SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-31 JUN2023

Issued 1994-12
Revised 2023-06

Superseding J1939-31 SEP2018

(R) Network Layer

RATIONALE

This document has been updated to generalize comments related to SAE J1939 data link layer characteristics and behavior so those comments are applicable to both the SAE J1939-21 or an SAE J1939-22 data link layer. Numerous edits to properly use the term “PG data” instead of “data field” when referring to the data content for a PG. Numerous edits to properly differentiate between an SAE J1939 message and an SAE J1939 data frame. Noted that a gateway NIECU is required between an SAE J1939-21 network segment and an SAE J1939-22 network segment.

FOREWORD

The SAE J1939 communications network is defined using a collection of individual SAE J1939 documents based upon the layers of the open system interconnect (OSI) model for computer communications architecture. The SAE J1939-31 network layer document defines the OSI network layer requirements and services that enable electronic control units (ECUs) on one network segment to intercommunicate with other ECUs on different network segments of the vehicle network.

The SAE J1939 communications network is a high-speed ISO 11898-1 CAN-based communications network that supports real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between electronic control units (ECUs) physically distributed throughout the vehicle.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable 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 physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Horizontally 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. The 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.

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1. SCOPE

SAE J1939-31 network layer describes the requirements and services for network interconnection ECUs (NIECU) that enable electronic control units (ECUs) on an SAE J1939 network segment to intercommunicate with other ECUs on different network segments of the vehicle or system network. This document defines various types of NIECUs. The information in this document applies only to ECUs that are intended to provide networking services. It is not necessary for an ECU to provide any of these services in order to be compliant with the SAE J1939 protocol.

2. REFERENCES

2.1 Applicable Documents

General information regarding this series of documents is found in SAE J1939.

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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1587	Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1922	Powertrain Control Interface for Electronic Controls Used in Medium- and Heavy-Duty Diesel On-Highway Vehicle Applications
SAE J1939	Serial Control and Communications Heavy-Duty Vehicle Network - Top Level Document
SAE J1939-21	Data Link Layer
SAE J1939-22	CAN FD Data Link Layer
SAE J1939-71	Vehicle Application Layer
SAE J1939-81	Network Management

2.1.2 ISO Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ISO 11783	Tractors and Machinery for Agriculture and Forestry - Serial Control and Communications Data Network
ISO 11898-1	Road Vehicles - Controller Area Network (CAN) - Part 1: Data Link Layer and Physical Signalling
ISO 11992	Road Vehicles - Interchange of Digital Information on Electrical Connections between Towing and Towed Vehicles
ISO 15765	Road Vehicles - Diagnostics on Controller Area Network (CAN)

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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1939-1 On-Highway Equipment Control and Communication Network

SAE J1939-2 Agricultural and Forestry Off-Road Machinery Control and Communication Network

2.2.2 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

ANSI/IEEE STD.802-1D Local Area Networks: Media Access Control (MAC) Bridges

3. DEFINITIONS AND ABBREVIATIONS

Refer to SAE J1939 for definitions that are not featured in this document.

3.1 Definitions

3.1.1 ADDRESS SPACE

The allowable range of addresses on a particular subnetwork. The address space is continuous for the set of network segments when connected by a repeater or bridge. The address space is separate for each network segment when connected by a router, which means the same address can be used by a different CA on each side of the router. When network segments have separate address space, CAs on one network segment cannot directly address individual CAs on the other network segment.

3.1.2 CLASSICAL BASE FRAME FORMAT (CBFF)

An ISO 11898-1 CAN data frame with an 11-bit identifier, a single bit rate, and a maximum data field length of 8 bytes.

3.1.3 CLASSICAL EXTENDED FRAME FORMAT (CEFF)

An ISO 11898-1 CAN data frame with a 29-bit identifier, a single bit rate, and a maximum data field length of 8 bytes.

3.1.4 DATABASE

A general reference to the collection of data in some NIECUs that defines the operation of the internetworking functions and contains status and statistical data about the NIECU internetworking activity. Examples of operation data are a list of PGNs for filtering messages forwarded between network segments or the filtering mode to apply. Examples of status and statistical data are the maximum size for the filter database or the average number of messages forwarded per second. The term can be used in reference to the data collection as a whole or in reference to a specific subset of the data collection, such as the data governing the transfer of messages between a pair of ports on the NIECU.

3.1.5 FD BASE FRAME FORMAT (FBFF)

An ISO 11898-1 CAN data frame with an 11-bit identifier, a flexible bit rate, and a maximum data field length of 64 bytes.

3.1.6 FD EXTENDED FRAME FORMAT (FEFF)

An ISO 11898-1 CAN data frame with a 29-bit identifier, a flexible bit rate, and a maximum data field length of 64 bytes.

3.1.7 FOREIGN MESSAGE TRANSPORT

Foreign message transport describes the functionality for transferring non-SAE J1939 messages (i.e., foreign messages) over an SAE J1939 network by encapsulating the foreign message as the message data in an SAE J1939 compatible PG. The definition for how a foreign message is encapsulated into the PG data of these special SAE J1939 PGs is defined elsewhere, typically within the industry standard documents associated with the special SAE J1939 PG, such as within ISO 11992 or ISO 15765. The addresses associated with the SAE J1939 messaging and any addressing that is a part of the foreign message are considered separate address spaces. Any addressing that is a part of the foreign message will need to be included in the encapsulated PG data content if necessary.

3.1.8 MESSAGE

A message is a protocol data unit (PDU) at the highest originating or consuming OSI layer, most commonly the application layer. The PDU consists of the information identity, its entire data content, and any metadata. A message can be transmitted over the data link layer in its entirety in a single message frame (single frame message) or it can be transmitted in its entirety using multiple message frames (multiple frame message).

3.1.9 MESSAGE FRAME

A message frame (data frame) is the data link layer protocol data unit (D_PDU) transmitted over the physical layer. A message frame can contain an entire message or a fragment of a message.

3.1.10 MESSAGE SEGMENT

The network layer PDU (N_PDU) for a data link layer message frame.

3.1.11 NETWORK

The complete collection of one or more physical communication links, or network segments, on a vehicle or system that are connected together physically and/or virtually through network interconnection devices.

3.1.12 NETWORK INTERCONNECTION ECU (NIECU)

An ECU that provides interconnection of messages between one or more network segments. The standard types of NIECUs are repeater, bridge, router, and gateway.

3.1.13 NETWORK SEGMENT

A physical section of a vehicle or system communications network. The physical section is bounded by the ECUs and any NIECUs directly connected to it. Multiple network segments can be connected together by NIECUs.

3.1.14 PG DATA

A structured data object containing the parameter data for an SAE J1939 Parameter Group. The contents and structure of the data is specified in the PG data definition. PG data should not be confused with the data field of a CAN data frame.

3.1.15 PG DATA DEFINITION

Specifies the content and structure of the data for a PG (PG data). The definition specifies the parameter data content (by SP) and the position of the data for each parameter within the data object. Parameter data position is specified as either an absolute position (specific byte and bits placement) or relative position (subsequent placement following data for another parameter). The structured data object is defined with a fixed (non-variable) length or a variable length.

3.1.16 PORT

The connection point on a controller to the network. An NIECU has two or more ports connected to different network segments.

3.1.17 PORT PAIR

A specific set of two ports on an NIECU.

3.1.18 SAE J1939 MESSAGE

A message (see 3.1.8) for an SAE J1939 PG, consisting of the PGN (PG identifier), the entire PG data, and its metadata. For SAE J1939, an SAE J1939 message refers to a PDU at the application layer; however, for some PGs, such as the Transport Protocol PGs, an SAE J1939 message refers to PDUs at OSI layers between the application layer and data link layer. An SAE J1939 message can be transmitted in its entirety in a single SAE J1939 message frame or it can be transmitted in its entirety using multiple SAE J1939 message frames (multiple frame message).

3.1.19 SAE J1939 MESSAGE FRAME

A CEFF, FEFF, or FBFF CAN data frame (see 3.1.9) according to SAE J1939-21 or SAE J1939-22. An SAE J1939 message frame can contain an SAE J1939 message in its entirety or an SAE J1939 message frame can contain a fragment of an SAE J1939 message.

3.1.20 SAE J1939 MESSAGE SEGMENT

The network layer PDU for an SAE J1939 message frame.

3.1.21 SAE J1939 NETWORK

A vehicle or system network consisting of one or more connected SAE J1939 network segments.

3.1.22 SAE J1939 NETWORK SEGMENT

A network where the physical layer is according to SAE J1939-11, SAE J1939-14, SAE J1939-15, or SAE J1939-17, and the data link layer is according to SAE J1939-21 or SAE J1939-22.

3.1.23 SUBNETWORK (SUBNET)

A subset of the vehicle or system network consisting of one or more network segments connected together. Subnetworks can include tractor, trailer, implement, and braking system. Subnetworks are typically separated by a bridge, router, or gateway to help minimize bus traffic on each network segment. Collectively, the subnetworks are the vehicle or system network.

3.1.24 TRANSIT DELAY

The amount of time delay incurred when an NIECU forwards a received message, or message frame, from one network onto another network. The time between the moment the message is received at an NIECU and the moment that same message is transmitted out by that NIECU.

