Intelligent Transportation Systems (ITS)
Commercial Vehicle Operations (CVO)

Survey of **On-Board Technologies** Applicable to Commercial Vehicle Operations

Final Version

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Executive Summary

In June 1997, the Federal Highway Administration (FHWA) Office of Motor Carriers (OMC) assigned The Johns Hopkins University Applied Physics Laboratory (JHU/APL) the task of completing "a literature search of all available publications, databases and information sources for a comprehensive description of the existing capabilities, and near-term capabilities, relating to commercial motor vehicle fleet safety management of the driver, vehicle, and cargo" as part of an overall task to provide technical support for a planned FHWA Intelligent Transportation System / Commercial Vehicle Operations (ITS/CVO) On-Board Technologies Operational Test. This document reports on the results of that effort.

This document was developed in parallel with the definition of the Intelligent Vehicle Initiative (IVI). With the advent of IVI, the operational test envisioned in June 1997 was renamed the IVI Commercial Vehicle Operational Test. Section 3 provides a cross-reference between the IVI Candidate Services as defined in September 1997 and the products and projects included in this study. Rather than repeat the IVI information in this document, the IVI Heavy Vehicle Roadmap is included here by reference. Information on the Commercial Vehicle Information Systems and Networks (CVISN) and International Border Crossing (IBC) initiatives is also included here by reference.

The study focused on technology developments in the product development pipeline in mid-1997 (Section 4), and public and private sector research efforts (Section 5). Products came from original equipment manufacturers (OEM) or third party manufacturers. The study addressed technologies emerging from international markets and technologies developed primarily for passenger cars and light trucks since they may make the transition to commercial vehicles. Throughout this document, the terms "commercial vehicles" and "heavy vehicles" apply to both trucks and buses.

Section 6 contains a comprehensive list of the materials used for this study. Much of the information came from publicly available studies and reports, many of which were available on the World Wide Web. Where possible, this material was augmented by draft reports and conversations with key OEM technology development staffs and FHWA personnel. No proprietary information has been included in this report.

Any opinions in this document, including the cross-referencing of products and projects to the IVI services, represents the perspective of the authors, and does not necessarily represent the opinion of JHU/APL or FHWA. The authors reserve the right to make corrections or additions to this report. Comments on this report should be sent to: Timothy Herder, JHU/APL, 11100 Johns Hopkins Road, Laurel, Maryland 20723-6099 or timothy.herder@jhuapl.edu.

1. Introduction

In June 1997, the Federal Highway Administration (FHWA) Office of Motor Carriers (OMC) assigned The Johns Hopkins University Applied Physics Laboratory (JHU/APL) the task of completing “a literature search of all available publications, databases and information sources for a comprehensive description of the existing capabilities, and near-term capabilities, relating to commercial motor vehicle fleet safety management of the driver, vehicle, and cargo” as part of an overall task to provide technical support for a planned FHWA Intelligent Transportation System / Commercial Vehicle Operations (ITS/CVO) On-Board Technologies Operational Test. This document reports on the results of that effort.

This document was developed in parallel with the definition of the Intelligent Vehicle Initiative (IVI). With the advent of IVI, the operational test envisioned in June 1997 was renamed the IVI Commercial Vehicle Operational Test. Section 3 provides a cross-reference between the IVI Candidate Services as defined in September 1997 and the products and projects included in this study. Rather than repeat the IVI information in this document, the IVI Heavy Vehicle Roadmap is included here by reference. Information on the Commercial Vehicle Information Systems and Networks (CVISN) and International Border Crossing (IBC) initiatives is also included here by reference.

2. Scope of the Study and Approach

The study focused on technology developments in the product development pipeline in mid-1997 (Section 4), and public and private sector research efforts (Section 5). Products came from original equipment manufacturers (OEM) or third party manufacturers. The study addressed technologies emerging from international markets and technologies developed primarily for passenger cars and light trucks since they may make the transition to heavy vehicles. Throughout this document, the terms “commercial vehicles” and “heavy vehicles” apply to both trucks and buses.

Section 6 contains a comprehensive list of the materials used for this study. Much of the information came from publicly available studies and reports, many of which were available on the World Wide Web. Where possible, this material was augmented by draft reports and conversations with key OEM technology development staffs and FHWA personnel. No proprietary information has been included in this report.

3. IVI Candidate Services

The following descriptions of the IVI Candidate Services were extracted from the IVI Request for Information . These candidate services include several promising heavy vehicle capabilities. In the course of the IVI program, the definition of the IVI services, and the mix of services selected for integration may vary among vehicle types. Please note that these services include some existing or slightly modified ITS user services.

Sections 3.1 through 3.26 contain both the IVI Candidate Service descriptions and cross-references to the applicable technologies described in Section 4, Product Developments and Section 5, Ongoing Research and Development Projects of this report. The cross-references point to the available technology building blocks that could be integrated to at least partially address the requirements of the candidate service. Where multiple examples of necessary technologies were available, all are referenced.

3.1 Rear End Collision Avoidance

This feature would sense the presence and speed of vehicles and objects in front of the equipped vehicle and would provide warnings and limited control of the vehicle speed (coasting, downshifting, or braking) to minimize risk of collisions with vehicles and objects in the vehicle's lane of travel. It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would monitor the motion and location of vehicles and other objects in front of the vehicle and would advise the driver, through an appropriate driver-vehicle interface, of imminent rear-end crashes. These systems may share some elements of, and are expected to complement the performance of, adaptive cruise control systems which are expected to precede collision avoidance systems as a commercial product. Later versions of these systems may include automatic braking in the event of an impending crash. The performance of these systems may be enhanced through future combination with other systems, such as other collision avoidance systems, route guidance-navigation systems with enhanced map data bases, and cooperative communication with the highway infrastructure to set adaptive cruise control systems at safe speeds.

Section 4.1.3, Mack Trucks Inc. Vehicle Dynamic Control, Page 19

Section 4.1.4, Mack Trucks Inc. Collision Warning, Page 19

Section 4.1.5, Mack Trucks Inc. Active Cruise Control, Page 20

Section 4.1.6, Mack Trucks Inc. Intelligent Vehicle Control, Page 20

Section 4.5.2, Mitsubishi Trailing Vehicle Detection System, Page 23

Section 4.5.3, Mitsubishi Vehicle Distance Warning System, Page 23

Section 4.5.6, Mitsubishi Automatic Collision Detection and Prevention System, Page 24

Section 4.15.4, Volvo DYNACRUISE, Page 30

Section 4.16.2, Delco Electronics Europe, Page 30

Section 5.2.1, Frequency Modulated Continuous Wave (FMCW) Radar, Page 35

Section 5.2.2, ALIRT Blind Spot Detector, Page 35

3.2 Road Departure/Lane Departure Collision Avoidance

This feature would provide warning and control assistance to the driver through lane or road edge tracking and by determining the safe speed for road geometry in front of the vehicle. It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would monitor the lane position, motion relative to the road edge, and vehicle speed relative to road geometry and road conditions and would advise the driver, through an appropriate driver-vehicle interface, of imminent unintentional road departure. Later versions of these systems may include cooperative communication with the highway infrastructure to automatically provide safe speeds for upcoming road geometry and conditions. The performance of these systems may be enhanced through future combination with other systems; such as other collision avoidance systems, drowsy driver advisory systems, and route guidance-navigation systems with enhanced map data bases.

Section 4.1.16, Mack Trucks Inc. Camera Guided Bus Page 21

Section 4.5.4, Mitsubishi Lane Deviation Warning System, Page 23

Section 4.7.4, Mazda Lane Deviation Warning System, Page 26

Section 4.7.6, Mazda Cornering Deceleration Regulation System, Page 26

Section 4.13.1, Fuji Lane Deviation Warning System, Page 29

Section 4.18, Navigation Technologies, Page 30

Section 4.20, NOKIA Mobile Phones, Page 31

Section 5.2.5, Laser-Based Tracking Device, Page 36

Section 5.2.6, Magnetic Lateral Guidance, Page 36

Section 5.2.8, Vehicle Lateral Control System Using Laser Radar, Page 36

3.3 Lane Change and Merge Collision Avoidance

It is expected that the first implementation of this service would be through in-vehicle systems which may be augmented with vehicle-to-vehicle communications. These systems would monitor the lane position, relative speed and position of vehicles, including motorcycles, beside and to the rear of the vehicle and would advise the driver during the decision-phase of a lane-change maneuver, through an appropriate driver-vehicle interface, of the potential for a collision. Later versions of these systems may provide additional advice of an imminent crash to the driver during the action-phase of the lane change or entry-exit maneuver. The performance of these systems may be enhanced through future combination with other systems; such as other collision avoidance systems and roadside communication and sensing systems.

Section 4.1.4, Mack Trucks Inc. Collision Warning, Page 19

Section 4.5.6, Mitsubishi Automatic Collision Detection and Prevention System, Page 24

Section 4.10.4, Toyota Collision Detection System, Page 28

Section 4.16.2, Delco Electronics Europe, Page 30

Section 4.17, Eaton VORAD Collision Warning System, Page 30

3.4 Obstacle/Pedestrian Detection

This service would warn the driver when pedestrians, vehicles, or obstacles are in close proximity to the driver's intended path. This could be accomplished with on-board sensors or infrastructure-based sensors communicating to vehicles.

Section 5.2.2, ALIRT Blind Spot Detector, Page 35

3.5 Intersection Collision Avoidance

This feature will provide warning to the driver when the potential for collision exists at an intersection. Due to the complexity of the intersection collision problem, it is anticipated that a cooperative vehicle-infrastructure solution will be desired. Complexities include sensing vehicles on intersecting roadways and determining the intent of these vehicles in terms of slowing, turning or potential for violation of traffic control devices.

Section 5.2.1, Frequency Modulated Continuous Wave (FMCW) Radar, Page 35

Section 5.2.3, Millimeter Wave Radar Sensor, Page 36

Section 5.2.4, Stereo-Based Vehicle Guidance, Page 36

3.6 Railroad Crossing Collision Avoidance

This feature would provide in vehicle warnings to drivers when they approach a railroad crossing that is unsafe to enter due to approaching or present rail traffic. Initial implementation of this feature is anticipated for buses and trucks carrying hazardous cargo. This service, which would share many onboard vehicle components with intersection collision avoidance systems, is dependent on communications and the deployment of infrastructure components.

