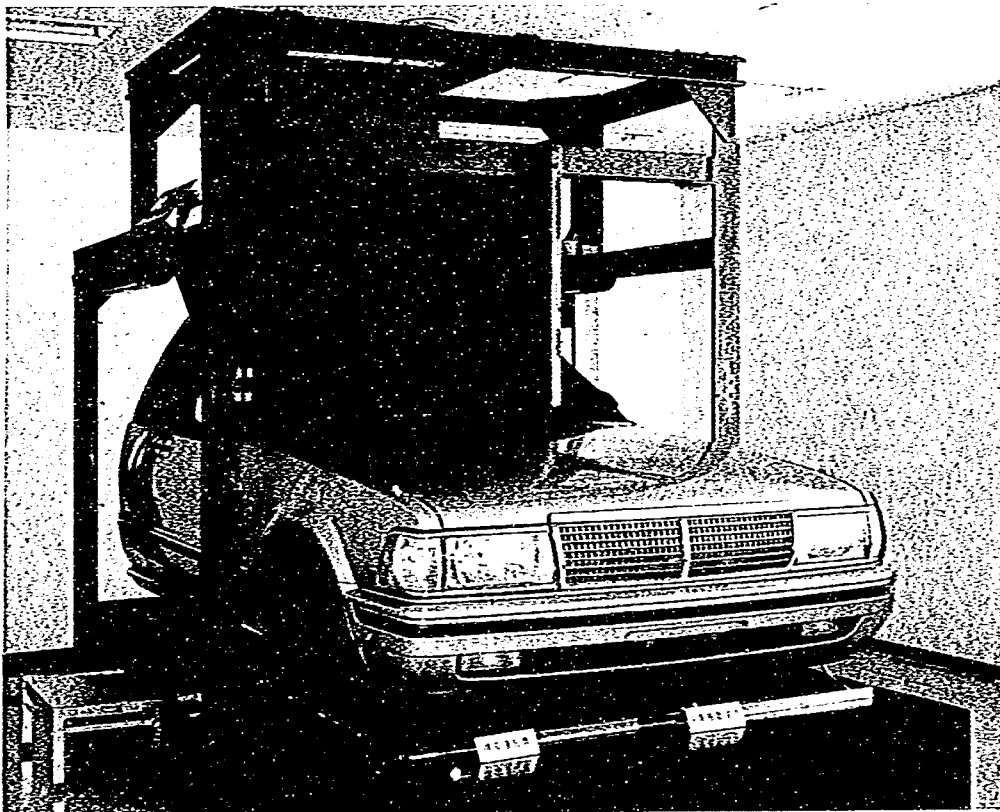
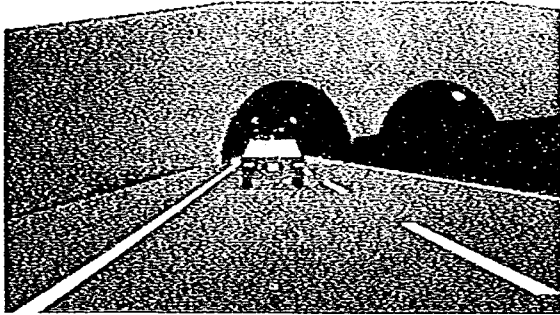
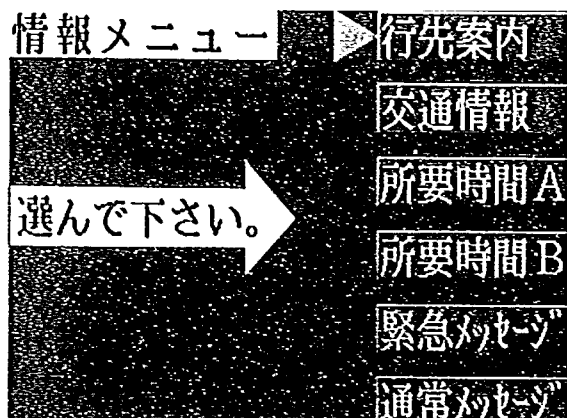
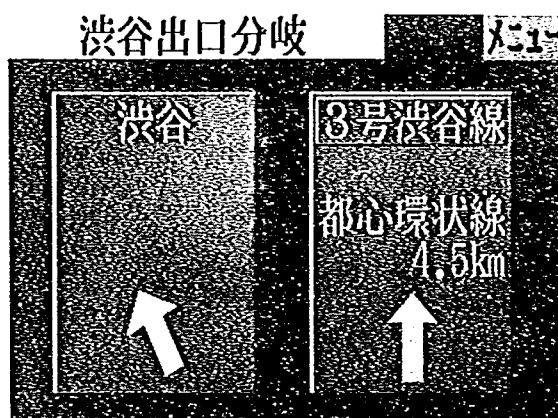