3.1.25 TRANSPARENT

The characteristic of an NIECU and its internetworking functions that are performed in such a way that the actions and operations are not perceived by other ECUs on the vehicle network. If the NIECU is transparent, then the other devices on the network do not need to know of the presence of the NIECU, and the NIECU network functions and services take place without any visible effects (i.e., invisible). A bridge NIECU between a tractor subnet and trailer subnet is characterized as transparent if ECUs on the tractor subnet and ECUs on the trailer subnet can communicate with one another without knowledge of the bridge involvement in forwarding some messages between the network segments, filtering other messages, and possibly changing the data rate between the networks.

3.1.26 TUNNELING

The networking function of encapsulating one network protocol’s message within messages of a second network protocol and carried over the second network. The network message that is tunneled is all or part of the payload of the messages carried on the other network.

3.2 Abbreviations

CA	Controller application
ECU	Electronic control unit
NIECU	Network interconnection ECU
OEM	Original equipment manufacturer
PG	Parameter Group
PGN	Parameter Group Number
SPN	Suspect Parameter Number

4. NETWORK LAYER DESCRIPTION

4.1 General

SAE J1939 network layer defines the requirements and services for NIECUs that provide intercommunications between different network segments of a vehicle or system SAE J1939 network. An NIECU is an ECU connected to more than one port, or network connection, that transfers messages and information from one network segment to another network segment. Most NIECUs have a controller application that performs the transfer of messages between ports. When a network has multiple network segments and messages need to be transferred between devices on separate network segments, then an NIECU is needed to provide for the transfer of messages from one network segment to another. The type of NIECU required between two SAE J1939 network segments depends upon the needs of the system and the protocol of each network segment. For example, a bridge can isolate the media and the bus traffic between two SAE J1939-21 network segments, but the two SAE J1939-21 network segments are still considered a single network in terms of SAE J1939 address space, SAE J1939 messages, and SAE J1939 message frames. There are several different types of NIECUs, each providing different internetworking functions. The principal internetworking functions include:

- Message forwarding
- Message filtering
- Address translation of messages
- Message repackaging (as part of protocol translation)

An NIECU can also support database management to permit access and configuration of the internal databases for some of these internetworking functions.

All network layer services are optional for any given NIECU, and the ability to supply any of these services is not a condition of compliance to the SAE J1939 Recommended Practice. Section 5.3 of this document outlines the minimum requirements for ECUs providing network layer services other than foreign message transport.

4.2 Reasons for Multiple Networks

There are many different reasons for having a vehicle network with multiple network segments. Some common reasons include:

1. Physical extension or separation of the network, such as a tractor-trailer configuration where the two networks aren't always physically connected.

2. Electrical extension of the network, such as too many node drops for a single network or backbone length of the network segment exceeds allowed lengths.

3. Electrical interface conversion, allowing such things as impedance differences between the network segments. The electrical interface conversion is, in general, built into the physical layer of each network segment. The design of the ECU that has nodes for each of the network segments will already have compensated in any way necessary for the electrical needs (such as signal rise time) of the networks.

4. Data rate compensation for cases where the network segments run at different rates.

5. Address extension of the network when the combined number of network addresses that are required exceeds the number allowed by the protocol. Separating it into multiple networks allows each to have an address space as large as the largest single network given the protocol.

6. Network traffic management, such as isolating high speed or time critical network segments from other network segments to reduce the message loading on the individual network segments.

7. Protocol interface, to allow data to be shared between network segments using different protocols.

4.3 Network Topology

The topology of the vehicle or system network shall be constructed so there is at most one communication path between any two ECUs for a given network. The OEM should therefore assure that no network loops exist on the vehicle. No special provisions are made for NIECUs to detect network loops or to prevent duplicate messages from being generated or replicated indefinitely. Redundant network segments can be provided for fault tolerance, but the mechanism to detect, select, and auto-reconfigure the message routing path is the responsibility of the NIECU supplier and is not defined within this document. Some examples of typical network topologies are shown in Figures 1 and 2.

4.3.1 Network Addressing

The SAE J1939 data link layers provides for the potential of up to 254 unique source addresses on an SAE J1939 network containing SAE J1939 network segments connected only by repeaters or bridges. If this address space is insufficient for an application, then a router can be used between SAE J1939 network segments to provide one or more separate subnetworks of SAE J1939 network segments, each with their own address space. Each subnetwork can be arranged with ECUs and messages related to a specific function (braking, suspension, trailer, implement, etc.) with a controller serving as the router to move selected messages to and from other SAE J1939 network segments.

4.3.2 Off-Tractor Network Segment (Trailer or Implements)

In order to isolate and protect the tractor network segment, an NIECU shall exist between the tractor network segment and any off-tractor network segment. The type of NIECU will depend upon the design requirements. For example, a bridge permits the off-tractor network segment to run at a different data rate and with reduced traffic by performing message filtering, while a router permits the off-tractor network segment to be developed independently, and optimized for specific functions. For those agricultural systems following the ISO 11783 standard, a tractor ECU (TECU) is used to separate the tractor from the implement bus. Refer to ISO 11783 Part 4 and ISO 11783 Part 9 for details. Refer to ISO 11992 for details of a possible trailer subnetwork for highway vehicles.