Section 4.1.3, Mack Trucks Inc. Vehicle Dynamic Control, Page 19

Section 4.5.7, Mitsubishi Cornering Deceleration Regulation System, Page 24

Section 4.7.6, Mazda Cornering Deceleration Regulation System, Page 26

Section 4.18, Navigation Technologies, Page 30

Section 4.19.1, Tele Atlas StreetNet, Page 31

Section 4.19.2, Tele Atlas RoadNet, Page 31

Section 4.20, NOKIA Mobile Phones, Page 31

Section 4.21, MANNESMANN AG, Page 31

Section 4.23.1, GT 'Orchid' Service, Page 32

Section 4.23.2, Radio Data System Traffic Message Channel, Page 32

Section 5.2.5, Laser-Based Tracking Device, Page 36

Section 5.2.6, Magnetic Lateral Guidance, Page 36

Section 5.5.1, Finnish National Road Administration (FINNR, Page 41

Section 5.5.2, Dutch Transport Ministry, Page 41

Section 5.5.5, Italian Ministry Of Public Works, Page 41

Section 5.5.8, Swiss Federal Highways Office, Page 45

3.7 Vehicle Stability Warning and Assistance

An early version of this service would assist drivers in maintaining safe speeds on curves by measuring the rollover stability properties of vehicles prone to rollover as it is operated on the roadway, and by providing the driver with a graphical depiction of the vehicle's loading condition relative to its rollover propensity. More advanced services would employ an active stability system coupled with electronic brake system technology and infrastructure provided information to selectively apply brakes to stabilize the vehicle and, thus, reduce the incidence of loss of control during crash avoidance or other emergency steering maneuvers.

3.8 Low Friction Warning

This service would initially warn the driver of reduced traction, but in advanced configuration, would also provide control assist capabilities to assist the driver in regaining control of the vehicle. Sensors on-board the vehicle would detect when the tire-to-road surface coefficient of friction is reduced due to water, ice, or road surface condition.

Section 4.1.3, Mack Trucks Inc. Vehicle Dynamic Control, Page 19

Section 4.1.9, Mack Trucks Inc. Tractor Trailer Communications, Page 20

Section 4.5.7, Mitsubishi Cornering Deceleration Regulation System, Page 24

3.9 Driver Condition Warning

This service would provide a driver monitoring and warning capability to alert the driver to problems, such as drowsiness or other types of impairments. It is expected that the first implementation of this service would be on commercial and transit vehicles.

Section 4.1.1, Mack Trucks Inc. Vigilance System, Page 19

Section 4.5.1, Mitsubishi Drowsy Driver Warning System, Page 23

Section 4.6.1, Nissan Drowsy Driver Warning System, Page 24

Section 4.7.1, Mazda Drowsy Driver Warning System, Page 25

Section 4.8.1, Honda Drowsy Driver Warning System, Page 26

Section 4.9.1, Isuzu Drowsy Driver Warning System, Page 27

Section 4.10.1, Toyota Drowsy Driver Warning System, Page 27

Section 5.1.1, Direct Psychophysiological Monitoring of Driver Alertness, Page 33

Section 5.1.2, Prototype Heavy Vehicle Drowsy Driver Monitor Detection System, Page 33

Section 5.1.3, Driver Status/Performance Monitoring, Page 33

Section 5.1.4, Walter Reed, Actigraphs, Page 34

Section 5.1.5, Continuous Fitness for Duty Monitor, Page 34

Section 5.1.6, PERCLOS, Page 34

Section 5.1.7, EYE-COM (Stay Awake Eye Com Biosensor and Communicator, Page 34

Section 5.1.9, Ultra-slow Electrophysiological Signals, Page 34

Section 5.1.10, PROCHIP Program, Page 35

Section 5.1.11, SAVE Program, Page 35

Section 5.1.12, ADS, Page 35

Section 5.1.14, Eye Tracking Using Imagery, Page 35

3.10 Longitudinal Control

Longitudinal control would range from normal cruise control to advanced cooperative cruise control and applications which permit full automatic braking. Intelligent cruise control senses the presence and relative velocity of moving vehicles ahead of the equipped vehicle, and adjusts the speed of travel to maintain a safe separation between vehicles. Vehicle speed is adjusted either by allowing the vehicle to coast or by transmission downshifting. More advanced longitudinal control systems would be capable of detecting a vehicle ahead in the same lane, which may be traveling at any speed or may be fully stopped. A full range of braking capability and operating speeds would be available to the equipped vehicle, including stop-and-go traffic operations. This service can be provided by autonomous in-vehicle systems or with assistance from vehicle-to-vehicle and vehicle-infrastructure cooperation.

Section 4.1.4, Mack Trucks Inc. Collision Warning, Page 19

Section 4.1.5, Mack Trucks Inc. Active Cruise Control, Page 20

Section 4.5.3, Mitsubishi Vehicle Distance Warning System, Page 23

Section 4.5.5, Mitsubishi Position Regulated Speed Control System, Page 24

Section 4.5.8, Mitsubishi Scan Laser Radar, Page 24

Section 4.6.3, Mazda Vehicle Distance Warning System, Page 26

Section 4.8.2, Honda Vehicle Distance Warning System, Page 26

Section 4.9.2, Isuzu Position Regulated Speed Control System, Page 27

Section 4.10.2, Toyota Vehicle Distance Warning System, Page 28

Section 4.10.3, Toyota Automatic Collision-Reduction Braking System, Page 28

Section 4.16.1, Delco Collision Avoidance, Page 30

Section 4.16.2, Delco Electronics Europe, Page 30

Section 4.17, Eaton VORAD Collision Warning System, Page 30

3.11 Lateral Control

This service would sense the center of the lane and continually actuate the steering to keep the vehicle in the center of its lane. For the service to dependably detect the lane boundaries, some infrastructure cooperation may be required, such as accurately painted lane marker stripes, embedded magnetic nails, or radar-reflective stripes. The driver would be able to assume control at any time.

Section 4.5.4 Mitsubishi Lane Deviation Warning System, Page 23

Section 4.5.7 Mitsubishi Cornering Deceleration Regulation System, Page 24

Section 4.7.4 Mazda Lane Deviation Warning System, Page 26

Section 4.7.6 Mazda Cornering Deceleration Regulation System, Page 26

Section 4.13.1 Fuji Lane Deviation Warning System, Page 29

3.12 Tight Maneuver/Precision Docking for Transit

This service would position the bus or commercial vehicle very precisely relative to the curb or loading platform. The driver would maneuver the bus into the loading area and then turn it over to automation. Sensors would continually determine the lateral distance to the curb, front and rear, and the longitudinal distance to the end of the vehicle loading area. The driver would be able to override at any time by operating brakes or steering, and would be expected to monitor the situation and take emergency action if necessary (for example, if a pedestrian steps in front of the vehicle). When the vehicle is properly docked, it would stop and revert to manual control. In freight or bus terminals this service could increase facility throughput as well as safety.

Section 4.1.16, Mack Trucks Inc. Camera Guided Bus, Page 21

3.13 Fully Automated Control at Certain Facilities

This service would enhance efficiency and productivity by providing automated movement of vehicles in dedicated facilities. Initial applications may include automated bus movement in maintenance areas and automated container movement within a terminal area. The transit bus application could be a preliminary use of automation in a low-speed, controlled environment. The automated container movement application would consist of using vehicle automation technologies to move containers within rail-, truck-, or ship-yards or other centralized facilities.

Section 5.2.5, Laser-Based Tracking Device, Page 36

Section 5.2.6, Magnetic Lateral Guidance, Page 36

3.14 Vision Enhancement

It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would use infrared radiation from pedestrians and roadside features to provide the driver with an enhanced view of the road-ahead. Later versions of these systems may include additional information from improvements in the highway infrastructure, such as infrared reflective lane edge markings.

Section 4.7.2, Mazda Nighttime Object Detection and Warning System, Page 25

Section 4.7.5, Mazda Automatic Collision Detection and Prevention System, Page 26

Section 4.16.2, Delco Electronics Europe, Page 30

3.15 Navigation/Routing

This feature would provide location and route guidance input to the driver and would support the various collision avoidance capabilities with road geometry and location data. It would also provide the necessary capability to filter traffic information to select those messages that are applicable to the vehicle location and route of travel. It would also offer the capability to recommend optimal routing based on driver preferences. More advanced versions of this service may integrate real-time traffic conditions into the calculations of optimal routes. For paratransit applications would assist passenger demand and record keeping.

Section 4.4.1, Daimler Benz Automated Personalization for Driver Assistance, Page 23

Section 4.15.3, Volvo Dynamic Navigation, Page 29

Section 4.18, Navigation Technologies, Page 30

Section 4.20, NOKIA Mobile Phones, Page 31

Section 4.21, MANNESMANN AG, Page 31

Section 5.5.8, Swiss Federal Highways Office, Page 45

Section 5.5.2, Dutch Transport Ministry, Page 41

Section 5.5.5, Italian Ministry Of Public Works, Page 41

Section 4.23.1, GT ‘Orchid’ Service, Page 32

Section 4.23.2, Radio Data System Traffic Message Channel, Page 32

Section 5.5.1, Finnish National Road Administration (FINNRA), Page 41

3.16 Real Time Traffic and Traveler Information

These IVI systems would have capabilities to access in-vehicle databases and receive travel-related information from the infrastructure (roadside or wide-area transmissions). Information categories would include items, such as vehicle location and route guidance instructions, motorist and traveler services information, safety and advisory information, and other real-time updates on conditions, such as congestion, work zones, environmental, and road surface conditions. This feature would provide an integrated approach to the presentation of information to the driver for safety warnings and other advisories related to the driving task. More advanced system capabilities would include the ability to react to dynamic information on environmental and road condition thereby augmenting information contained in the static map databases.