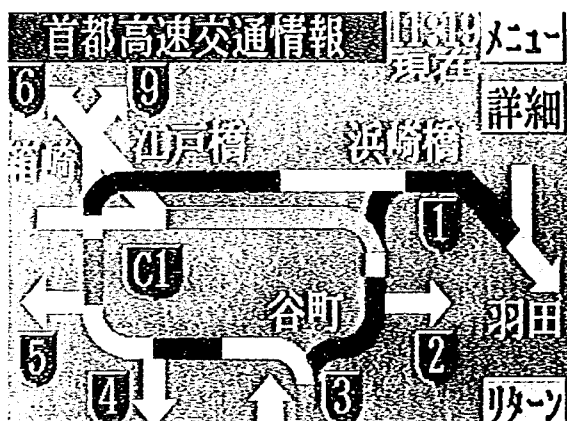
Photo 3. Appearance and Picture on Screen of Highway Driving Simulator



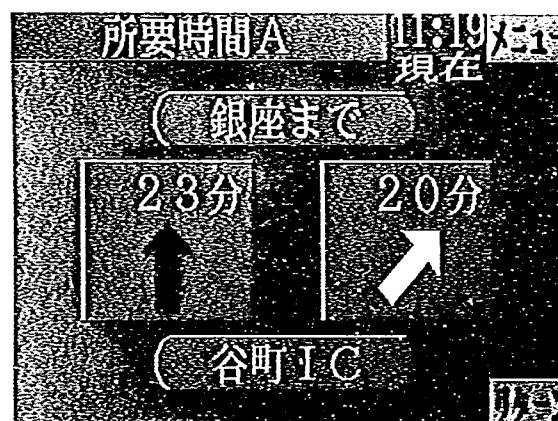
(1) Menu



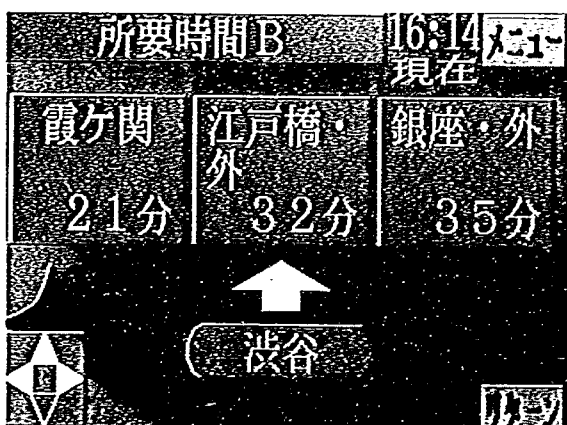
(2) Route Information



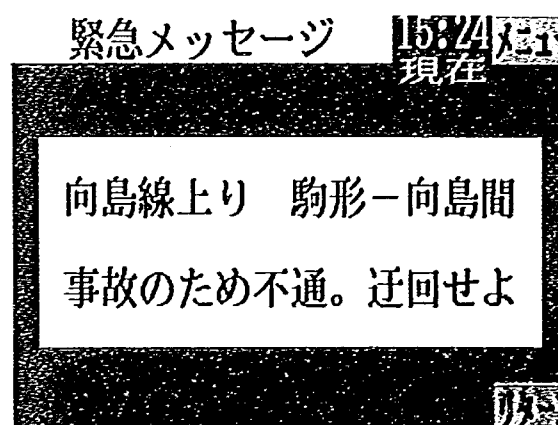
(3) Traffic Information



(4) Route Guidance



(5) Required Travel Time



(6) Emergency Message

Photo 4. Information Displays of IVHS Experimental Car

8. Participants list

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Ryutaro Oishi	Coordinator for International Research Cooperation, Planning and Research Administration Department
Hiroo Kanzaki	Director of Road Department
Yutaka Anzaki	Research Coordinator for Road Traffic, Road Department
Testuo Matsumura	Research Coordinator for Traffic Safety, Road Department
Makoto Nakamura	Chief of Traffic Engineering Division, Road Department
Yohei Hioki	Chief Researcher of Traffic Engineering Division, Road Department
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