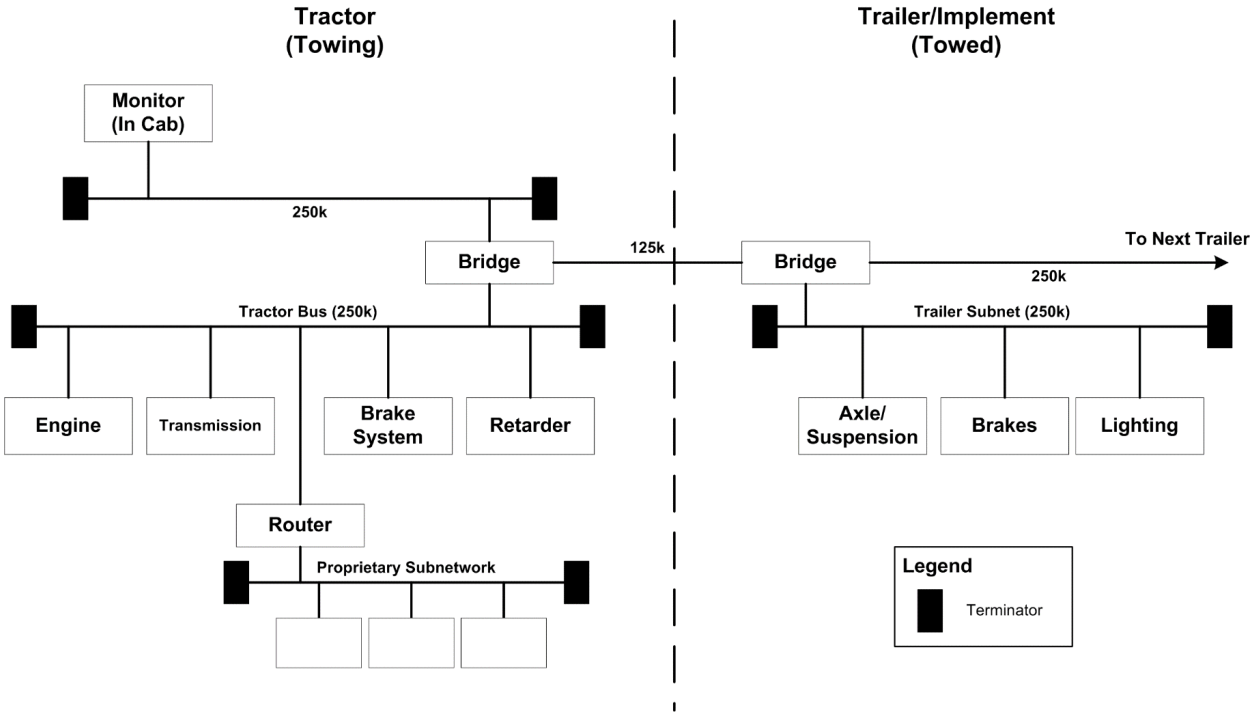


Figure 1 - Example of SAE J1939 vehicle network for truck and bus

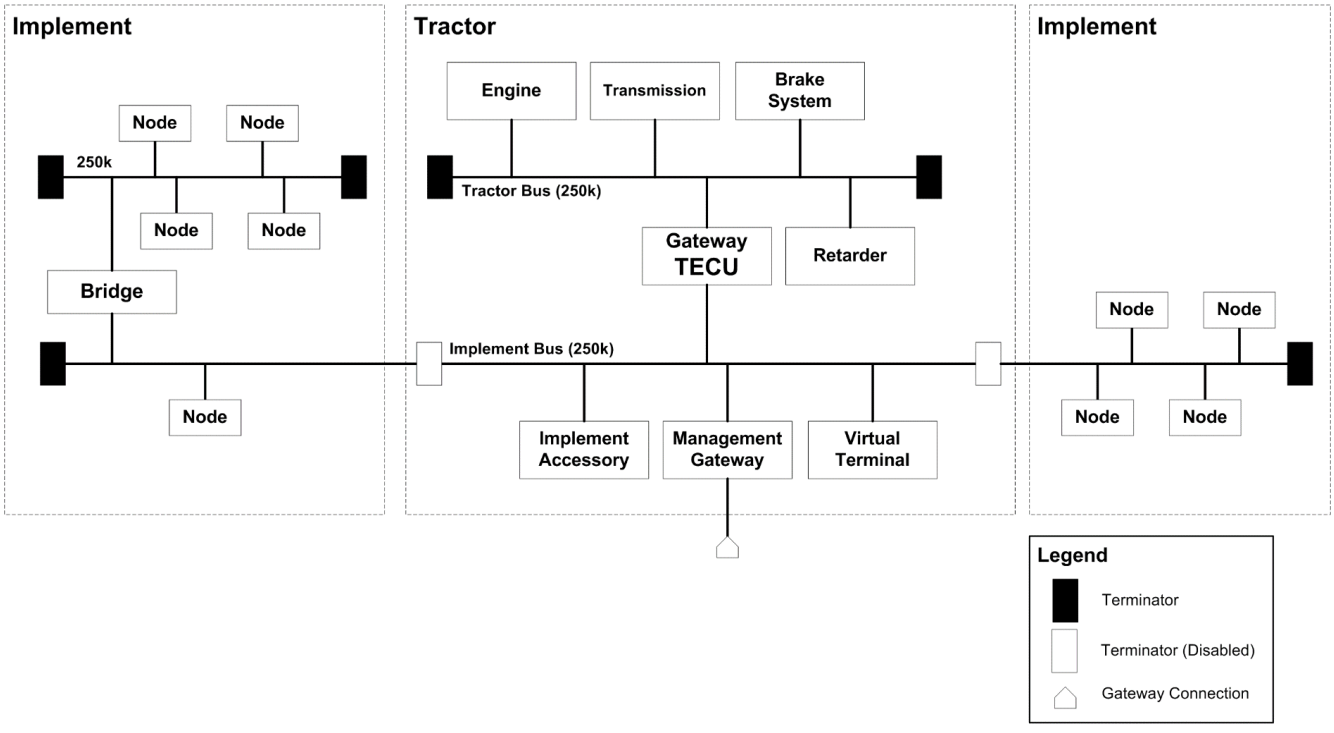


Figure 2 - Example of SAE J1939 vehicle network for agricultural applications

4.3.3 Proprietary Messages and Networks

SAE J1939 has provisions for communications with proprietary messages. If bus traffic and latency become an issue, a separate network segment can be used to handle the proprietary messages. The supplier of this separate network segment and its related devices shall also provide any router/gateway function needed to share data with the main network. This document does not define any NIECU configuration, status, and statistics services for proprietary SAE J1939 PGs based upon PG data content.

4.3.4 CAN 11-Bit Identifier Network Interface

SAE J1939 network segments, per SAE J1939-21 and SAE J1939-22, specify an 8-bit SAE J1939 source address as part of the 11-bit identifier of the ISO 11898-1 CBFF and FBFF data frames. This document does not define any NIECU configuration, status, and statistics services for CBFF and FBFF data frames.

A gateway NIECU is required for internetwork communication of CBFF and FBFF data frames between an SAE J1939 network and a non-SAE J1939 network. Component suppliers and OEMs are responsible for the gateway translation of 11-bit identifiers since this document does not specify how to manage addresses or identifiers for those devices.

A gateway NIECU is required for internetwork communication between an SAE J1939 network based on SAE J1939-21 data link protocol and an SAE J1939 network based on the SAE J1939-22 data link protocol. Even though both are SAE J1939 network segments, the SAE J1939 data link protocols are different and with different and incompatible definitions for CBFF data frames.

A gateway NIECU is not required for internetwork communication of CBFF and FBFF data frames between two SAE J1939 networks as long as both SAE J1939 networks support the same data link protocol and are part of the same address space.

4.3.5 SAE J1587 Network Interface

Devices requiring SAE J1587 for information or diagnostics shall have a separate port to access that link. No provisions for defining a gateway to SAE J1587 are planned for this document.

4.3.6 SAE J1922 Network Interface

Since SAE J1922 was intended to be an interim standard for drivetrain control, no specific support or gateway definition will be included in this document.

5. NETWORK INTERCONNECTION ECUS

5.1 Types of Network Interconnection ECUs

There are four standard types of network interconnection ECUs for internetworking communications. The different types are based upon the highest OSI layer where the NIECU performs its internetworking functions.

1. Repeater: A component used to extend the physical length of a network or increase the number of devices connected to a network through physical segmentation of the network. A repeater is a physical layer NIECU device that regenerates the digital signal from one network segment to another physical network segment, with no processing of the data in any way. No changes in data rate, address space, or protocol are permitted for network segments that are joined by a repeater. In general, these devices are specialized hardware that transfer the data with sub-bit time delays.

2. Bridge: A device used to transfer message frames between two or more network segments that have the same address and data link protocol. A bridge permits changes in the media and data rate between network segments (i.e., physical layer), but the network segments have the same address and data link protocol. A bridge is frequently used to connect network segments with different data rates. A bridge is a data link layer NIECU device with a software application for the message forwarding functions. In its simplest implementation, a bridge functions as a repeater with a software application for filtering message frames going from one network to the other. In more advance implementations (sometimes referred to as a switch), a bridge transfers message frames between the network segments by storing and forwarding messages; however, it can simply transfer message frames from one network segment to another. A bridge can provide error checking before forwarding message frames so message frames with errors are not forwarded. A bridge permits changes in the media and data rate between network segments (i.e., physical layer), but the network segments have the same address and data link protocol. A bridge is frequently used where data rate changes are needed. A bridge does not perform address or protocol translation.

3. Router: A device used to transfer message segments between two or more network segments where the protocol is the same on the network segments but the networks have separate address spaces, so address translation shall be performed as the message segment is transferred between network segments. A router is a network layer NIECU device. A router also determines how to move the data from the source to the destination, i.e., how to route the message through the network. The networks shall have the same transport layer, but can have different network layers. A router can expand the address space of the network by connecting network segments and allowing communication between separate address spaces. Protocol is the same on network segments connected by a router.

4. Gateway: The highest complexity NIECU, the gateway can exchange data across differing protocols in addition to handling the other functions as needed. A gateway NIECU can make changes to the packaging and presentation of the data, including combining data from multiple messages into one.

In the ordered listed above, an NIECU toward the bottom of the list can have any of the internetworking functions of the NIECUs toward the top of the list. Thus, a router, although capable of doing address translation, can perform message forwarding if it has a port pair that use the same address space on both network segments. In software terms, the NIECU type is simply taken as that corresponding to the most complex function that the ECU is programmed to perform. In this sense, a router does not forward message frames; the ECU that contains the “router” function of address translation also contains an instance of the “bridge” function of message forwarding. It can use those two software functions on separate port pairs, or (if there is an overlap in the address spaces) on the same port pair.

5.1.1 Repeater

A repeater is a physical layer component that receives a digital signal from one network segment and regenerates the digital signal on another network segment, with no processing of the data in any manner. The data rate, protocol (data link layer), and address space shall be the same on both sides of the repeater. Only the physical media may differ between network segments connected by a repeater. A repeater overcomes signal attenuation with electromagnetic media and removes noise occurring on the received signal, providing a stronger and undistorted signal on the generated signal. A repeater is commonly used to extend the network length to cover a greater distance (area), to connect more electrical loads (devices) onto the network, or to connect to another type of media (physical layer expansion). A repeater implements message forwarding at the signal bit level, without storing and forwarding, and therefore does no re-ordering of messages by priority.

The principal function provided by a repeater is signal regeneration between network segments running at the same data rate. This is achieved by regenerating the digital signal from one network segment onto another at the physical layer of the network, not by storing and forwarding complete message frames. Repeaters should incorporate an anti-loopback/lockout function. Bitwise arbitration is also achieved across the repeater. The repeater is essentially transparent to any ECU on the vehicle network. All messages are forwarded as there is no message filtering capability. If fault isolation is provided, the repeater has the ability to disable one or more of its transmitters if a bus fault is detected on one of the network segments. No management function is defined for a repeater, so an address is not required.

5.1.1.1 Repeater Networking Functions

5.1.1.1.1 Forwarding

A repeater performs forwarding by regenerating the digital signal from one network segment to another network segment. Each digital signal bit is regenerated between network segments with sub-bit-time delay. There are no changes in data rate, address space, or protocol when a repeater forwards the digital signal onto another network segment. Forwarding is discussed in more detail in 6.1.

5.1.2 Bridge

A bridge is a data link layer NIECU device with a software application for message forwarding functions. The media and data rate (i.e., physical layer) may differ between network segments, but data link protocol and address space shall be the same on both network segments. A bridge can selectively filter message frames going across it so that the bus load is minimized on both network segments. In its simplest implementation, a bridge functions as a repeater with a software application for filtering message frames going from one network to the other. In more advanced implementations (sometimes referred to as a switch), a bridge transfers message frames between the network segments by storing and forwarding message frames; however, it can simply transfer message frames from one network segment to another. A bridge can provide error checking before forwarding message frames so message frames with errors are not forwarded.

The principal function provided by a bridge is message frame forwarding and filtering between network segments. This is achieved by storing, filtering, and forwarding message frames at the data link layer of the network. By filtering message frames, the bridge can effectively reduce the amount of bus traffic present on each network segment of the network. The bridge is essentially transparent to any ECU on the vehicle network. There is some transit delay through the bridge. If no database management function, address management, or diagnostic capability is provided, an address is not required for the bridge.