Section 5.4.1, Atlanta Driver Advisory System (ADAS), Page 37

Section 5.4.2, Driver Information Radio Experimenting with Communication Technology (DIRECT), Page 37

Section 5.4.3, GENESIS, Page 37

Section 5.4.4, Seattle Wide-Area Information for Travelers (SWIFT), Page 38

3.17 Location-Specific Alert and Warning

This feature would provide intelligent in-vehicle warning information by integrating vehicle speed and pertinent vehicle dynamics information with knowledge of road geometry (from a map database or beacon input). Later versions would include information about environmental and road surface conditions to provide the driver with warnings, such as excessive speed for curves or alerts on upcoming traffic signs and signalized intersections. This feature may include the ability, at unusually complex and hazardous highway locations, to provide in-vehicle warnings which replicate one or more types of roadside signs. These capabilities would be integrated with other in-vehicle navigation and route guidance features with collision avoidance warning.

Section 4.1.3, Mack Trucks Inc. Vehicle Dynamic Control, Page 19

Section 4.16.2, Delco Electronics Europe, Page 30

Section 4.13, BMW, Page 29

Section 4.23.1, GT ‘Orchid’ Service, Page 32

Section 4.23.2, Radio Data System Traffic Message Channel, Page 32

Section 5.5.1, Finnish National Road Administration (FINNRA), Page 41

Section 5.5.2, Dutch Transport Ministry, Page 41

Section 5.5.8, Swiss Federal Highways Office, Page 45

Section 5.5.5, Italian Ministry Of Public Works, Page 41

3.18 Vehicle Diagnostics

The vehicle diagnostic information service would be an extension of current vehicle monitoring and self-diagnostic capabilities, such as oil pressure and coolant temperature gauges. This service would monitor vehicle safety-related functions. Examples of conditions monitored include braking system integrity, tire pressure, sensor and actuator performance, and the communication system. This information is intended to be useful to the driver, as well as to assist and support fleet maintenance and management functions.

Section 4.1.6, Mack Trucks Inc. Intelligent Vehicle Control, Page 20

Section 4.1.7, Mack Trucks Inc. Data Management System, Page 20

Section 4.16.2, Delco Electronics Europe, Page 30

3.19 Cargo Identification

This service would focus on heavy vehicle operations, especially material transportation. This feature would identify and monitor key safety parameters of the cargo, such as temperature, and pressure. The driver would be warned if any unsafe conditions existed.

Section 4.1.7, Mack Trucks Inc. Data Management System, Page 20

Section 5.2.9, National Institute for Environmental Renewal (NIER), Page 36

3.20 Transit Passenger Monitoring

This service would assist the driver in detecting any passenger activities that may affect the safety or security of the vehicle's operation.

3.21 Transit Passenger Information

This service would provide transit passengers with real-time transit network information during travel. The emphasis within the IVI program would be to reduce the non-driving task workload of the driver by providing alternative means for passengers to access location and transit service information.

Section 4.10.5, Toyota Navigation System, Page 28

Section 4.12.2, Suzuki Navigation System, Page 28

Section 4.15.3, Volvo Dynamic Navigation, Page 29

Section 4.19.1, Tele Atlas StreetNet, Page 31

Section 4.19.2, Tele Atlas RoadNet, Page 31

Section 4.20, NOKIA Mobile Phones, Page 31

Section 5.4.10, Transcal, Page 39

3.22 Automated Transactions

This feature would implement capabilities for electronic transactions, as electronic toll collection, parking fee payment, transit fare payment and additional commercial vehicle-related functions, such as credentials and permit verification, using such technology as transponders and "smart cards."

Section 4.16.2, Delco Electronics Europe, Page 30

Section 5.3.1, Dedicated Short Range Communications (DSRC), Page 37

3.23 Driver Convenience Communications

This service is included in the IVI program to ensure that the increasing number of comfort and convenience features in vehicles, such as cellular telephones and fax machines, do not distract the driver or increase the complexity of the driving task. This service would integrate these features into the driver vehicle interface to permit prioritization of information sources and reduce distractions. Real-time dispatching for fleet operations is included in this category.

Section 4.15.1, Volvo Dynafleet Info System, Page 29

Section 4.15.2, Volvo Dynafleet Message, Page 29

3.24 Automatic Collision Notification

It is expected that the first implementation of this service would be through in-vehicle systems which are augmented by communication links to Public Safety Answering Points (PSAP). These systems would monitor position of the vehicle and severity of the crash. The information would be transmitted automatically to the appropriate PSAP for the location of the crash and may be used to predict the type and severity of crash. These systems may also be combined with manual systems for requesting roadside assistance.

Section 4.1.6, Mack Trucks Inc. Intelligent Vehicle Control, Page 20

Section 4.10.4, Toyota Collision Detection System, Page 28

Section 4.13, BMW, Page 29

Section 4.15.1, Volvo Dynafleet Info System, Page 29

Section 4.15.2, Volvo Dynafleet Message, Page 29

Section 4.16.2, Delco Electronics Europe, Page 30

Section 4.21, MANNESMANN AG, Page 31

Section 4.23.1, GT 'Orchid' Service, Page 32

Section 4.23.2, Radio Data System Traffic Message Channel, Page 32

Section 5.5.2, Dutch Transport Ministry, Page 41

Section 5.5.5, Italian Ministry Of Public Works, Page 41

Section 5.5.8, Swiss Federal Highways Office, Page 45

3.25 Smart Restraints

This feature would provide advance warning of impending (forward or side) crashes and would pre-deploy the appropriate occupant protection systems in a vehicle prior to the impact to obtain maximum protection for the vehicle occupants. If reliable under all potential impact situations, this might permit slower deployment speeds for the air bags, allow pre-tensioned or load limited belt systems or smart head protection systems and ultimately more protection for the vehicle occupants.

Section 4.1.8, Mack Trucks Inc. Suspension Seat Safety System, Page 20

3.26 Safety Event Recorder

This feature would record selected driver and vehicle parameters to support the reconstruction of conditions leading to a critical safety event. Data from this recorder could provide input to the crash notification subsystem for transmission of collision data to the emergency service provider.

4. Product Developments

The technology products found in this section are those already in the product development pipeline that could reasonably be expected to be available in the next three to five years. These products are those that the OEMs, or third party manufacturers, have already identified as meeting a market need and could reasonably be expected to transition to full vehicle integration. These technologies may be stand alone features or layered products which incrementally build on base capabilities.

Sections 4.1 through 4.4 contain information from materials and discussions with Mack Trucks, Inc., PACCAR, Freightliner, and Daimler Benz.

Sections 4.5 through 4.13 contain information from passenger car manufacturers participating in the Japanese Advanced Safety Vehicle program.

Sections 4.14 through 4.23 contain information from European manufacturers, suppliers of third party system components, and other efforts.

4.1 Mack Trucks Inc.

The Mack Trucks Inc. technology product development pipeline provides the process through which products are developed for eventual market debut. The time and effort expended is in part a function of the value and difficulty involved in the actual product but, is generally a three year cycle. The products described below represent a mix of products which may by offered to the commercial market place.

The information contained in the following sections was presented by Mack Trucks Inc. during a meeting held at the MACK Technical Center in Allentown Pa. on September 9, 1997.

4.1.1 Mack Trucks Inc. Vigilance System

The Vigilance System uses infrared (IR) sensing technology to monitor the operator's eye blinks in order to detect a drowsy driver. Having detected a drowsy driver, the system would then warn the driver to stop and rest.

4.1.2 Mack Trucks Inc. Electronic Braking System

Electronic Braking System (EBS) offers improved brake system response over the traditional heavy vehicle brake systems. Additionally, the EBS through its interface to on-board electronic controls, enables advanced heavy vehicle handling and traction options.

4.1.3 Mack Trucks Inc. Vehicle Dynamic Control

The Vehicle Dynamic Control detects vehicle yaw and individual wheel slip and automatically controls braking pressure and engine throttle to re-stabilize vehicle

4.1.4 Mack Trucks Inc. Collision Warning

The Collision Warning system is envisioned to include the VORAD Collision Warning system specially configured to detect imminent collision conditions. The warnings may be generated for collision conditions at the vehicle side or front. The side mounted blind spot sensor may be the initial offering.

4.1.5 Mack Trucks Inc. Active Cruise Control

Active Cruise Control is an enhanced Collision Warning system that is coupled through the vehicle on-board electronic control system and adjusts vehicle speed to maintain safe distances from other vehicles and obstacles. The concept is for the Collision Warning system to detect the range to vehicles in front of the heavy vehicle and communicate that range to the vehicle on-board electronic control. The range or vehicle spacing is then compared to the desired safe highway spacing interval based on the leading and trailing vehicle speeds. The trailing vehicle's speed is then automatically reduced or increased to maintain safe spacing. This system is especially helpful to convoy vehicles.

4.1.6 Mack Trucks Inc. Intelligent Vehicle Control

The Intelligent Vehicle Control couples a cellular communications system with the vehicle on-board electronics control and the Global Positioning System (GPS). These systems operate together to allow remote access to the on-board vehicle status through the cellular link. Additionally, the vehicle position is also available through the GPS.

4.1.7 Mack Trucks Inc. Data Management System

The Data Management System incorporates on-board processing capabilities for fleet management, service scheduling, fuel tax computation and optionally an electronic driver's log. The system may be offered with a high capacity Dedicated Short Range Communications (DSRC) transponder for radio frequency (RF) linked information transfer.

4.1.8 Mack Trucks Inc. Suspension Seat Safety System

The Suspension Seat Safety System couples with a specially designed driver seat that incorporates a pneumatic charged shock absorbing device. The pneumatic shock absorbing seat is incorporated to reduce the vibrations normally felt by the driver. In the case of an accident, and especially a rollover, the seat retracts and positions the driver in the lowest and most safe position. Activation is triggered by the air bag sensor and is timed to work in concert with the air bag.

4.1.9 Mack Trucks Inc. Tractor Trailer Communications

The Tractor Trailer Communications system incorporates the necessary electronic control mechanisms for enhanced control of trailer systems. With these communications mechanisms in place, the vehicle Electronic Braking or Vehicle Dynamic Control systems could control trailer braking systems in order to enhance total vehicle braking performance. Other information is now easily available in the cab, such as reefer temperature, rear of trailer video signal, trailer brake temperature, or any other sensor information. Since the data is multiplexed, many signals can be communicated on the same line.

4.1.10 Mack Trucks Inc. Noise Cancellation

Noise Cancellation uses active noise cancellation techniques to reduce noise levels. This can be achieved with in cab abatement through the radio speakers or with abatement at the muffler with the addition of a sound condition device located in the exhaust.

