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PERFORMANCE PREDICTION OF THE SAE J1850 AND RELATED BUSES FOR IN-VEHICLE COMMUNICATIONS REQUIREMENTS FOR THE ITS SAFETY-RELATED SERVICES

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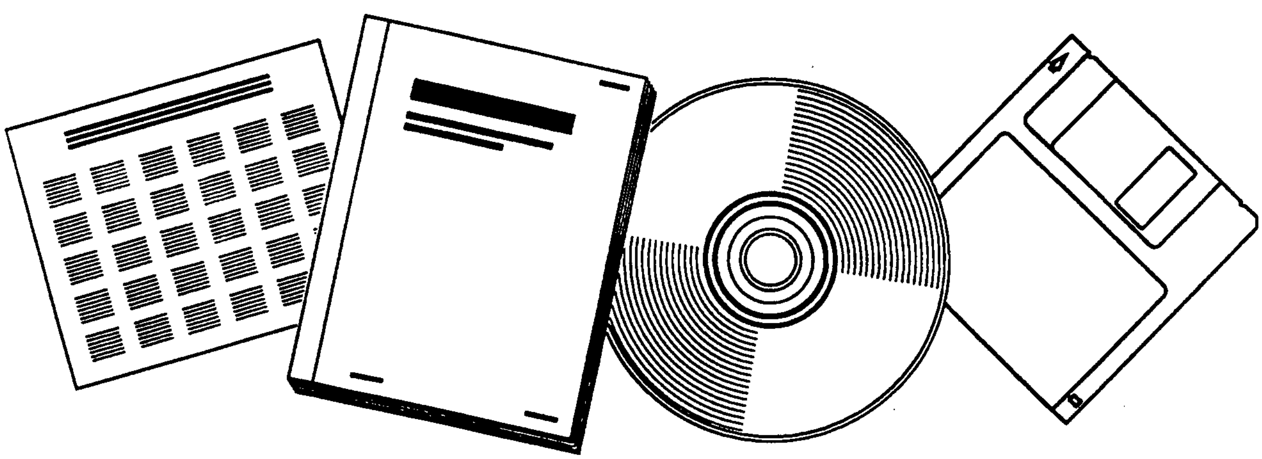

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Technical Summary

Performance Prediction of the SAE J1850 and Related Buses for In-Vehicle Communications Requirements for the ITS Safety-Related Services

Key Study Results

Based on detailed simulation of in-vehicle data bus standards, the SAE J1850 in-vehicle data bus standard may meet the need for some lower data rate safety systems but is not adequate for other, higher rate systems supporting vehicle control. The SAE J1850 standard defines two versions of the data bus with different data rates (10.4 kbps and 41.6 kbps), and the higher data rate version can potentially support a wider range of safety systems. Based on the analyses of this study, the CAN protocol may be able to support future ITS safety systems with full vehicle control.

The fundamental observation is that, in general, the J1850 and CAN data buses can support safety systems providing warnings to the driver while the CAN protocol can also support systems controlling the vehicle during emergency situations. The J1850 data bus cannot, in general, support safety systems with control functions. However, the 41.6 kbps version of J1850 can support some limited high-rate control systems. It should be emphasized that this is only a general observation concerning the performance, particularly the capacity and latency affects, of a data bus. In addition, specific design parameters such as the priority and messaging scheme may also affect this general conclusion. Collision avoidance input data used in these analyses are based on information, which may be tentative or preliminary, obtained from OCAR principal investigators, investigators from universities and private industry, and vendors and manufacturers of safety systems.

An increasingly important consideration for in-vehicle networks is the ability to support multiple data buses within a vehicle and communications to the ITS infrastructure. Due to the differing needs of various in-vehicle systems, multiple in-vehicle networks are planned to support these different functions. Since little government or industry attention has been paid to internetworking guidelines or standards, future developments must ensure sufficient attention is given to this issue. Internetworking will play a larger role in future vehicles because of intra-vehicle communications and an increased need for communications between the vehicle and the ITS infrastructure.