5.1.2.1 Bridge Networking Functions

5.1.2.1.1 Forwarding

A bridge performs message frame forwarding using a store and forward method, whereby the complete message frame from one network segment is stored before that message frame is forwarded (transmitted) onto another network. When a bridge forwards a message frame onto another network segment, the message frame uses the identical source address of the original message. A bridge can perform error checking on message frames so message frames with errors are not forwarded. Forwarding is discussed in more detail in 6.1.

5.1.2.1.2 Filtering

A bridge can filter any, all, or none of the message frames it receives. This will be dependent on the application. Filtering is discussed in more detail in 6.2.

5.1.2.1.3 Bridge Database Management

Although not required, it is recommended for a bridge to support the database management function to provide a standard access to configure the forward and filter databases. Database management is discussed in more detail in 6.5.

5.1.3 Router

A router is a network layer device that transfers message segments between network segments that have separate address spaces, data rates, and/or media. The data link protocol shall be the same between network segments connected through a router. The principal operation provided by a router, in addition to those functions provided by a bridge, is address remapping (message routing).

A router performs address remapping on all messages transferred between the network segments. A router requires some form of address look up tables so a message with address X on network segment 1 appears as a message with address Y on network segment 2. Address Claimed messages do not get transferred between network segments.

Once operational, the router should be essentially transparent to any ECUs on the vehicle network. There is some translation and forwarding delay through the router.

A router between two SAE J1939 network segments operates on the SAE J1939 message segment—the network layer PDU for an SAE J1939 message frame. The data field of the message frame remains unmodified.

5.1.3.1 Router Networking Functions

5.1.3.1.1 Address Translation

In addition to forward and filter functions, a router shall remap message addresses when the message frame is transferred from one network segment to another network segment. A router requires some form of a lookup table that provides the address translation map. Address translation is discussed in more detail in 6.3.

5.1.3.1.2 Message Filtering

A router can filter any, all, or none of the message frames between two network segments. The typical default filter configuration for a router is pass mode (filter mode = 1), where all message frames are blocked unless the message ID is among the list of message IDs to be passed through the router. This will be dependent on the application. Filtering is discussed in more detail in 6.2.

5.1.3.1.3 Router Database Management

Although not required, it is recommended that a router support database management functions to configure address translation mapping data in addition to the forward and filter databases. Database management is discussed in more detail in 6.5.

5.1.4 Gateway

A gateway is a device that permits data to be transferred between two network segments with different protocols or message sets. A gateway can also provide a means to repackage parameters into new message groups when transferring messages from one network segment to another, as in the case where the different “protocols” are actually different message sets (for instance, one being a proprietary subnet with all proprietary messages) on SAE J1939.

The principal operation provided by a gateway, in addition to those functions provided by a router, is message repackaging. This permits any data from another, non-SAE J1939 network, to be placed on the SAE J1939 data link as though it were being generated by the ECU that contains the gateway function. This can simplify the design of other ECUs by giving access to data without forcing each ECU to be connected to multiple data links.

A gateway NIECU is required to transfer messages between an SAE J1939-21 based network segment and an SAE J1939-22 based network segment. Even though both are SAE J1939 network segments, the SAE J1939 data link layers and message frames are different, the Transport Protocols are different, and their rules are different for how SAE J1939 messages are communicated using SAE J1939 message frames. Address Claimed messages do not get transferred between network segments.

Once operational, the gateway should be essentially transparent to any ECUs on the vehicle network. There is some translation, repackaging, and forwarding delay through the gateway.

5.1.4.1 Gateway Networking Functions

5.1.4.1.1 Protocol Translation and Message Repackaging

In addition to forward, filter, and address translation functions, a gateway performs protocol translation between the networks. A common method of protocol translation is message repackaging, when the device takes parameters from one or more messages and repackages them into one or more “new” messages. This permits parameters to be grouped for easier transfer, reception, and interpretation by another ECU. A gateway requires some form of database that provides the message repackaging details. Message repackaging is covered in more detail under protocol translation in 6.4.

5.1.4.1.2 Message Filtering

A gateway can filter any, all, or none of the messages between two network segments. The typical default filter configuration for a gateway is pass list mode (filter mode = 1), where all messages are blocked unless the message ID is among the list of message IDs to be passed through the gateway. This will be dependent on the application. Filtering is discussed in more detail in 6.2.

5.1.4.1.3 Gateway Database Management

Although not required, it is recommended that the database management function be supported to provide standard access to configure the forward, filter, address translation, and message repackaging databases. Database management is discussed in more detail in 6.5.

5.2 Message Forwarding Transit Delay Requirements

The following sections define requirements for the maximum transit delay for message forwarding by different types of NIECUs.

5.2.1 Repeater (Bitwise Forwarding)

The maximum transit delay for each forwarded bit should be less than 10% of a bit time (400 ns at 250 kbps) to permit bitwise arbitration to occur properly across the repeater, while still permitting reasonable propagation delay (cable distance).

5.2.2 Bridge (Store and Forward Forwarding)

The maximum transit delay permitted for “store and forward” forwarding will be application dependent. When no specific application limit exists, a recommended maximum value is 50 ms. Refer to SAE J1939-21 for message timing information and SAE J1939-81 for examples of bridge delays.

5.3 NIECU Conformance (Minimum Requirements)

An SAE J1939 NIECU that claims conformance to this document shall meet the following requirements.

5.3.1 Forwarding Requirements

1. Shall forward messages as described in this document based on NIECU type.

2. Messages with the same priority level shall be forwarded onto another network in the same order they were received.

3. Messages with a higher priority shall be forwarded before messages with a lower priority to avoid higher priority messages being excessively delayed due to priority inversion by lower priority messages being forwarded to a specific port. This requirement prohibits the use of a simple first-in-first-out (FIFO) queue for message forwarding. Repeaters are exempt from this requirement. An NIECU can bound the maximum latencies of messages at different priorities and is recommended to drop messages that exceed the maximum latency at the given priority.

4. An NIECU may begin to forward messages from one network segment to another before it has claimed an address if it is simply acting as a repeater or bridge (i.e., not performing any address translation).

5. An NIECU shall not retransmit a message onto the same network segment where the message was originally received.

6. An NIECU shall not go bus off due to CAN arbitration problems when forwarding an Address Claimed message. When an NIECU forwards an SAE J1939 message, it transmits the message using the source address of the originator of the message. Ordinarily, this will not cause CAN arbitration problems since the network segments have the same address space. However, there is one exception where forwarding can result in bus errors due to a bit collision outside of the Arbitration field of the CAN message. This one exception occurs when an Address Claimed message is forwarded onto a network segment where another ECU is simultaneously transmitting an Address Claimed message for the same address. In this very low probability case, the NIECU shall have the ability to detect a bus error when transmitting this message, and should stop the automatic retransmission sequence within the CAN controller chip. Otherwise, the NIECU can experience multiple collisions and go bus off, thereby preventing other messages from being forwarded until the NIECU is able to recover from the bus off condition.

7. Shall control transit delay. See 5.2 for recommended values.

5.3.2 Other Requirements

1. An NIECU design shall specify its guaranteed rate for performance characteristics, such as filtering rate and the guaranteed measure (e.g., average, minimum, maximum). A design can specify guaranteed rates for multiple different measures for the same performance characteristic, e.g., average message rate and maximum message rate.

2. An NIECU design shall specify a guaranteed filtering rate and forwarding rate. Guaranteed rates are not required to be specified as a singular value; they can be specified as a collection of conditional values. For example, when employing a priority based forwarding queue, forwarding of messages with a lower priority can be affected by the volume of higher priority messages being forwarded and, therefore, it can be necessary to specify forwarding rates for different message priorities as a function of messages at other priorities.

3. May support NIECU database management (highly recommended).

5.4 NIECU Suitability Criteria

Three performance criteria are typically associated with determining if an NIECU is suitable for a given application. These criteria should be used by the system integrator to evaluate the suitability of an NIECU for use on a particular vehicle.

1. Maximum number of messages guaranteed to be forwarded per second. An NIECU can fail to forward some messages if this rate is exceeded due to average or peak bus loads.

2. Maximum number of messages guaranteed to be filtered per second. If this rate is exceeded due to the number of entries in the database, it is possible that messages will be excessively delayed across the NIECU.

3. Maximum transit delay. This parameter is used to determine what the worst case latency can be for a message to be transmitted by an ECU and received by another ECU on a different network segment.

6. NETWORK INTERCONNECTION FUNCTIONS

The principal network interconnection functions that can be provided by an NIECU are message forwarding, message filtering, address translation, and protocol translation. Some NIECUs also provide a database management service to access and configure these network interconnection functions. Once operational, the NIECU should be essentially transparent to any ECUs on the vehicle network, in that these principal functions (excluding database management) are provided as services without the need for a specific request by the ECUs to use them. This section defines these functions as they pertain to an NIECU between two SAE J1939 network segments or an NIECU between an SAE J1939 network segment and a non-SAE J1939 network segment.

