SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Superseding J1939-01 SEP2000

(R) On-Highway Equipment Control and Communication Network

RATIONALE

This document has been updated to more accurately describe the SAE J1939 network as typically used in heavy duty on-highway vehicle applications. References to the relevant SAE J1939 documents published since 2000 have also been included. The previous version included an extensive section on the use of SAE J1939 in an ITS implementation. That application has not materialized in industry as originally foreseen, thus that section has been removed from this revision.

FOREWORD

The set of SAE J1939 Recommended Practices documents define a highspeed CAN-based communications network that can support real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between Electronic Control Units (ECUs) physically distributed throughout the vehicle. SAE J1939 network is the next generation successor to the SAE J1708 and SAE J1587 low speed networks. SAE J1708 and SAE J1587 are older, widely used networks intended to provide simple information exchange, including diagnostic data, between ECUs. SAE J1939 is capable of performing all of the functions of SAE J1708 and SAE J1587 networks as well as providing control system support.

The SAE J1939 communications network is suitable for use in heavy-duty environments and suitable for use in vertically integrated vehicle industries. The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Vertically integrated vehicles involve the integration of different combinations of loose package components, such as engines and transmissions that are sourced from many different component suppliers. SAE J1939 common communication architecture strives to offer an open interconnect system that allows the ECUs associated with different component manufacturers to communicate with each other. The SAE J1939 communications network is intended for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road, and for appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements.

The series of SAE J1939 documents has been developed by the SAE Truck and Bus Control and Communications Network Committee of the SAE Truck and Bus Electrical and Electronics Steering Committee. These documents are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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http://www.sae.org/technical/standards/J1939/01_201105

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1. SCOPE

SAE J1939-01 On-Highway Equipment Control and Communication Network specifies the minimum set of SAE J1939 documents that define the Truck and Bus Control and Communications Vehicle Network as it applies to on-highway equipment. Vehicles covered include all on-highway straight trucks and road trains. A road train consists of one towing vehicle (tractor) and one or more towed vehicles (trailers and dollies). Dolly axles within the road train are considered to be towed vehicles.

1.1 Purpose

It is the intention of the SAE J1939 family of recommended practices to allow electronic devices to communicate with each other by providing a standard architecture. SAE J1939-01 describes the particular set of SAE J1939 documents used to implement an open interconnect system for electronic systems in a heavy-duty on-highway vehicle.

Vehicles covered include on-highway straight trucks and combination vehicles. A combination vehicle consists of one towing vehicle (tractor), and one or more towed vehicle(s) (trailers and dollies). Dolly axles within the combination vehicle are considered to be towed vehicles.

1.2 Degrees of Openness

A network based upon this document is open to the degree that any two devices which conform to SAE J1939-01 can be connected via the network and communicate with each other without functional interference. Devices that conform to different SAE J1939-0x documents may not be capable of communicating directly with one another and in some cases may cause degradation or complete disruption of the entire network.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1939 Recommended Practice for a Serial Control and Communications Vehicle Network

SAE J1939-03 On Board Diagnostics Implementation Guide

SAE J1939-11 Physical Layer, 250K bits/s, Twisted Shielded Pair

SAE J1939-13 Off-Board Diagnostic Connector

SAE J1939-15 Reduced Physical Layer, 250K bits/s, UN-Shielded Twisted Pair (UTP)

SAE J1939-21 Data Link Layer

SAE J1939-31 Network Layer

SAE J1939-71 Vehicle Application Layer

SAE J1939-73 Application Layer - Diagnostics

SAE J1939-81 Network Management

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1587 Electronic Data Interchage Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1708 Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications

2.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 7498 Information Processing Systems – Open Systems Interconnection (OSI) – Basic Reference Model

ISO 11898 Road Vehicles-Interchange of digital information-Controller area network (CAN) for high-speed communications

ISO 11992 Interchange of Digital Information on Electrical Connections Between Towing and Towed Vehicle

3. DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

3.1.1 Bridge

A device which stores and forwards messages between two SAE J1939 network segments.

3.1.2 Diagnostic Connector

A connector on the vehicle that is used to get access to the vehicle communications network.

3.1.3 Network integrator

The person, company or entity that manages the overall integration of ECUs into a complete vehicle network.