Potential Application of Study Results

The analyses and simulations provide a general assessment of the performance of in-vehicle data bus standards when supporting ITS safety systems. The results also provide a baseline for NHTSA to determine recommended network performance and architecture guidelines. The performance measures used by the analysis indicate important parameters that NHTSA should review when considering guidelines for in-vehicle data bus support of ITS safety systems.

In addition, the simulation models developed for this analysis are flexible so they may be expanded and modified to assess the performance of different standards, architectures, and implementations. NHTSA may wish to use these models to determine performance requirements or other recommendations for developing ITS safety systems. Specific areas that the results and models from this analysis may be applied include:

- Performance of internetworked systems. The analysis provides a baseline network architecture from which future in-vehicle network evolution may be assessed. In addition, the simulation models may be expanded to assess the performance of multiple data bus architectures. This capability can support any NHTSA development of guidelines for network performance.
- ITS Infrastructure Communications. Understanding the requirements for communications between the infrastructure and a vehicle can help identify areas of limitations and areas requiring standardization. The simulation models can be expanded to include areas of analysis such as infrastructure protocol, the propagation and error effects of the radio signal, and the internetworking between the infrastructure and the in-vehicle bus.
- In-vehicle networking testbed. The efforts of this study can begin a development of a computer-based automotive communications testbed that could provide a cost-effective facility to test innovative safety systems using in-vehicle networks.

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TECHNICAL SUMMARY

CONTRACTOR Stanford Telecommunications, Inc.	CONTRACT NUMBER DTNH22-93-D-07317
REPORT TITLE "Performance Prediction of the SAE J1850 and Related Buses for In-Vehicle Communications Requirements for the ITS Safety-Related User Services"	REPORT DATE 30 June 1997
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Task Objective

The National Intelligent Transportation System (ITS) Architecture provides a robust framework for integration of safety systems, but the ITS Architecture does not define the methods or techniques for such integration. In-vehicle networks and data buses provide a flexible and effective method for integrating various in-vehicle ITS systems. This study, through the use of detailed analyses and simulations, defines quantitatively the key shortcomings and design considerations of data buses and network architectures that may inhibit implementation of ITS safety services. The key objectives addressed by this study are:

- To determine the performance (impact of safety systems) of the SAE J1850 and CAN data bus standards when loaded with the communications necessary for ITS safety-related services;
- To assess the influence standard data buses have on the reliability of safety systems built around them;
- To assess the ability of standard automotive data buses to support internetworking between multiple data buses and networks; and
- To identify limitations within existing data bus standards and make recommendations for areas that may require NHTSA effort.

Background

As vehicle manufacturers embrace in-vehicle data buses and networking, this technology will provide opportunities for future collision avoidance systems and other safety-related services. In-vehicle multiplexing systems not only decrease the amount of wiring required for the proliferation of electronic modules in vehicles today, but also include advantages such as information sharing and distributed control. This distributed processing and information sharing enables new strategies for developing safety systems. Many vehicle manufacturers are expanding their deployment of these networks to reduce wiring within vehicles, to provide access to on-board diagnostic information, and to enable sharing of data for distributed processing or ITS devices. Vehicle manufacturers are implementing standards such as Society of Automotive Engineers (SAE) J1850 and J1939 and the Controller Area Network (CAN) for general vehicle functions and control.

Task Approach

The overall approach to performing this study was to develop simulation models of in-vehicle data buses and safety systems and to investigate, through contacts with industry, developments in in-vehicle networking. The assessment modeled the data interfaces for safety-related user services using Optimized Network Engineering Tool (OPNET) simulation environment, developed by MIL 3 Inc., and established the performance of the J1850 and CAN data bus standards under the data load of individual and combinations of safety system devices and other vehicle elements. The computer-based tool, OPNET, provides a software environment to model and simulate networks and other distributed computer and communication systems such as automotive networks. This study also investigated the fault tolerance reliability of the emerging in-vehicle networks using fault tolerance analysis techniques. Finally, this study investigated the ability of automotive network standards to support internetworking among multiple in-vehicle data buses. The study team also participated in the SAE committee developing the emerging SAE ITS data bus standard.

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