6.1 Message Forwarding

Forwarding is the networking function of transferring individual messages or message frames, with minimal delay, from one network to another network segment. The forwarding function allows physical and electrical extension of the network. Forwarding can be performed bit by bit (with less than bit time delay) with bit-wise message arbitration extended across the interface as long as the data rates are identical, or message by message (store and forward) with the added ability to re-order the transmission of the messages to accommodate message priority.

Forwarding function by repeaters and bridges does not involve any address translation. Repeater and bridge NIECUs shall only be used between network segments where the address space is continuous between the network segments and the data link protocol (e.g., SAE J1939-21) is identical on both network segments.

Until an NIECU has completed its power on and self-test (POST) sequence, ECUs will not receive forwarded messages from ECUs on other subnetworks.

6.2 Message Filtering

Filtering is the networking function that manages the messages passed by an NIECU from one network segment to another network segment. Filtering reduces the message traffic shared between different network segments. The NIECU applies a set of rules that define the messages that will be transferred from one network segment to another. In general, filtering can be done based upon message ID, source address, and/or destination address. However, SAE J1939-31 doesn’t provide database management services for filters based on source address or 11-bit CAN ID.

Bridges, routers and gateways can perform message filtering, though it is performed on different message objects (message frames, message segments, and messages, respectively).

There are two basic modes of operation for the filtering process within an NIECU: block mode or pass mode. These modes apply to a particular pair of ports (i.e., port pair) on the NIECU, which means a filtering rule defines the filtering of a message being passed from one specific port to another specific port.

6.2.1 Block Mode Filter

In block mode, the NIECU transfers all SAE J1939 message frames and SAE J1939 messages whose message ID (PGN) are not among the list of message IDs to be blocked (block list). The default behavior in block mode shall be to transfer all SAE J1939 messages. If there are no entries in the block list, then all message frames and messages are transferred and bus utilization (traffic) can be higher on each network segment. If the bus utilization is determined to be within acceptable limits with no entries in the block list, then the use of message filtering is not required.

For NIECUs connected to SAE J1939 network segments, this document only specifies block list data management services for reporting and configuring the list of SAE J1939 messages, by PGN, that are to be blocked from being transferred from one specific port to another specific port.

Block mode is the preferred filtering mode for SAE J1939 bridges. Block list entries are typically programmed during initial vehicle build and configuration, and should be retained in nonvolatile memory.

6.2.2 Pass Mode Filter

In pass mode, the NIECU only transfers message frames and messages whose message ID are not among the list of message IDs to be passed (pass list). An entry shall exist with a specific identifier (PGN value) for each message to be transferred. This filter mode is best used on NIECUs connected to subnetworks performing a specific function (braking, suspension, etc.) or to proprietary subnetworks with few or no messages destined for the global network. For pass mode, some of the pass list entries should be permanent (configured to always be present) so the corresponding messages will always be forwarded across the whole network, such as network management, diagnostics, and global requests.

Configuring the pass list requires detailed knowledge of the ECUs and functions present on the whole network, or requires the ability for ECUs to add entries to the pass list. The pass list can require more memory and processing power to exist within the NIECU if it is to accommodate and handle a potentially large number of pass list entries.

For NIECUs connected to SAE J1939 network segments, this document only specifies pass list data management services for reporting and configuring the list of SAE J1939 messages, by PGN, that shall only be passed from one specific port to another specific port.

6.3 Address Translation

Address translation is the networking function of changing the address data for a message segment as it is passed from one network segment to another network segment. Address translation is performed only on the source and destination address data of the message frame header; address translation is not performed on any address parameters contained in the PG data of the message segment. Address translation allows each network segment to have separate address space, which allows a single network address to be used on each network by different devices. Address translation can be done based upon the NAME or function associated with each claimed addresses on each network. The addresses in the address translation database shall be based upon NAME and not simply source addresses.

Routers and gateways can perform address translation, though it is performed on different message objects (message segments and messages, respectively). For SAE J1939 communications through a router NIECU, address translation is performed on an SAE J1939 message segment, i.e., the network layer PDU for an SAE J1939 message frame. The data field content from the SAE J1939 message frame remains unmodified in the network layer PDU.

An NIECU can also provide address translation for message frames for particular message IDs, permitting a single address to be used to reference a particular network segment (i.e., trailer or implement) without knowledge of the specific address for a particular function on the network segment (i.e., lighting). When performing address translation for messages, the address translation database shall identify the associated source or destination address. The NIECU shall have a valid Address Claimed before it can provide this address translation service.

6.4 Protocol Translation

Protocol translation is the networking function that allows communication between networks supporting different communication protocols. Protocol translation involves extracting data content from messages received from one network using one communication protocol, converting the data to the other communication protocol, assembling the standard message for the other communication protocol, and sending that message onto the other network using the other communication protocol. An NIECU can provide services to extract data from a network segment using one communication protocol and make that data available to an SAE J1939 network or vice-versa. The scope of this network function is defined by the need for information from the non-SAE J1939 protocol, and implementing this network function requires full knowledge of both protocols to be successful. An implementer of this function will identify particular parameters that are available on one protocol and convert, re-scale, and broadcast that information inside the standard messages of the other protocol. This document does not provide more specific rules for protocol translation.

Protocol translation is required when transferring SAE J1939 messages between an SAE J1939-21 based network segment and an SAE J1939-22 based network segment. Even though both are SAE J1939 network segments, the SAE J1939 message frame structures are different, the Transport Protocols are different, and their rules are different for how SAE J1939 messages are communicated using SAE J1939 message frames.

6.5 Database Management

Database management is the collection of services to configure the networking function databases within an NIECU, read the NIECU parametric data (such as status and statistics), and read network topology. This is an optional service, but its support is highly recommended for applicable types of NIECUs. The term database is used as a general reference to the collection of data that supports the networking functions, such as the list of messages (by PGN) to filter or the association of addresses between network segments. The Network Message PG, detailed in 7.1, provides services for reading and configuring the database management information.

6.5.1 Database Configuration Options

The filter database that exists within an NIECU can be configurable in several different ways.

6.5.1.1 Fixed, Pre-Defined Filter Database

A supplier of an NIECU may provide it with a fixed (pre-defined) filter database.

6.5.1.2 Configuration at Vehicle Manufacture

An NIECU can be designed such that it permits the vehicle OEM to configure the filter database at the time of vehicle manufacture. This requires prior knowledge of the whole vehicle network including the ECUs and messages present. This method can be inadequate to handle additions or changes to the vehicle network over time unless the NIECU can also be reconfigured during a service procedure.

6.5.1.3 Service Procedure Configuration

Service procedure configuration is configuration over the network during a service procedure by a diagnostic tool using the messages defined in this section to access the filter database.

6.5.1.4 Run-Time Configuration by ECUs

Run-time configuration describes NIECU reconfiguration at any time by any ECU on the network. A separate security procedure to enable modification of the database should also exist. Restrictions on which ECUs are allowed to reconfigure the filter database is application/implementation dependent.

6.5.2 Database Management Design Recommendations

The following are recommendations for the design of database management. NIECUs are not required to conform to these recommendations, but are encouraged to take these under consideration.

1. It is recommended to use nonvolatile memory to retain the database values and parametric data through power loss. This is particularly important for static filter database data. Provisions for a separate dynamic filter database which is cleared upon power loss to permit easy reconfiguration as ECUs are added and removed from the network is not presently defined.

2. For filter database entries created using the database management message functions, a source address and/or NAME can be associated with each entry. This address/NAME represents the ECU which placed the entry, since it is also the only ECU which should remove it. Although this does not prevent ECUs from entering conflicting requests, it can prevent them from deleting entries within the filter database unexpectedly. A provision should also exist for diagnostic tools to override this address/NAME match requirement in order to remove entries. This document does not include details of a universal method of managing filter database entries under all conditions.

6.6 Tunneling (Foreign Message Transport)

Tunneling is the internetworking function of communicating a message from one network segment over another network segment by encapsulating the original message or message packet within the data of another message or message packet. SAE J1939 refers to this networking function as foreign message transport (FMT) because it allows non-SAE J1939 protocol (foreign protocol) messages to be transferred over an SAE J1939 network in a non-interfering manner. FMT can allow more efficient use of the network wiring on a vehicle by allowing the use of separate, non-interfering message sets.

SAE J1939 supports tunneling of particular foreign protocols, or non-SAE J1939 protocols, by assigning SAE J1939 PGs for tunneling specific foreign protocol messages. The definition for how the foreign protocol message is encapsulated into the PG data of the SAE J1939 PG is defined elsewhere, such as within ISO 11992 or ISO 15765. Examples of some of the FMT PGs assigned by SAE J1939 are PGNs 52480, 52736, 55808, and 56064.

SAE J1939 FMT messages are SAE J1939 messages, and shall comply with and abide by the SAE J1939 data link protocol rules and the SAE J1939 addressing methods to assure the message frames are transported without conflict. Only the PG data portion of the FMT messages belong to the foreign protocol; the message frames shall conform strictly to the SAE J1939 Recommended Practice.

Since 11-bit identifier and 29-bit identifier CAN data frames can be communicated over the same physical network segment, it is possible for the foreign message transport function to be performed by an ECU with only one port. Such a scenario requires the 11-bit identifier CAN data frames to use a foreign protocol, such as ISO 11992.

6.6.1 Foreign Message Transport Examples

There are many different vehicle network situations where tunneling, or foreign message transport, might be necessary. Several examples of different use case scenarios are provided below to illustrate FMT over SAE J1939.