4. TECHNICAL REQUIREMENTS

4.1 Use of SAE J1939 Documents

Vehicle networks described by the SAE J1939 family of documents follow the 7 layer OSI network architecture with a different document describing each layer used (not all 7 layers are used). The SAE J1939-01 on-highway equipment network makes use of the following SAE J1939 related documents:

SAE J1939 This top-level document describes the network in general, the OSI layering structure, the subordinate document structure, and provides control for all preassigned values and names.

SAE J1939-03 On Board Diagnostics Implementation Guide. Describes the implementation of On Board Diagnostics as may be applicable to heavy duty on-highway diesel trucks, which utilize the SAE J1939 network.

SAE J1939-11 Physical Layer 250K Bits/s, Shielded Twisted Pair. Used on the tractor and as a subnetwork on trailers.

SAE J1939-13 Off-Board Diagnostic Connector. Used to access the network with external devices such as diagnostic tools.

SAE J1939-15 Reduced Physical Layer 250K Bits/s, Unshielded Twisted Pair. Used on the tractor and as a subnetwork on trailers.

SAE J1939-21 Data Link Layer

SAE J1939-31 Network Layer

SAE J1939-71 Vehicle Application Layer. Provides the definition of data elements and messages for vehicle functionality.

SAE J1939-73 Application Layer - Diagnostics. Provides the definition of data elements and messages used for diagnostics and related network support functions.

SAE J1939-81 Network Management. Provides definition of handling source addresses and device identities.

4.2 Physical Layer Definition

SAE J1939-11 and SAE J1939-15 define physical layer implementations of the ISO 11898 Controller Area Network (CAN) specification that may be used for heavy-duty on-highway vehicle applications. The network integrator shall use either SAE J1939-11 or SAE J1939-15 for the SAE J1939-01 implementation. Any single segment of the vehicle network shall use only one of these physical layers.

Network topology requirements in SAE J1939-11 are relaxed in SAE J1939-15 to provide additional design flexibility to the OEM in the placement of network termination devices and for the use of the diagnostic connector. This allows the OEM to better optimize the cost/performance of their design.

4.2.1 Signal Definition

Electronic devices that connect to the SAE J1939-01 vehicle network shall meet the signal characteristics as specified in SAE J1939-11 and SAE J1939-15. SAE J1939-15 is harmonized with SAE J1939-11 allowing the backwards-compatible interoperation among components. SAE J1939-11 and SAE J3939-15 provide reference designs that are compatible with ISO 11898.

4.2.2 Media

The physical media shall meet the requirements of either SAE J1939-11 or SAE J1939-15, as appropriate for the network. Any single segment of the vehicle network shall use only one of these physical layers. The implementer should note that there are specific differences between SAE J1939-11 and SAE J1939-15 in regard to media. SAE J1939-11 specifies a shielded twisted-pair cable media, while SAE J1939-15 specifies a un-shielded twisted-pair cable media. These cable media have been specified with regard to the harsh environment typically encountered in heavy-duty on-highway vehicle applications.

4.2.3 Topology

The network integrator, typically the vehicle OEM, is responsible for the design and implementation of the SAE J1939 network topology in the vehicle, following the requirements within SAE J1939-11 or SAE J3939-15. The implementer should note that there are specific differences between SAE J1939-11 and SAE J1939-15, for example in regard to backbone termination, stub length and number of ECUs allowed. Any single segment of the complete vehicle network shall meet the requirements of either SAE J1939-11 or SAE J1939-15. Also as specified in SAE J1939-31, Network Interconnection ECUs shall be used to interconnect different segments into a complete vehicle network topology.

A ‘typical’ implementation includes a single segment of SAE J1939-11 or SAE J1939-15 connecting all of the ECUs on the truck/tractor. SAE J1939 does not specify a method to connect a towed device (trailer) to the network, but ISO 11992 can be used for this if needed. In this situation, a bridge device would be required to interface between the SAE J1939 network segment and the ISO 11992 network segment.

4.2.4 Diagnostic Connector

The diagnostic connector defined in SAE J1939-13, Diagnostic Connector, shall be used as described therein.

4.3 Data Link Layer Definition

The data link layer on SAE J1939 vehicle networks shall conform to SAE J1939-21.