4.1.11 Mack Trucks Inc. Advanced Headlamp

The Advanced Headlamp is the inclusion of high intensity headlamps in the commercial heavy vehicle. Many commercial vehicle operators choose to operate at night to avoid traffic. It is common for the ratio of daytime to nighttime operation for commercial vehicles to be the inverse of passenger vehicles.

4.1.12 Mack Trucks Inc. Electronic Turn Signal

Traditional heavy vehicle turn signal actuators are mechanical switching devices that are subject to frequent failure and do not have automatic canceling after a turn. The Electronic Turn Signal is an entirely electronic signaling device that offers enhanced reliability, automatic canceling or alert and also reduced maintenance.

4.1.13 Mack Trucks Inc. Improved Engine Brake

The Improved Engine Brake incorporates advanced engine timing controls to enhance vehicle stopping and improve control on down grades. This is accomplished by increasing the engines normal compression braking to increase the resistance to turning of the vehicle's drive wheels.

4.1.14 Mack Trucks Inc. Weigh-in-Motion

This application of Weigh-in-Motion, which differs from the classical use of the term computes the gross vehicle weight from engine load measurements. The concept recognizes that, the engine power required to accelerate the vehicle is a function of vehicle gross weight. The on-board electronic control system monitors the engine parameters necessary to determine engine load and consequentially gross vehicle weight. The electronic control system will make the computed gross vehicle weight available to the on-board DSRC (Section 4.1.7) and subsequently to roadside readers for possible weigh station bypass clearance.

4.1.15 Mack Trucks Inc. Independent Front Suspension

This concept replaces the traditional straight beam front axle with independent front suspension for a more stable and comfortable ride.

4.1.16 Mack Trucks Inc. Camera Guided Bus

The Camera Guided Bus is a special European development that may be offered for sale in the U.S. The system includes a camera and an electronic processor that senses the location of the curb while approaching bus stops. The system will then automatically steer the bus to a stop at the curb allowing a precise bus curb spacing for ease of passenger access.

4.2 PACCAR

PACCAR contributions to the On-Board Technology Survey are in the form of verbal comments regarding technology utilization on-board heavy vehicles. These contributions resulted from a meeting held at the PACCAR Technical Center on October 30, 1997 and a telephone conversation on December 9, 1997. The following are PACCAR comment summaries:

- The IVI Candidate Services are leading both the market place and the state-of-the-art in heavy vehicle technology designs.
- Candidate Services requiring the use of in-cab displays are better implemented by heavy vehicle OEMs. This is especially true in cab configurations containing displays that could be integrated and shared by multiple systems. Systems integration would mitigate both performance and cost issues.
- Technology building blocks such as anti-lock brakes, electronic brakes, on-board computers as well as on-board communications systems are available or are being developed and could be utilized in individual services.
- The algorithms controlling full capability IVI Services, where actual control of the heavy vehicle during emergency situations would be automated, may require direct FHWA technology investment.
- Services that enhance the heavy vehicle operator's knowledge of the road ahead e.g. surface condition, geometry, vehicles (same lane and opposing lanes), obstacles, intersections and railroad crossings would be of immediate benefit.
- Given the width of heavy vehicles and that of roadway lanes, and vehicle velocities could road/lane departure collision avoidance systems react fast enough to safely guide the operator through a corrective maneuver?
- Services requiring the use of infrastructure features such as lane markings or intersection crossing traffic detection systems may not be commercially viable until upgrades are substantially completed.

4.3 Freightliner Corporation

In-sights into Freightliner Corporation heavy vehicle on-board technology developments were gained during discussions, held on October 29, 1997, with representatives from Freightliner, the Daimler Benz Vehicle Systems Technology Center and the Johns Hopkins University Applied Physics Laboratory. The technology developments discussed, in part, included: advanced active vehicle control systems for enhanced stability; route planning; vehicle communications; infrastructure monitoring for hazard warning, road condition warning and lane departure. The breadth of corporate technology developments spanned passenger vehicles and heavy vehicles.

Detailed research and product development information were not available for inclusion in this report.

4.4 Daimler Benz

The following material came from http://www.daimler-benz.com.

4.4.1 Daimler Benz Automated Personalization for Driver Assistance

The intelligent travel assistant helps drivers find desirable routes, predict transit times, and select restaurants, hotels, and similar points of interest. The resulting system will include software agents that personalize themselves to individual drivers.

4.4.2 Daimler Benz Acquisition of Annotated High-precision Maps

Using high-resolution GPS traces, Daimler Benz is working to frequently update digital maps and to refine and annotate these maps with information about transit time, traffic load, and temporary obstructions. The resulting maps can provide information for the intelligent travel assistant and also improve driving safety.

4.4.3 Daimler Benz Adaptive Distributed Guidance and Control

Daimler Benz is exploring techniques that consolidate information about vehicle locations and speeds, again using GPS data, for presentation to drivers. This information should also prove useful in learning distributed strategies to guide and route drivers, with the aim of improving overall traffic flow.

4.5 Mitsubishi

Except where noted otherwise, the following material came from the Japanese Advanced Safety Vehicle brochure.

4.5.1 Mitsubishi Drowsy Driver Warning System

The system detects a drowsy or non-attentive driver by monitoring steering input and vehicle behavior. A warning is applied by means of seat vibration or other external stimuli.

4.5.2 Mitsubishi Trailing Vehicle Detection System

System detects a vehicle catching up from behind by rear stereo cameras and warns not only the lead vehicle driver but also the rear vehicle driver by rearward projected message board.

4.5.3 Mitsubishi Vehicle Distance Warning System

System detects and displays the headway distance between a following vehicle and the preceding vehicle through the use of a laser radar. System warns driver of the hazardous condition judged from the headway distance and the relative speed between the two vehicles by audible alarm and shift down control.

4.5.4 Mitsubishi Lane Deviation Warning System

System detects lane demarcations by video camera and warns driver by audible signal of lane departure.

4.5.5 Mitsubishi Position Regulated Speed Control System

This system detects a preceding vehicle by scanning laser radar and video camera, and regulates throttle and shift schedule so as not to follow too closely in the case of activating cruise control.

4.5.6 Mitsubishi Automatic Collision Detection and Prevention System

System detects potentially hazardous conditions by two scanning laser radar, several video cameras detecting road and other vehicles, and passive beam sensors in six directions and warns the driver. If the driver fails to take appropriate maneuvers, the system activates steering and braking control to avoid collision.

4.5.7 Mitsubishi Cornering Deceleration Regulation System

The system receives the radius of approaching corners and curves from infrared roadside beacons and warns drivers of the over speed. If ignored, the system automatically reduces vehicle speed.

4.5.8 Mitsubishi Scan Laser Radar

The laser radar was developed by Mitsubishi to provide not only distance to an object but the ability to detect movement of the preceding vehicle and the existence of nearby obstacles. The radar uses in vehicle distance warning system or intelligent cruise control. (Development of a Scan Laser Radar, 1997 SAE)

4.5.9 Mitsubishi Navigation System

The system detects vehicle position correctly by GPS, self-reliant navigation (geomagnetic sensor, vehicle speed sensor and oscillating cantilever gyroscope), and map-matching method. The photo shows zoomed-up crossing configuration in route guidance mode. Voice direction is also implemented.

4.6 Nissan

Except where noted otherwise, the following material came from the Japanese Advanced Safety Vehicle brochure.

4.6.1 Nissan Drowsy Driver Warning System

This system detects a driver's drowsiness and provides a warning to eliminate the possibility of driving while drowsy. A camera in the instrument panel monitors the driver's facial expression and recognizes at an early stage that the driver is becoming drowsy. When drowsiness is detected, it triggers a warning sound. The system also detects the driver taking his/her eyes off the road and triggers a warning sound. The system attempts to relieve the driver's drowsiness by releasing a menthol scent and cold air from the air conditioning. If the driver's condition does not improve, this system works to stop the vehicle automatically with flashing hazard lights.

4.6.2 Nissan Vehicle Lane Change Hazard Avoidance System

Cameras at the bottom of right and left door mirrors scan following vehicles, and radar at the lower part of right and left rear fenders detects the distance to a vehicle aside. The system warns when the driver activates the turn signal and there is a possibility of collision.

4.6.3 Nissan Vehicle Distance Warning System

A camera located above the rear view mirror scans lanes and vehicles ahead and a radar calculates the relative velocity and distance to the object and/or vehicle ahead.

4.6.4 Nissan Automatic Braking System

The braking system engages the brake automatically when the driver's braking is late in response to obstacles ahead of the vehicle. The system stops the vehicle automatically by controlling the brake unit when it detects that the driver has not taken evasive action and a collision becomes unavoidable.

4.6.5 Nissan Collision Detection System

If the collision sensor detects an accident, the vehicle position, ID data of the vehicle and the driver are automatically sent to the operation center through wireless communications such as cellular phone.

4.6.6 Nissan Birdview Navigation System

This system establishes a focal point high above the vehicle, constantly showing the area in the direction being traveled. This provides a detailed view of the vicinity of the vehicle's current location along with a field of view that extends all the way to the horizon. This means that the bird's eye view navigation system provides an image of the vehicles current location, and recommends routes to the destination, without the need to switch the scale of the view. (Nissan ITS World Congress '96 brochure).

4.7 Mazda

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.7.1 Mazda Drowsy Driver Warning System

The system recognizes the white line on the road with the CCD camera and calculates the deviation of the vehicle. When the system recognizes the driver's drowsiness from the transition of the deviation, the system warns the driver.

4.7.2 Mazda Nighttime Object Detection and Warning System

The system detects pedestrians in front and on-coming vehicles approaching in a diagonal direction with a scanning laser radar and ultrasonic sensors. A heads-up display provides driver warnings.

4.7.3 Mazda Vehicle Distance Warning System

The system detects vehicles ahead with a scanning laser radar. A preceding vehicle with the potential danger for a collision is specified by on-going path estimate calculated by the yaw rate and the vehicle speed. The system provides driver warnings and, if required, automatically controls the brakes.

4.7.4 Mazda Lane Deviation Warning System

The system recognizes the white line on the road with the CCD camera and gives a warning alarm when the vehicle starts to depart from its lane without the driver-operated turn signal. If the driver does not return to the lane, the system automatically steers the vehicle to stay in its lane.