Figure 3 and Figure 4 illustrate an example of FMT messages to tunnel messages when two foreign protocol network segments are separated by an SAE J1939 network segment. In this example, an NIECU shall exist at each end of the SAE J1939 network segment to tunnel the foreign messages using FMT messages over the SAE J1939 network segment. For a foreign protocol message going from ECU1 to ECU2, NIECU1 receives the message from ECU1 and encapsulates the foreign protocol message into the PG data of an FMT message. Next, NIECU1 sends the FMT message over the SAE J1939 network to NIECU2 using the SAE J1939 SA for NIECU2 as the destination address for the FMT message. NIECU2 extracts the foreign protocol message from the PG data of the FMT message and forwards it to ECU2. Figure 4 illustrates the messaging sequence involved in an ISO 15765 request and response transaction between ECU1 and ECU2.

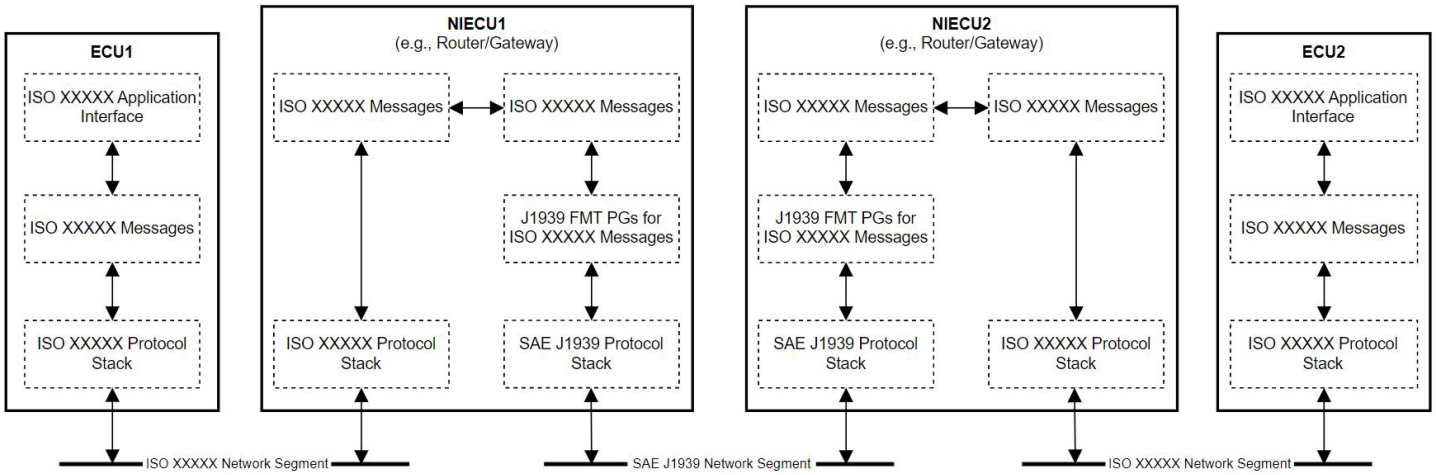
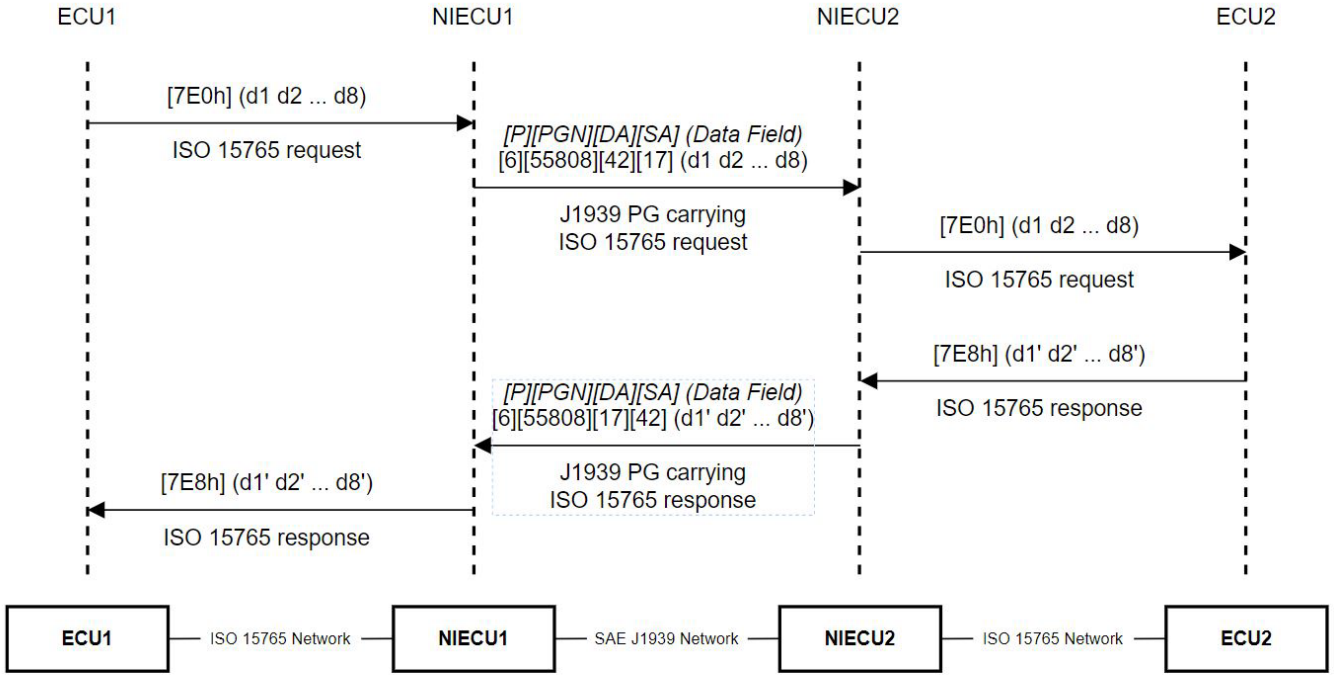


Figure 3 - Foreign message transport example 1—logical model



NOTE: For illustrative purposes only. Refer to ISO 15765-2 for use of SAE J1939 PGs for different modes of ISO 15765 addressing.

Figure 4 - Foreign message transport example 1—messaging sequence

Figure 5 illustrates the use of FMT messages when a pair of ECUs support an application based upon a foreign protocol but one ECU is connected to an SAE J1939 network segment and the other ECU is connected to the foreign protocol network. For a message going from ECU1 to ECU2, NIECU1 receives the message from ECU1 and encapsulates the foreign protocol message into the PG data of the FMT message. Next, NIECU1 sends the FMT message over SAE J1939 network to ECU2 using the SAE J1939 SA of ECU2 as the destination address for the FMT message. ECU2 extracts the foreign protocol message from the FMT message PG data and uses it in its application. For a message going from ECU2 to ECU1, ECU2 shall know that ECU1 is accessed via NIECU1 using FMT messages for a particular foreign protocol. ECU2 builds and encapsulates the foreign protocol message into the PG data of a FMT message and sends the FMT message over SAE J1939 using the SAE J1939 SA of the NIECU1 as the destination address for the FMT message. NIECU1 extracts the foreign protocol message from the FMT message PG data and forwards it to ECU1.

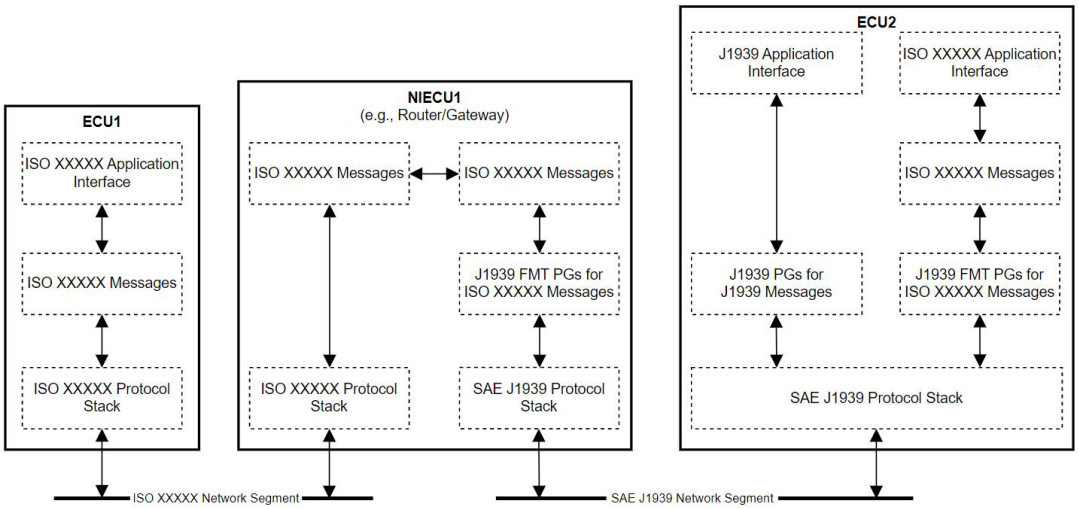


Figure 5 - Foreign message transport example 2

Figure 6 illustrates the use of FMT when the applications in a pair of ECUs interact based upon a foreign protocol service even though both ECUs are connected to the same SAE J1939 network segment. For a foreign protocol message going from ECU1 to ECU2, ECU1 shall know that ECU2 is accessed over the local SAE J1939 network using the particular FMT message. ECU1 builds the foreign protocol message and encapsulates it into the PG data for an FMT message and sends the FMT message over the SAE J1939 network addressed to the SAE J1939 SA of ECU2. ECU2 extracts the foreign protocol message from the FMT message PG data and uses it in its application.