4.4 Network Layer Definition

SAE J1939-31 defines the network layer provisions in the SAE J1939 family of specifications. The overall vehicle network may consist of multiple network segments, and as noted in discussion of Topology, Network Interconnection ECUs as described in SAE J1939-31 shall be used to connect the different network segments together.

4.5 Application Layer

There are two documents that define the application layer functionality that may be implemented on a heavy duty on-highway vehicle. SAE J1939-71 defines various data elements and messages used for vehicle control and communications. SAE J1939-73 defines various diagnostic services and data content for diagnostics messages on a SAE J1939 network. The data elements and messages defined in SAE J1939-71 and SAE J1939-73 can be considered as a dictionary of the possible information that can be communicated on a SAE J1939 network. The components on the vehicle and their supported functionality determine what actual data elements and messages will be present on a network. The network integrator has the responsibility to assure that all network devices adhere to these application documents, with regard to correct data content and message structures and timing.

4.6 On Board Diagnostics (OBD) Considerations

Many heavy-duty on-highway vehicles that utilize an SAE J1939 network may be subject to regulatory requirements for OBD. SAE J1939-03 has been developed to provide guidelines for the implementation of OBD on heavy-duty vehicles that use the SAE J1939 family of standards. Implementers should review the specific regulations for the markets where their products will be sold to determine applicability.

4.7 Network Management Considerations

SAE J1939-81 describes network management facilities for devices on a SAE J1939 network. Network management in the SAE J1939 network is concerned with the management of source addresses and the association of those addresses with an actual function and the detecting and reporting of network related errors. All devices that operate on a SAE J1939 network have to meet at least the minimum network management requirements per SAE J1939-81.

4.8 Use of Subnetworks

The network may consist of a single physical layer as shown in Figure 1, as a primary network with one or more subnetworks connected to it, or as multiple subnetworks as shown in Figure 2. The particular devices shown in these figures are only for illustrative purposes; the exact set of devices used may vary considerably from vehicle to vehicle. Either SAE J1939-11 or SAE J1939-15 physical layers may be used for the primary network or subnetworks. A bridge is used whenever a subnetwork connects to a primary network or to another subnetwork. An example of bridge placement is at every trailer or dolly which will provide address assignment and electrically isolate the trailer subnetwork from the primary network. Not explicitly illustrated but implied is that dollies utilize the same bridge and subnetwork structure as trailers. Figure 3 illustrates the use of these different physical layers within a typical truck with trailers connected.

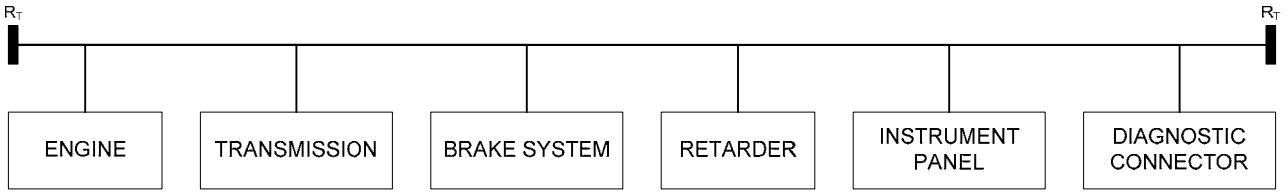

FIGURE 1 - EXAMPLE OF VEHICLE NETWORK USING SINGLE NETWORK
(DEVICES SHOWN ARE FOR EXAMPLE ONLY)