4.7.5 Mazda Automatic Collision Detection and Prevention System

Detects vehicles and pedestrians ahead with scanning laser radar and provides driver warnings or automatically operates the brakes as required.

4.7.6 Mazda Cornering Deceleration Regulation System

When a vehicle is approaching a corner, this system estimates a safe speed in order to negotiate the turn and the distance to the starting point of the curve based on information from the road marker. If the vehicle speed sensor detects a speed greater than the estimated safe speed then the system provides driver warnings or automatically operates the brakes as required.

4.7.7 Mazda Collision Notification System

When vehicle collision occurs, information of accident location and accident vehicles is transmitted to the operations center. The occurrence of an accident is determined by accelerometers and the position by GPS.

4.8 Honda

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.8.1 Honda Drowsy Driver Warning System

This system does not use special sensors but employs a navigation technology. The yaw-rate sensor installed in a navigation system, detects vehicle's erratic movement when the driver's level of consciousness falls, and sends an aural warning to the driver.

4.8.2 Honda Vehicle Distance Warning System

The system senses distance of a vehicle ahead and the velocity of that relative to its own vehicle by radar sensor. The radar sensor is a fan-beam scanning laser radar. When a possible collision is detected, the system aurally warns the driver.

4.8.3 Honda Position Regulated Speed Control

The system was developed by Honda as an advanced cruise control system. The system keeps the headway distance properly with automatic control of throttle and brake.

4.8.4 Honda Automatic Collision Detection and Prevention System

The system detects potentially hazardous traffic conditions ahead and aurally warns the driver to take preventive action to avoid collision. If a collision is likely to occur, the system automatically actuates the brakes.

4.8.5 Honda Collision Detection System

An on-board, non-directional impact sensor detects the occurrence of a collision. Accurate accident information such as geographic location, road category, etc. are provided.

4.8.6 Honda Navigation System

Traffic information is shown on a navigation system display and such urgent information as traffic jams, accidents, etc. in the traffic ahead are projected through a heads-up display to prevent a possible occurrence of accidents. Drivers are also given the best alternative route to take, the configuration of an intersection ahead, and the remaining distance to the intersection, all of which are also shown on the head-up display by processing the traffic information ahead.

4.9 Isuzu

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.9.1 Isuzu Drowsy Driver Warning System

The warning system was designed to detect a drowsy or non-attentive driver by monitoring steering maneuver and vehicle position. It estimates the driver's level of drowsiness by means of revise-steering signal which is processed by use of the steering signal or yaw-rate signal. If the system judges driver's drowsiness, it provides alarms to the driver by means of seat-vibration or audible alarm in proportion to the degree of drowsiness.

4.9.2 Isuzu Position Regulated Speed Control System

The system can recognize the preceding vehicle on the same lane and control vehicle speed in order to maintain proper following distance. The system automatically operates the throttle, gearbox, and the brake according to driver conditions.

4.10 Toyota

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.10.1 Toyota Drowsy Driver Warning System

The purpose of the system is to prevent accidents caused by drowsy drivers. The system monitors steering motions through the use of an angle sensor and a pulse sensor. Through this monitoring, a drowsy or non-attentive driver will be detected and the system then warns the driver to rest by means of audiovisual warning and vibrating the driver's seat. If alertness decreases further, the system stops the vehicle automatically.

4.10.2 Toyota Vehicle Distance Warning System

The warning system was developed for ASV to support avoiding collisions. Uses a millimeter wave radar and CCD camera to detect other vehicles ahead. When the distance from the lead vehicle decreases below a certain value, the system provides an audiovisual warning.

4.10.3 Toyota Automatic Collision-Reduction Braking System

A radar and CCD camera is used to detect the presence of a preceding vehicle and to measure the distance between it and the trailing vehicle. When the distance between the vehicles decreases below a safe value, the system provides an audiovisual warning. If the system determines that a collision is imminent, it stops the vehicle automatically.

4.10.4 Toyota Collision Detection System

Upon activation of the collision detection sensor and activation of the emergency vehicle stop and accident report switches by the driver, the system automatically reports to the emergency center the current location, driver name, etc.

4.10.5 Toyota Navigation System

This system reduces driving stress by providing timely information about traffic and other conditions. It provides a screened map with information on the current location of the vehicle, a route guide, traffic conditions, accident locations, and parking availability with its route guide.

4.11 Diahatsu

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.11.1 Diahatsu Vehicle Detection and Distance Warning System

This system provides the proximity of the trailing vehicle with respect to the leading vehicle. It uses both a scanning laser radar and mono camera as the sensors.

4.12 Suzuki

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.12.1 Suzuki Vehicle Distance Warning System

This system warns the driver when the vehicle exceeds the safe distance to an object ahead.

4.12.2 Suzuki Navigation System

The Suzuki Navigation System offers route guidance, traffic condition and emergency information through a voice and visual display, using information from external infrastructure, namely signpost beacons and FM multiplex broadcast. Also indicates maintenance information or failure, if any, of the electronic control systems and how to cope with the situation through a voice and visual display.

4.13 Fuji Industries

The following material came from the Japanese Advanced Safety Vehicle brochure.

4.13.1 Fuji Lane Deviation Warning System

The warning system uses a three-dimensional image recognition system with two CCD cameras which can recognize lane markings and obstacles. It provides operator warnings when obstacles ahead are too close or when the vehicle deviation from the lane is excessive.

4.13.2 Fuji Heavy Industries Navigation Systems

This system arranges complicated and various information, for example vehicle status, traffic jam, or navigation, and displays optimized information to driver on LCD.

4.14 BMW

BMW's ITS activities include introduction of the BMW navigation system in the US market; final phase of the EU research project 'Munich Comfort'; field test of the road-side warning system 'COMPANION'; research and development of driver assistance systems; participation and organization of the research project 'MOTIV'; project research 'Bayern online'; 'Infoten'; and 'TABASCO'. (http://www.ertico.com/ch6/ch6-1-11.htm)

4.15 Volvo

The following material came from http://www.volvo.se/technical/index.html.

4.15.1 Volvo Dynafleet Info System

Dynafleet Info System is a PC-based transport management system developed by Volvo, which uses the mobile phone network or a satellite network to transmit data (e.g. text messages, vehicle and driver information) to and from vehicles.

4.15.2 Volvo Dynafleet Message

This Volvo system is a PC-based transport management system. It uses the mobile telephone network to transmit text messages to and from different types of vehicles.

4.15.3 Volvo Dynamic Navigation

RTI is the first system on the European market featuring both route guidance and traffic information. RTI is integrated in the dashboard to guarantee maximum user-friendliness, safety and design. The system can also be bought as an accessory.

4.15.4 Volvo DYNACRUISE

For comfort and safety on the road, Dynacruise is a further development of the present-day cruise control. Dynacruise assists the driver in adapting the vehicle's performance to the prevailing traffic flow which in turn results in a higher level of safety on the road, reduced fuel consumption and lower emission levels. The system has been developed for several companies, including Volvo Bus Corporation.

4.15.5 Volvo PROMISE

The objective of PROMISE is to provide travelers with easy access to multimodal travel and information services during their journey.

4.16 Delco Electronics Corporation

4.16.1 Delco Collision Avoidance

Delco is developing advanced collision warning system technology to improve driver safety using emerging low-cost, millimeter-wave and microwave object detection sensors. The integrated collision warning system incorporates four basic steps: road object sensing, collection of vehicle data, data processing and threat assessment, and driver warning execution. These systems employ front and rear sensors together with vehicle data and a collision avoidance processor to make split-second, intelligent assessment of collision threats. Appropriate driver warnings are made by audio, visual, and tactile means. (http://www.delco.com/art/dc210_04.gif)

4.16.2 Delco Electronics Europe

Demonstration of SSC (Safety, Security, Communications) concept vehicle at auto shows; customer events; and technical symposiums all over Europe; integrating sophisticated technologies from all three areas and featuring systems such as adaptive cruise control; collision warning; night vision; reconfigurable head-up display; mayday emergency communication; navigation; and vehicle-to roadside communications. (http://www.ertico.com/ch6/ch6-1-37.htm)

4.17 Eaton VORAD Collision Warning System

The warning system uses high frequency Doppler radar as side sensors for blind spot vehicle detection. It alerts drivers to potential hazards such as slow moving vehicles ahead and vehicles alongside hidden from view. (http://www.eaton.com)

4.18 Navigation Technologies

European expansion of supplies of high quality digital map databases for additional customers developing products in the automotive navigation, fleet and traffic management, travel and geographic information sectors. Growth of regional offices to 27 ensures optimal coverage and real-time updating of the data base on a pan-European scale. Use of databases in numerous route-guidance field tests, and EU-supported consortia, such as PROMISE, GI-base, and other 4^{th} Framework Programs; support to ERTICO Board, and Location Referencing/GDF and GSM. (http://www.ertico.com/ch6/ch6-1-44.htm)

4.19 Tele Atlas

The following material came from http://www.teleatlas.com/.

4.19.1 Tele Atlas StreetNet

StreetNet is a highly accurate geographic street database at 1:10.000 scale. It is the reference map for GIS (Geographic Information Systems) and FMS (Fleet Management Systems) applications.

4.19.2 Tele Atlas RoadNet

The Tele Atlas RoadNet is an accurate digital roadmap for applications which require a regional or national overview. It is available for applications in GIS and transport, and interfaces seamlessly with StreetNet.

4.19.3 Tele Atlas PointNet

The Tele Atlas PointNet is a digital map that offers point files with the center co-ordinates and a limited set of information on all streets.