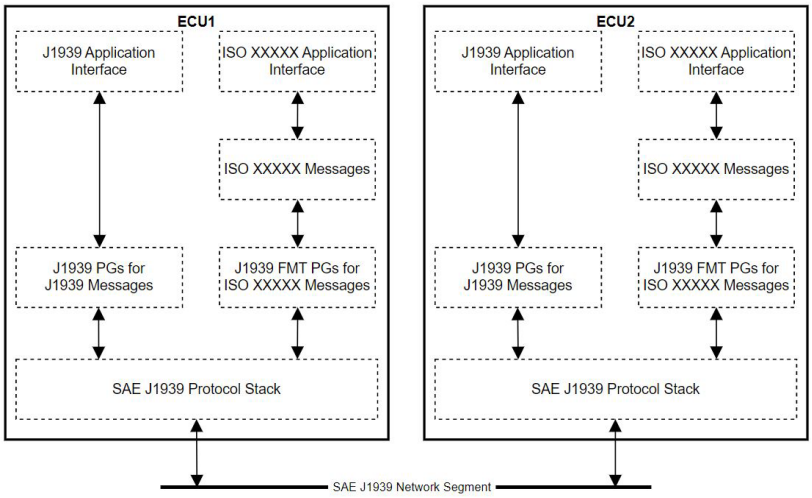


Figure 6 - Foreign message transport example 3

7. NETWORK INTERCONNECTION ECU DATABASE MANAGEMENT MESSAGE

The Network Message PG provides the means to configure the networking function databases and access the parametric data and network topology information from an NIECU. Network Message is a bidirectional communication message used to carry the network requests and commands to the NIECU and carry most of the network responses and acknowledgements from the NIECU. Network Message provides a means to:

- Access and configure the filter database within the NIECU
- Access port addresses of the NIECU
- Access status and statistics from the NIECU

7.1 Network Message PG

The basic definition of the Network Message PG is shown in Figure 7. The first byte of the PG data for every Network Message is the Network Message Control Byte value that identifies the service or function of that instance of the Network Message PG. The remaining PG data content for the Network Message PG depends upon the Network Message Control Byte value. Some instances of the Network Message PG can require use of Transport Protocol.

PGN 60672 Network Message (N.xx)

Used to access network interconnection ECU parametric data and databases

Transmission Repetition Rate:	Per user requirements, not recommended to exceed 5 times per second
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	237
PDU Specific:	0
PDU Type:	PDU1 (destination specific)
Default Priority:	6
Parameter Group Number:	60672 ($00ED00_h$)

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte	5592	7.1.1
2 to n	7 to 1784 bytes	Network Message Function-Specific Data Content		

Figure 7 - Network message PG (PGN 60672) definition

7.1.1 Network Message Control Byte (SPN 5592)

The Network Message Control Byte (i.e., control byte) identifies the function or service of the Network Message PG. The content of the PG data bytes after the control byte are dependent upon the control byte function. The control byte is the first byte of the PG data of all Network Message instances.

Identifies the function or service of an instance of the Network Message. A summary of the Network Message Control Byte values is provided in Table 1.

Data Length:	1 byte	
Resolution:	1 / bit, 0 offset	
Data Range:	0 to 250	Operational Range: same as data range
Type:	Status	
Supporting Information:		
PGN reference:	60672	

Table 1 - Network message control byte values

Control Byte Value	Network Message Alias	Function Description	Function Direction	Reference
0	N.MFDB_Request	Message filter database request	ECU to NIECU	7.3.1
1	N.MFDB_Response	Message filter database response	NIECU to ECU	7.3.2
2	N.MFDB_Add	Add message to the message filter database	ECU to NIECU	7.3.3
3	N.MFDB_Delete	Delete message from the message filter database	ECU to NIECU	7.3.4
4	N.MFDB_Clear	Clear the message filter database for a port pair	ECU to NIECU	7.3.5
5		Obsolete, not to be used	N/A	N/A
6	N.MFDB_Create_Entry	Create message filter database for a port pair	ECU to NIECU	7.3.6
7 to 63		Reserved for future assignment by SAE	N/A	N/A
64	N.NT_Request	Source addresses request	ECU to NIECU	7.4.1
65	N.NT_Response	Source addresses response	NIECU to ECU	7.4.2
66	N.NTX_Request	Source address and NAMEs request	ECU to NIECU	7.4.3
67	N.NTX_Response	Source address and NAMEs response	NIECU to ECU	7.4.4
68 to 127		Reserved for future assignment by SAE	N/A	N/A
128	N.GP_Request	NIECU general parametric data request	ECU to NIECU	7.5.1
129	N.GP_Response	NIECU general parametric data response	NIECU to ECU	7.5.2
130	N.GP_Reset	NIECU general parametric data reset request	ECU to NIECU	7.5.3
131	N.SP_Request	Port pair parametric data request	ECU to NIECU	7.6.1
132	N.SP_Response	Port pair parametric data response	NIECU to ECU	7.6.2
133	N.SP_Reset	Port pair parametric data reset request	ECU to NIECU	7.6.3
134 to 250		Reserved for future assignment by SAE	N/A	N/A
251 to 255		Indicators (per SAE J1939-71, Table 1)	N/A	N/A

7.2 General Network Message Requirements

1. If the length of the PG data for the Network Message PG is less than 8 bytes, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes.

2. An NIECU shall respond when the NIECU supports the Network Message PG and the instance of the Network Message PG was sent to the NIECU using a specific destination address.

3. An NIECU shall respond when the NIECU supports both the Network Message PG and the Network Message Control Byte value and the instance of the Network Message PG was sent to the global destination address. However, an NIECU shall not respond to an instance of the Network Message PG sent to the global destination address when NIECU does not support the Network Message PG, does not support the Network Message Control Byte value, or cannot perform the operation specified by the Network Message Control Byte value.

4. The Acknowledgement PG (PGN 59392) shall be used as the response for Network Message interactions for some of the Network Message acknowledge responses. The Acknowledgement PG shall be used with the Network Message to provide a negative acknowledge response when an NIECU response is required, such as a destination specific instance where the Network Message Control Byte value is not supported or when the Network Message function cannot be performed. When the Acknowledgement PG is used to respond to a Network Message request or command, the PG data for the Acknowledgement PG shall have the PGN of the Network Message PG (PGN 60672) reported in the Parameter Group Number bytes and the Network Message Control Byte value reported in the Group Function value parameter bytes. Refer to SAE J1939-21 and SAE J1939-22 for details on the Acknowledgment PG.

5. An ECU shall wait for a response to its Network Message request or command, or for the “no response” time-out, before sending another Network Message request or command.

6. An NIECU should be capable of configuring the filter database properly if the global port number is specified for either or both of the port values in a port pair.

7.3 Message Filter Database Services (N.MFDB)

The message filter database services are a set of Network Message messages for accessing and configuring the message filter database in the NIECU. The first byte of PG data for each N.MFDB message is the Network Message Control Byte value that identifies the message filter database service. The second byte of the PG data for each N.MFDB message is the port pair data. The remaining bytes in the PG data for each N.MFDB message are dependent on the Network Message Control Byte value.

7.3.1 Message Filter Database Request (N.MFDB_Request)

The N.MFDB_Request message is used to request the message filter database information for the port pair specified by the To Port and From Port parameters. This message is sent from the ECU to the NIECU.

N.MFDB_Request Message (Network Message Control Byte = 0)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 0	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3 to 8	1 byte	Fill each byte with FF_h		

7.3.2 Message Filter Database Response (N.MFDB_Response)

The N.MFDB_Response message is used to provide the message filter database entries, in response to a N.MFDB_Request. The message identifies the list of SAE J1939 messages, identified by their PGN, and the Filter Mode applied to those messages when going from the “From Port” to the “To Port.” PGN List can contain zero, one, or more PGNs. This message is sent from the NIECU to the ECU.

N.MFDB_Response Message (Network Message Control Byte = 1)

Transmission Repetition Rate: On Request
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 1	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3	1 byte	Filter Mode	5596	7.7.5
4 to 6	3 bytes	PGN	5599	7.7.8
		Byte 4 LSB of PGN		
		Byte 5 2nd byte of PGN		
		Byte 6 MSB of PGN		

NOTE 1: The PG data contains a list of one or more PGNs.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = Filter Mode
d = PGN
PG data will be as follows: a, b, c, d, d, d .... etc.

NOTE 2: When only 1 PGN is included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

EXAMPLE: The SAE J1939-21 CEFF message frames in Figure 8 illustrate the Network Message exchange for the filter database information from the tractor-trailer bridge. The example shows the N.MFDB_Request from an offboard diagnostic tool (SA 248) and the subsequent N.MFDB_Response from the tractor-trailer bridge (SA 32). The N.MFDB_Request is a request for the filter database entries for messages going from the network at port 1 to the network at port 2, i.e., from port 1 to port 2. The N.MFDB_Response indicates block list filtering is used from port 1 to port 2 (filter mode = 0) and the Engine Configuration PG (PGN 00FEE3$_h$) is the only SAE J1939 message being blocked by the filter.