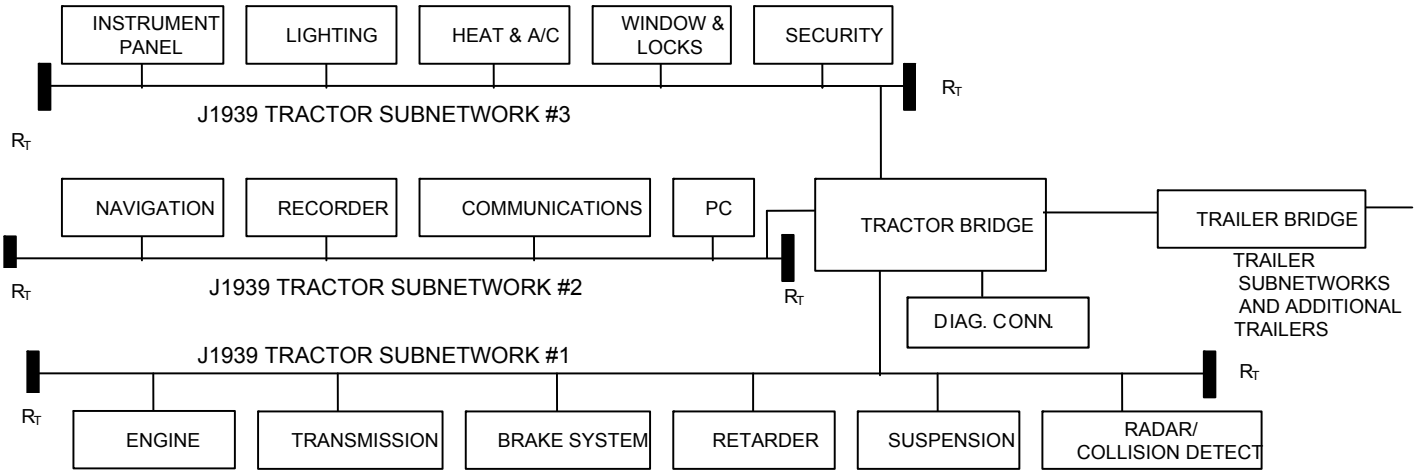

FIGURE 2 - EXAMPLE OF VEHICLE NETWORK USING MULTIPLE SUBNETWORKS
(DEVICES SHOWN ARE FOR EXAMPLE ONLY)

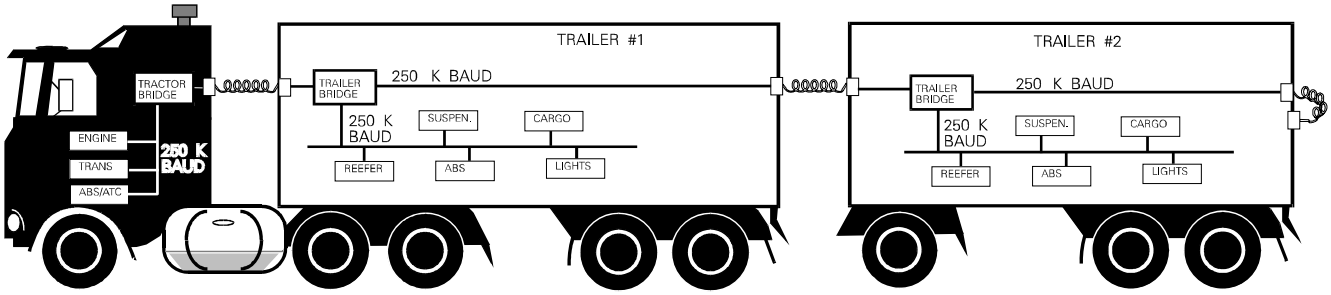

FIGURE 3 - EXAMPLE OF A POSSIBLE ON-HIGHWAY TRUCK IMPLEMENTATION
(DEVICES SHOWN ARE FOR EXAMPLE ONLY)

The number of subnetworks and the selection of devices to be connected to each are left to the vehicle manufacturer to define. The use of SAE J1939 on any towed vehicle (trailer or dolly) will automatically result in the use of at least two subnetworks, one for the tractor and one for the towed vehicle.

The decision to use multiple subnetworks on the tractor may be driven by the number or types of devices to be supported. The bridge between these subnetworks can be used to filter messages between them, effectively isolating one subnetwork from the other with the exception of those messages that are allowed to pass through the bridge. The tractor and trailer bridges may also include the ability to filter messages on each side of it that are not applicable to the vehicle on the other side. For instance, there is no need to transmit the majority of engine or transmission messages back to the towed vehicle.

ISO 11992 has been published as a worldwide standard to allow point-to-point communications between towing and towed vehicles across dedicated twisted pair wiring. This solution is used in countries (primarily in Europe) where it is a legal requirement for braking systems that use digital data communication between towing and towed vehicles. Because two (new) connector pins are needed for this connection, ISO 11992 has not been generally accepted by North American manufacturers. Nevertheless, ISO 11992 could be implemented also in the North American market if a need is identified.

5. NOTES

5.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE TRUCK AND BUS CONTROL AND COMMUNICATIONS COMMITTEE
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