4.20 NOKIA Mobile Phones

Nokia established a new corporate unit to develop and manufacture future products for the automotive industry to cover solutions for navigation, security, telemetrics and other areas of ITS; co-ordination of PROMISE project in the Telematics Program of the EC DGXIII which aims to develop and demonstrate a multi-modal travel and traffic information service for travelers and drivers using mobile portable and in-vehicle GSM terminals; representation in the standardization group of CEN TC 278 WG4 “Traffic and Traveler Information”. (http://www.nokia.fi)

4.21 MANNESMANN AG

Mannesmann Autokom, part of the co-ordinating holding company Mannesmann Eurokom, has developed a traffic telematics system based on GPS and GSM, that will include ITS services, efficient route planning, security and emergency services. Other activities are bi-modal freight management, in-car information systems and fleet management and safety information. (www.mannesmann.de)

4.22 COMBITECH TRAFFIC SYSTEMS AB

COMBITECH implemented an ETC system in Buenos Aires, Argentina, for motorway company AUSOL; participation in several EU 4^{th} Frame Work projects (e.g. VASCO and ADEPT 2); interoperability efforts in CEN and together with Bosch Telecom and CGA Cegelec demonstrating interoperability according to GSS (Global Specification for Short-range Communications); introduction of GTS (Global Tolling System) at the 1996 ITS World Congress in Orlando, Florida; the Store Bealt Bridge order for the automatic toll collection system. (www.combitech.se)

4.23 The Automobile Association (AA) UK

The following material came from phone conversations and email with Steve Hoffman at steve.hoffman@theaa.com.

4.23.1 GT 'Orchid' Service

Global Telematics, a joint venture of Racal Survey and European Telecom, launched its 'Orchid' service in the UK on November 20, 1997. Orchid combines GSM (digital mobile telephony) with differential GPS (DGPS) technology in a special on-board telematics unit that is used for these services: bureau service providing monitoring and information; vehicle tracking; navigational assistance, route planning and real-time traffic updates; roadside assistance and emergency callout; local service information (hotels, restaurants, gas stations etc) and fleet management packages with mapping and reporting facilities.

4.23.2 Radio Data System Traffic Message Channel (RDS-TMC)

RDS-TMC uses the silent RDS digital data channel in the FM broadcast band to provide a constant feed of current traffic events to commercial and private drivers. The service uses a standard European traffic message format to describe the nature and location of traffic problems. Receivers can be audio-only, screen-display or full route guidance systems and can automatically translate the problems into different languages. The route guidance receivers offer the customer the option of requesting a re-route around the problem.

5. Ongoing Research and Development Projects

This section of the report lists relevant research projects in the public and private sectors. Projects appear once under a heading according to whether they primarily focus on the driver, the vehicle, automated transactions, or traveler advisory.

5.1 Driver Monitors

5.1.1 Direct Psychophysiological Monitoring of Driver Alertness

This Small Business Innovative Research (SBIR) project will develop a low cost device for direct monitoring of eye activity as an indicator of driver alertness. The envisioned device, Personal Alertness Monitor (PAM), will be able to function as a stand alone alertness monitor. PAM will also have the capability to work cooperatively with driver performance monitoring systems as component of a more complex system that includes continuous measure of driver performance, and with an integrated protocol for the presentation of warning signals. Completion date is June 1997. (ITS Project Book, page 209).

5.1.2 Prototype Heavy Vehicle Drowsy Driver Monitor Detection System

This project will develop, test, and evaluate a prototype in-vehicle continuous driver alertness monitoring/drowsiness detection system for heavy trucks. System drowsiness detection algorithms and warning signals will be derived primarily from the findings of the Driver Status/Performance Monitoring program. Completion date July 1997. (ITS Project Book, page 218).

5.1.2.1 MTI Research

MTI is developing a device to detect eyelid closure using opto-electronic techniques and miniaturized emitters and sensors. It uses the duration of eye blinks to determine drowsiness via a device mounted on eye glasses or a headset. Current efforts concentrate on validation of the device's capability. (Current NHTSA Drowsy Driver R&D, 1996).

5.1.2.2 Carnegie Mellon Research Prototype Drowsy Driver Detection System

CMR plans to develop and integrate prototype drowsy driver detection system. The instrumented vehicle will contain steering wheel sensor, lateral accelerometer, lane position sensor, video detection of eye movements, MTI eye blink monitor and head position sensor. Project will be completed in 1998. (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance).

5.1.3 Driver Status/Performance Monitoring

Driver Status/Performance Monitoring is a cooperative agreement leading to the development of detection algorithms and alerting mechanisms for a vehicle-based drowsy driver detection/warning system, countermeasures that will monitor driver status/performance and detect degraded performance to provide a warning signal or other countermeasure to prevent its continuance. Completion date December 1996. (ITS Project Book, page 231)

5.1.4 Walter Reed, Actigraphs

The actigraph records arm movement as a means to measure drowsiness. A wrist monitor (Actigraph Watch) is used to measure and record arm movements. The data is used to predict performance relative to developed models. (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance).

5.1.5 Continuous Fitness for Duty Monitor

A system called Smart Truck from Evaluation Systems, Inc., which is currently under study, uses lane tracking as monitored by a camera scanner. The camera recognizes the contrast differences of lane markings and the roadway and uses lane tracking to measure driver performance. When the system is fully implemented it will integrate a continuous driving monitor with a pre-drive test. (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance)

5.1.6 PERCLOS

The University of Pennsylvania has conducted laboratory experiments to evaluate the validity, sensitivity, and reliability of selected personal (psychophysiological) fatigue detection devices and measures, including eye closure measures such as PERCLOS, a measure of eyelid droop identified by earlier NHTSA research as a promising index of fatigue. Preliminary results corroborate the validity of PERCLOS and related eyelid droop measures; these findings will be announced in early 1998. Follow-up field testing of promising devices and measures is planned. (http://mcregis.fhwa.dot.gov/fatigue.htm#r&tcomplete)

5.1.7 EYE-COM (Stay Awake Eye Com Biosensor and Communicator)

The Washoe Sleep Disorders Center has developed an eyelid movement detecting device and alarm system that has been designed for the silent detection and alarm response to different states of alertness or drowsiness and impending sleep. (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance)

5.1.8 Capacitive Proximity Sensor

The Capacitive Proximity Sensor is being developed by Advanced Safety Concepts to detect the position of the head out to 12-18 inches away from the sensor. It is a roof mounted device which employs sine waves to triangulate the head position (changes in head position create a voltage change). (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance)

5.1.9 Ultra-slow Electrophysiological Signals

Pulse Technologies has developed an approach to extract ultra slow waves from physiological signals. The device includes an EKG machine to provide signals and breathing patterns. This research is in the early stages. (Technical Conference on Enhancing Commercial Motor Vehicle Driver Vigilance)

5.1.10 PROCHIP Program

The PROCHIP Program is a European effort to develop a system to identify driver faults through characterizing abnormal driving. The project was completed in 1995. The primary device applied was an obstacle detection sensor. Three different types of detection were explored, LIDAR-IR, microwave, and smart-retina. Final demonstration equipment (using LIDAR-IR) is planned for vehicle integration 1997/98. (Traffic Technology International, Drowsy Driver Detection)

5.1.11 SAVE Program

The SAVE Program is a European effort (1995-1998) to determine the driver's state in real-time, provide advisory information and take control of the vehicle, if required. SAVE is a multi-sensor approach which uses wheel angle, position of pedals, vehicle position on the road, speed, and acceleration in combination with eye motion sensors (video camera) to determine both driver and vehicle status. (Traffic Technology International, Drowsy Driver Detection)

5.1.12 ADS

ADS is an electronic system activated by a sensors located on the posterior portion of the steering wheel. When the hand grip is relaxed, warnings are provided to the driver which stop as soon as proper grip is regained. (ADS: Sleep Deterrent System, Technical Paper 970173, 1997 SAE)

5.1.13 SAFETRUCK Program

The SAFETRUCK Program is a research effort to design a steering system that works with the driver or it can take full control of the vehicle using high accuracy differential GPS system as a position reference. The system is intended to provide feedback to the driver via steering wheel inputs and a heads-up display. (Eighth Annual Transportation Research Conference)

5.1.14 Eye Tracking Using Imagery

University of Minnesota has developed an algorithm to locate eyes in an image in real-time using a feature-based approach. Using edge detection, the eye regions are identified and subsequently used to detect driver fatigue. (Eighth Annual Transportation Research Conference)

5.2 Vehicle Monitors

5.2.1 Frequency Modulated Continuous Wave (FMCW) Radar

A frequency modulated continuous wave radar system based on MMIC technology was developed to reduce the power and costs required over pulsed radar systems. Both the distance and velocity of the target can be detected simultaneously. (Automotive Radar Signal Source Using InP Based MMIC's, 1997 SAE)

5.2.2 ALIRT Blind Spot Detector

The ALIRT Blind Spot Detector is a new collision detection device based on thermal infrared sensor technology. Instead of using reflected energy (i.e. radar, ultrasonic) it senses the emitted thermal energy of a vehicle. (New Thermal Infrared Sensor Techniques for Vehicle Blind Spot Detection, Technical Paper 970176, 1997 SAE)

5.2.3 Millimeter Wave Radar Sensor

The Millimeter Wave Radar Sensor is being developed by Raytheon Electronic Systems to support intelligent cruise control and forward looking collision warning systems. Prototype sensors have been built and tested. (Collision Avoidance and Automotive Traffic Management Sensors, SPIE 1995)

5.2.4 Stereo-Based Vehicle Guidance

Stereo-Based Vehicle Guidance improves longitudinal control by detecting and measuring the distances to leading vehicles using binocular stereo. The detection and measurement of the lane markers provides positional references and road curvature estimates which are needed for lateral vehicle control. (Collision Avoidance and Automotive Traffic Management Sensors, SPIE 1995)

5.2.5 Laser-Based Tracking Device

Aerometrics is developing a laser-diode based device that provides a warning signal when a motor vehicle deviates from the center of the lane. The device is based on a sensor that scans the roadway on either side of the vehicle and determines the lateral position relative to the painted lines. (Collision Avoidance and Automotive Traffic Management Sensors, SPIE 1995)

5.2.6 Magnetic Lateral Guidance

Hughes and 3M have developed an approach using high sensitivity magneto-resistive sensors and magnetic marking tape to provide lateral position information. (Collision Avoidance and Automotive Traffic Management Sensors, SPIE 1995)

5.2.7 Autonomous Intelligent Cruise Control

This system developed by MATRA and RENAULT is based on a Laser Detection and Ranging (LIDAR) sensor. It provides the equipped vehicle with the distance and relative speed of other vehicles enabling the safe distance to be controlled by acting on the throttle and the automatic gear box. (Collision Avoidance and Automotive Traffic Management Sensors, SPIE 1995)

5.2.8 Vehicle Lateral Control System Using Laser Radar

Toyota has developed a laser radar based automatic steering control system which is based on the retroreflective road markers. The system consists of a laser radar sensor, steering actuator, steering controller, and data processing system. It measures not only range but the azimuth angle of the target. (Intelligent Vehicle Highway Systems SPIE 1994)

5.2.9 National Institute for Environmental Renewal (NIER)

This project is designed to demonstrate the feasibility of utilizing computerized emergency response information, including telecommunications technologies, to provide hazardous materials information to emergency response units. The objectives are to ; 1) identify the contents of shipments of hazardous materials transported by carriers and 2) link systems that identify, store and allow retrieval of data for emergency response to incidents and accidents involving transportation of hazardous materials by motor carriers either directly of through links with other systems. (ITS Project Book, Jan 1997, page 180)

5.3 Automated Transactions

5.3.1 Dedicated Short Range Communications (DSRC)

DSRC consists of a vehicle mounted transponder and roadside reader that together provide vehicle-to-roadside communications. Basic applications include electronic toll collection, electronic screening at commercial vehicle weigh and inspection sites, international border clearance, transmission of safety data, and fleet management. DSRC components are in use today in several production or test systems, including:

- HELP PrePass™ (http://www.cvo.com/)
- Oregon's Green Light Project (http://gopher.odot.state.or.us/motcarr/hweb/its/green/light.htm)
- Advantage I-75 (http://www.engr.uky.edu/KTC/a75tst.html)
- International Border Clearance Operational Tests

DSRC is also a key concept in the National ITS Architecture. DSRC may constitute a means of vehicle-to-infrastructure communications in support of the IVI. (Draft CVO DSRC Concept of Operations for ITS)

5.4 Traveler Advisory/Vehicle Navigation

5.4.1 Atlanta Driver Advisory System (ADAS)

The purpose of ADAS is to test and evaluate the benefits of traveler advisory and traveler services information that use FM subcarrier wide area communications systems and application of the 220MHz frequency pairs. The communication elements are planned to be integrated into Atlanta's advanced traffic management system. Completion date March 1997. (ITS Project Book, Jan 1997, page 64).

5.4.2 Driver Information Radio Experimenting with Communication Technology (DIRECT)

DIRECT is an operational field test which deployed and evaluated several alternative low-cost methods of communicating advisory information to motorists. The Michigan Intelligent Transportation Systems Center collected traffic information, fused the data and provided traffic advisory updates to travelers. Completion date December 1997. (ITS Programs and Projects, Michigan Dept. of Transportation).

5.4.3 GENESIS

GENESIS is an advanced traveler information system that uses personal communication devices to distribute timely information to travelers. Genesis is part of Minnesota's Guidestar program.

With transit and traffic data, Genesis is able to provide the urban traveler with current data relevant to a chosen trip mode and route. Completion date March 1997. (ITS Project Book, Jan 1997, page 67).

5.4.4 Seattle Wide-Area Information for Travelers (SWIFT)

This project will test the delivery of traveler information via three devices: the Seiko Receptor Message Watch, an in-vehicle FM subcarrier radio, and a portable personal computer. This project will also expand service formerly available under the Bellevue Smart traveler project. Completion date December 1997. (ITS Project Book, Jan 1997, page 70).

5.4.5 TRAVINFO

This project will implement a comprehensive, region-wide traveler information system capable of supplying transportation information to a broad array of devices and users. Travinfo includes the development and operation of a multi-modal transportation information center that will integrate transportation information from a wide variety of sources and make the information available to the general public, public agencies, and commercial vendors. Completion date is December 1998. (ITS Project Book, Jan 1997, page 71).

5.4.6 Atlanta Traveler Information Showcase

This project provides timely transportation information to travelers in the Atlanta metropolitan area through the use of Personal Communication devices, in-vehicle navigation devices, on-line computer information services, interactive television, and cable TV. Completed March 1997, operational in 1996. (ITS Project Book, page 73).

5.4.7 National Capital Region Traveler Information Project

This project will implement a regional traveler information system which will become the source for a broad range of information about transportation conditions in the region. Completion date is December 1999. (ITS Project Book, Jan 1997, page 74).

5.4.8 Evaluation of Radio and Microwave Technology for Motor Vehicle Safety Warning Systems

This cooperative agreement has three objectives: (1) To assist FHWA in evaluating the utility of a prototype motor vehicle safety warning system that utilizes police radar frequency transmissions to alert drivers of hazardous road conditions. (2) to characterize system technical requirements for an effective warning system, and to evaluate the performance of the prototype system. (3) To characterize user performance under a variety of roadway environments and driving stress levels. Completion date is December 1997. (ITS Project Book, page 93).

5.4.9 Herald En-route Driver Advisory System Via AM Subcarrier

The main concept of this project is to disseminate important traveler information in difficult-to-reach, remote rural areas using a subcarrier on an AM broadcast station. The three basic components of Herald—message generation, message transmission and message reception—have been developed under an effort by the multi-state organization called ENTERPRISE. Completion date is October 1997. (ITS Project Book, Jan 1997, page 99).

5.4.10 Transcal

This project is a comprehensive Inter-Regional Traveler Information System, integrating road, traffic, transit, weather, and value-added traveler services information sources from the entire geographic region. Land line and cellular telephone, and wireless FM subcarrier networks will be used to transport information to and from travelers via telephones, personal digital assistants, in-vehicle devices and kiosks. Additionally, the test will assess the ability to integrate information from multiple sources and the ability to integrate traveler services and transit information with real-time regional congestion and incident content. Completion date December 1997. (ITS Project Book, Jan 1997, page 101).

5.4.11 Travel-Aid

This project will use variable speed limit signs, variable message signs, and in-vehicle communications and signing equipment to improve safety. Warnings about road conditions, accidents, or slow-moving equipment will be equipped with devices to deliver information similar to that displayed from the roadway variable message sign system. Completion date is July 1998. (ITS Project Book, Jan 1997, page 102).

5.4.12 In-vehicle Safety Advisory and Warning Systems (IVSAWS)

This is a FHWA program to develop a nationwide vehicle information system that provides drivers with advance, supplemental notification of dangerous road conditions using electronic warning zones with precise areas of coverage. The operational concept selected uses centralized broadcasts from a regional IVSAWS operations center. Systems design analysis showed that an electronic warning zone with a specific area of coverage is the proper means for implementing these electronic warning zones. Completion date March 1995. (ITS Project Book, page 237).

5.4.13 Automated Travel Time Acquisition Prototype

This project involved the design development and testing of a prototype device for automating traffic speed and travel time surveys. The device makes use of a commercial off-the-shelf GPS receiver and a laptop computer in a moving vehicle. It acquires speed and location information in real-time and generates time vs. distance and speed vs. distance plots. Completion date June 1996. (ITS Project Book, page 389).

5.4.14 SOCRATES

SOCRATES uses cellular radios to provide two-way communications between information centers and vehicles. The communications and on-board computer are used to provide drivers up-to-date traffic information and an emergency call capability. (SOCRATES - Progress towards commercial implementation, from 1995 Vehicle Navigation and Information Systems Conference Proceedings)

5.4.15 Trafficmaster

Trafficmaster demonstrated in-vehicle devices that provide real-time traffic information to the driver. The types of information include speed limit, traffic congestion information, accident information, and weather conditions. (Travel Aid: An In-Vehicle Signing Operational Test, from 1995 Vehicle Navigation and Information Systems Conference Proceedings)

5.4.16 Vehicle Information and Communication System (VICS)

Operational since April 1996. In this system, a center collects and processes the traffic information of each area and provides information to moving vehicles via beacons installed at road sides and on wide area FM broadcasting systems. (PATH database, Oki technical review. Vol. 62, no. 157, December 1996).

5.4.17 Car Information and Navigation System (CARiN)

CARiN was introduced in 1994 as a factory installed system for BMW 7-series automobiles and is a self contained navigation information system using a digital map database and GPS. The system also uses an on-board gyro and vehicle speed sensors to determine position within 10 meters. (Vehicle Navigation Systems: Is America Ready?, 1997 SAE)

5.4.18 R/WIS

Minnesota is currently establishing a statewide road and weather information system (R/WIS). The system will include automatic collection of weather and road condition information. Additional traveler information will also be available. (Eighth Annual Transportation Research Conference)

5.4.19 Advanced Driver and Vehicle Advisory Navigation Concept (ADVANCE)

ADVANCE provides drivers with real-time traffic and route information. A mobile navigation assistant recommends alternate routes as congestion is identified. Developed by the GCM Corridor Coalition. (The Gary/Chicago/Milwaukee ITS Priority Corridor Brochure)

5.4.20 TruckDesk

The project will test an automated traveler information system. TruckDesk will gather information on highway conditions and travel in the corridor; organize the information; and make it available to dispatchers and drivers using a range of communications technologies. The system will provide information on congestion, incidents, weather, and routing. (National ITS/CVO Program)

5.4.21 PLEIDES

This system was developed by Ford Motor Company and uses a GPS receiver to determine the vehicle’s location. The driver specifies a destination and current routing information is provided. (Applications of Advanced Technologies in Transportation Engineering).

5.5 European ITS Developments

5.5.1 Finnish National Road Administration (FINNRA)

FINNRA completed a four-year "traffic management research program" (1993-1996), the objectives of which were to increase knowledge of traffic management and transport telematics in Finland, assess potential ITS solutions and their suitability for Finnish conditions and to promote the implementation of proven solutions; build-up of a strategy for traffic management in FINNRA; initiation of the Euro-regional VIKING project; development of new road weather data collection and management systems, including the traffic management service database, and various traffic management services (RDS-TMC, Internet and GSM-based services, VMS). (http://www.tieh.fi)

5.5.2 Dutch Transport Ministry

Set-up, together with the police and the ANWB, of a Traffic Information Center for the main Roads; exploitation of RDS-TMC in 1998 by a consortium paid by the Ministry; the Euro-Delta-Testsite is made available for public and private organizations; the making of a multi-modal travel information system (MRI) by a consortium supported by the Ministry; setting-up of an ITS-NL organization. (http://www.ertico.com/ch6/ch6-1-16.htm)

5.5.3 French Ministry of Transport

With the implementation of the Schéma Directeur d'Exploitation de la route (SDER) or National Traffic Management Plan, the French Ministry of Transport now has at its disposal a coherent policy for the deployment of intelligent transport systems. This plan anticipates equipping the urban motorways of the most important French agglomerations and the large motorway corridors with road telematic systems. For the next five years, this plan expects to complete the equipment of Lyon, Marseille and Paris and to start that of Bordeaux, Lille and Toulouse as well as that of the large North-South corridors. Other important activities of MELTT are the development of an advanced information distribution system and the setting up of a fully interoperable electronic fee collection standard. (http://www.ertico.com/ch6/ch6-1-28.htm)

5.5.4 French National Institute for Transport and Safety Research (INRETS)

INRETS approaches ITS in 6 different ways: the human factors such as ergonomics, and car driving itself; new sensors (image processing) for detection of mobile or static objects like pedestrians and vehicles; dynamic modeling of networks (dynamic allocation of vehicles, traffic prediction at short term); control, regulation and information (traffic engineering, user information, maritime information); advanced data processing for fleet management and air traffic; telecommunications use (standardization, electronic fee collection, interoperability). (http://www.inrets.fr)

5.5.5 Italian Ministry Of Public Works

The ITALIAN MINISTRY OF PUBLIC WORKS has completed the National Plan for the development of telematics applied in the sector of highway transportation. The National Plan provides for first-phase studies on the entire national TERN network and a pilot test for the application of RDS-TMC and other ITS systems on some portions of the northern Italian TERN network. The completion of the RDS-TMC installation on the entire Italian TERN network is scheduled to take place during the second phase. The Inspectorate co-ordinates the activities of the other Italian Partners in many different projects such as ECORTIS, SERTI, CORVETTE and the Italian project PITAGORA. (http://www.ertico.com/ch6/ch6-1-24.htm)

5.5.6 UK Department Of Transport

The UK Department of Transportation participates in the EU HLG on implementing RTT; launch of controlled Motorway Pilot Project on SW M25; start up of Strategic VMS on London-Midlands 'envelope'; publication of consultation document on providing Regional Traffic Control Centers under the Private Finance initiative; publication of a consultation document on a Policy for Using New Telematic Technologies for Road Transport. (http://www.ertico.com/ch6/ch6-1-15.htm)

5.5.7 Transportation Research Group at the University of Southampton UK

The following material came from http://www.soton.ac.uk/~trgwww/frames.htm.

5.5.7.1 ROMANSEII: A Road Management System For Europe

The ROMANSEII project builds upon the very successful pilot on-line traffic information and control center developed within the ROMANSE project. It is part of the larger EC DRIVE III project, EUROSCOPE, in which complementary activities are co-ordinated between nine European cities. The ROMANSEII project, led by Hampshire County Council, has twelve U.K. partners.

This activity involves the design, development and evaluation of Integrated Urban Traffic Management routing and control strategies to deal with a wide range of potential incidents. Driver behavior surveys are being undertaken to enhance the understanding of the network effects under incident conditions. Additional surveys will evaluate the perceived effectiveness of the new ATT systems (such as route guidance VMS and car parking guidance VMS) currently being installed within Southampton. The close association of the core partners in the project has led to the development of several associated strands of research.

5.5.7.2 Establishing User Requirements From Traveler Information Systems

Technological, data and user requirements must be met in order to provide an effective traveler information system. The first two requirements are actively being addressed. This research project aims to expand the scope and detail of understanding of user requirements. Current and proposed systems will be reviewed to identify salient features and commonalties. Relevant traveler information literature will also be reviewed. Feedback from discussion groups will also contribute to development of a simulation tool which will allow a prototype traveler information system to be evaluated. The user interface will be able to interrogate a database of detailed information associated with a library of tripmaking scenarios representative of tripmaking at local, regional, national and international levels. The tool will be designed to run on a laptop PC. Suitable business and community groups (and other sites and venues) will be identified to allow collection of user requirement information from subjects. Subjects will use (and comment on) the system in order to plan a number of trips selected from the library. A detailed analysis of the collected information will aim to synthesis a series of generic user requirement factors leading to recommendations and guidelines for future development of effective systems to provide (pre-trip) information.

5.5.7.3 Collaborative Research Into The Effectiveness Of Parking Guidance And Information Systems

Inefficiencies in both the parking search process and in the allocation of available spaces can produce substantial “costs” to drivers, car park operators, city authorities and the community as a whole. New parking guidance and information (PGI) systems are now being installed in many cities, offering the potential for substantial efficiency gains.

This project is aimed at helping this potential to be realized, through the enhancement and application of an established route guidance network model (RGCONTRAM), to study PGI effectiveness in a range of scenarios. The project brings together the experience of the Institute of Transport Studies, University of Leeds and the Center for Transport Studies, Imperial College in addition to TRG. A full review of PGI technologies, parking behavior evidence/theories and parking modeling has been carried out and specifications of surveys, data collection and modeling requirements are being completed. Data relating to the PGI facilities in Southampton and Kingston will then be collected. The resulting improved models of parking behavior will be implemented in the network model, which will then be used to establish those factors influencing the effectiveness of PGI systems. Results will lead to recommendations for PGI policies and practice.

5.5.7.4 ROMANSE On-Line: An Internet Traveler Information System

TRG, in association, with Atkins Wootton Jeffreys, have developed a prototype traveler information system which is accessible using the Internet and World Wide Web. This is a project associated with ROMANSEII and supported by Hampshire County Council.

Visitors to the site are able to obtain a range of information relating to their travel to, from and within Southampton. Information includes: current availability of spaces in the city’s car parks; images and maps indicating the levels of traffic and congestion on the road network; information about incidents and roadworks; timetables and information concerning bus services; and an on-line version of TRIPlanner (an interactive service which allows the user to plan and obtain details concerning public transport trips to, from or within Southampton).

The service is currently undergoing an extensive trial within the University domain. An on-line questionnaire is included in the service. The objective is to extensively pilot the service and evaluate user requirements based on feedback from staff and students. This will enable a refined version of the site to be produced prior to ‘public release’. It is hoped in this way that a credible, useful and reliable service can be eventually delivered to the public ‘first time’, and which will be capable of further extension/enhancement as data bases develop.

5.5.7.5 An Instrumented Vehicle For Behavioral Data Collection

Understanding of driving processes, including effects of driver reaction time, is currently limited due to the use of static, point based techniques for data collection, and it is almost impossible to accurately monitor the progress of an individual vehicle/driver over sufficient distance to understand the behavioral decision process. To overcome this lack of microscopic behavioral data, a method of data collection is required that is: Dynamic (describing the behavioral, and processes as they evolve in time), Accurate, Flexible, in terms of implementation and adaptability.

Although modern vehicle simulators, such as those now available at TRL/ITS Leeds, allow some dynamic experiments to be made, they are currently restricted to relatively simple scenarios. They are also in an artificial environment which may affect the driving styles of the subjects. This project is aimed at gaining information on behavior through the use of an instrumented vehicle. Such a vehicle, equipped with speed/range sensors, can enable data on the behavior of adjacent drivers to be collected from within the traffic stream. During 1995 and 1996, TRG has assembled such a vehicle equipped with:

- A radar range finder (loaned by LUCAS Automotive Ltd.) to measure the distance to, and relative speed of, a number of adjacent vehicles,
- A laser speedometer to accurately determine ground speed,
- Video and audio surveillance facilities, to allow driver commentary and the compilation of records on macroscopic variable, e.g. ‘level of service’, vehicle type, %HGV, etc.
- An accelerometer, to measure the small longitudinal accelerations that occur in car following, and
- Pedal displacement and pressure sensors, to monitor a drivers physical reaction to stimuli.

The vehicle has undergone initial calibration tests and its flexibility has been supplemented by the availability of major processing software modules, allowing pre-analysis (isolating specific, operator defined events) and editing of the large databases produced, (according to time segments, data tracks and video images required). Other facilities allow data archiving, using both magneto-optical and CD storage media, to enhance transferability.

Initial use of the vehicle has been made in the calibration of the ‘fuzzy logic motorway simulation model’ (described below), with full scale use due to start in 1997 for the collection of data on motorway close following (where driver speed adaptation and its role in the formation of “flow breakdowns” will be investigated). In addition the vehicle is likely to be used as one of the test vehicles in the RTA project, as well as investigating the impact of the M25 controlled speed limit system within the ‘DIATS’ project in the coming year.

5.5.7.6 INCOME: Integration Of Traffic Control With Other Measures

INCOME is a project for DGVII (Transport) of the European Commission, concerned with the development and integration of strategies to optimize integrated urban traffic control, driver information systems and public transport systems, and their integration. It is a consortium of 8 partners from 6 countries across Europe.

The project began with a review of European, national and INCOME city policies and strategies for Urban Traffic Management Systems (UTMS) including questionnaires conducted with the City Authorities. These concentrated the INCOME activities into specific areas, with new strategies to be developed and evaluated using simulation modeling and field trials. An evaluation methodology has also been produced.

Activities in the U.K. center on bus priority in London and its integration with traffic control. Developments include (i) bus priority in fixed time UTC, using a method called SPRINT, to build on bus priority developments in SCOOT achieved in the PROMPT project, (ii) new bus priority architecture incorporating the use of AVL to select buses for priority, and new data communications systems, (iii) congestion strategies for buses and (iv) integrating physical and signaling methods for priority. The potential integration of UTC, AVL and VMS centers will also be considered at the strategic level.

5.5.8 Swiss Federal Highways Office

Establishment of a concept for the implementation of RDS-TMC including the location coding in co-ordination with the German BMV and other European countries; analysis of traffic and weather data collection and data dissemination; implementation of EFC for heavy trucks; use of DSRC technology; participation in the European MOVE-IT and ENTREPRICE projects and others such as CORVETTE; study and tests of the use of GPS in the trans-alpine corridor and monitoring of dangerous goods. (http://www.ertico.com/ch6/CH6-1-45.HTM)

5.5.9 Swedish National Road Administration (SNRA)

Start of the establishment of a digital national road database (NRDB); elaboration of SNRA system for traffic information; installation of a motorway control system on the northern approach by E4 to Stockholm; road assistance experiment; initiation of an extensive R&D program on ITS to be implemented in Sweden concentrating on quality in data acquisition and information exchange; dynamic speed adaptation and user acceptance.

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