Function	Identifier						Data							
N.MFDB_Request	PRI	EDP	DP	PF	DA	SA	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	110b	0	0	237	32	248	00h	12h	FFh	FFh	FFh	FFh	FFh	FFh
							Control Byte	Port Pair	Fill bytes					

Function	Identifier						Data							
N.MFDB_Response	PRI	EDP	DP	PF	DA	SA	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	110b	0	0	237	248	32	01h	12h	00h	E3h	FEh	00h	FFh	FFh
							Control Byte	Port Pair	Filter Mode	PGN			Fill bytes	

Figure 8 - Example of message data frames for filter database information

7.3.3 Add Messages to Message Filter Database (N.MFDB_Add)

The N.MFDB_Add message is used to add one or more messages (by PGN) to the message filter database. The PG data contains a list of one or more PGNs, where each PGN is the PGN of an SAE J1939 message to add to the message filter database for the specified port pair. If the “To Port” is set to global value, then the message is a request to add these messages to the message filter database for each port pair. An ECU using this function shall already know the Filter Mode of the particular filter database before making an entry as the filter mode is not included with this command and cannot be changed without clearing and rebuilding the database for that port pair. See 7.3.6 for comparison. Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.MFDB_Add Message (Network Message Control Byte = 2)

Transmission Repetition Rate: As Required
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name		SPN	
1	1 byte	Network Message Control Byte = 2		5592	7.1.1
2.1	4 bits	To Port		5594	7.7.3
2.5	4 bits	From Port		5595	7.7.4
3 to 5	3 bytes	PGN		5599	7.7.8
		Byte 3	*LSB of PGN*		
		Byte 4	*2nd byte of PGN*		
		Byte 5	*MSB of PGN*		

NOTE 1: The PG data contains a list of one or more PGNs.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = PGN
PG data will be as follows: a, b, c, c, c .... etc.

NOTE 2: When only 1 or 2 PGNs are included in the PG data, then bytes of FF$_h$ shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.3.4 Delete Messages from Filter Database (N.MFDB_Delete)

The N.MFDB_Delete message is used to delete one or more SAE J1939 messages, specified by their PGN, from the message filter database for a port pair. The PG data contains a list of one or more PGNs, where each PGN is the PGN of an SAE J1939 message to delete from the message filter database for the specified port pair. If the "To Port" is set to global value, then the message is a request to delete these messages from the message filter database for each port pair. Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.MFDB_Delete Message (Network Message Control Byte = 3)

Transmission Repetition Rate: As Required
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name		SPN	
1	1 byte	Network Message Control Byte = 3		5592	7.1.1
2.1	4 bits	To Port		5594	7.7.3
2.5	4 bits	From Port		5595	7.7.4
3 to 5	3 bytes	PGN		5599	7.7.8
		Byte 3	*LSB of PGN*		
		Byte 4	*2nd byte of PGN*		
		Byte 5	*MSB of PGN*		

NOTE 1: The PG data contains a list of one or more PGNs.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = PGN
PG data will be as follows: a, b, c, c, c .... etc.

NOTE 2: When only 1 or 2 PGNs are included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.3.5 Clear Message Filter Database for a Port Pair (N.MFDB_Clear)

The N.MFDB_Clear message is used to clear the all messages from the message filter database for the port pair. Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.MFDB_Clear Message (Network Message Control Byte = 4)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 4	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3 to 8	1 byte	Fill each byte with FF_h		

7.3.6 Create Message Filter Database for a Port Pair (N.MFDB_Create_Entry)

The N.MFDB_Create_Entry message is used to create (initialize) a message filter database entry for the port pair. The message data specifies the port pair, the filter mode to apply to the port pair, and the SAE J1939 messages, specified by their PGN, to add to the message filter for the port pair. If the "To Port" is set to global value, multiple entries can be made in the filter database, one for each port pair containing the "From Port." The filter mode is included with this command to explicitly indicate whether the new entry is for block or pass mode. The PG data contains a list of one or more PGNs, where each PGN is the PGN of an SAE J1939 message to add to the message filter database for the specified port pair.

If an NIECU receives a N.MFDB_Create_Entry message and the NIECU message filter database already has message filter entries for the port pair, then the NIECU should respond with a negative acknowledgement using the Acknowledgement PG. The N.MFDB_Create_Entry service is not intended to be used to modify an existing message filter database for a port pair, such as changing the filter mode or adding messages to the filter. The N.MFDB_Add and N.MFDB_Delete services should be used to modify the messages in the filter for a port pair.

Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.MFDB_Create_Entry Message (Network Message Control Byte = 6)

Transmission Repetition Rate: As Required
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 6	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3	1 byte	Filter Mode	5596	7.7.5
4 to 6	3 bytes	PGN	5599	7.7.8
		Byte 4 LSB of PGN		
		Byte 5 2nd byte of PGN		
		Byte 6 MSB of PGN		

NOTE 1: The PG data contains a list of one or more PGNs.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = Filter Mode
d = PGN
PG data will be as follows: a, b, c, d, d, d .... etc.

NOTE 2: When only 1 PGN is included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.4 Network Topology Information Services (N.NT)

The network topology information services (N.NT) are a set of Network Message messages to get basic information about the nodes connected to other ports of the NIECU. The first byte of the PG data for each N.NT message is the Network Message Control Byte value that identifies the network topology information service. The second byte of the PG data for each N.NT message contains a single port number, placed in the lower nibble, to identify the NIECU port that the topology information is associated. The remaining PG data bytes in each N.NT message are dependent on the Network Message Control Byte value.

Even though NIECUs should be transparent to the ECUs on a network, there are circumstances when it is necessary for an ECU to know the actual topology of the network in order to properly set up the databases. Topology information for network segments using non-SAE J1939 address spaces is not defined in this document.

If there are multiple bridges present on a given vehicle network, it may be necessary to get network topology information from all of the bridges in order to identify the network segment containing the device using a particular source address. A bridge can only identify its network segment connection where a particular source address is located. However, it is possible that particular source address appears on that network segment due to another bridge connected to that same network segment.

Topology information for networks containing non-SAE J1939 address spaces is not defined in this document.

7.4.1 Source Addresses on a Port Request (N.NT_Request)

The N.NT_Request message is used to request the list of SAE J1939 source addresses found on a given NIECU port.

N.NT_Request Message (Network Message Control Byte = 64)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 64	5592	7.1.1
2.1	4 bits	Port	5593	7.7.2
2.5	4 bits	Fill with F_h		
3 to 8	1 byte	Fill each byte with FF_h		

7.4.2 Source Addresses on a Port Response (N.NT_Response)

The N.NT_Response message is used to provide the list of SAE J1939 source addresses found on an NIECU port, in response to an N.NT_Request. The PG data contains a list of zero or more SAE J1939 source addresses.

N.NT_Response Message (Network Message Control Byte = 65)

Transmission Repetition Rate: On Request
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 65	5592	7.1.1
2.1	4 bits	Port	5593	7.7.2
2.5	4 bits	Fill with F_h		
3	1 byte	Source Address (SA)	5600	7.7.8

NOTE 1: The PG data contains a list of one or more Source Addresses (SA).
Given:
a = Network Message Control Byte
b = Port
c = SA
PG data will be as follows: a, b, c, c, c .... etc.

NOTE 2: When fewer than 6 SAs are included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.4.3 Source Addresses and NAMEs on a Port Request (N.NTX_Request)

The N.NTX_Request message is used to request the list of SAE J1939 source addresses and associated NAMEs found on a given NIECU port. This message should be used only when the ECU on the local network segment will not see the address claim messages of the controller applications on the network segment connected to the specified NIECU port; for example, when the network segments are separated by a router. This message should be used only when the network segment connected to the specified NIECU port supports the SAE J1939 NAME entity, such as an SAE J1939 or ISO 11783 network.

N.NTX_Request Message (Network Message Control Byte = 66)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 66	5592	7.1.1
2.1	4 bits	Port	5593	7.7.2
2.5	4 bits	Fill with F_h		
3 to 8	1 byte	Fill each byte with FF_h		

7.4.4 Source Addresses and NAMEs on a Port Response (N.NTX_Response)

The N.NTX_Response message is used to provide the list of SAE J1939 source addresses and associated NAMEs found on an NIECU port, in response to an N.NTX_Request. The “Number of SA/NAME Pairs” parameter indicates the number of 9-byte SAE J1939 Source Address and NAME pairs contained in the PG data. The message is limited to a maximum of 198 SA/NAME pairs.

N.NTX_Response Message (Network Message Control Byte = 67)

Transmission Repetition Rate: On Request
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 67	5592	7.1.1
2.1	4 bits	Port	5593	7.7.2
2.5	4 bits	Fill with F_h		
3	1 byte	Number of SA/NAME Pairs	5602	7.7.11
a	1 byte	Source Address	5600	7.7.9
b	8 bytes	NAME associated with SA	5601	7.7.10

NOTE 1: The PG data contains a list of one or more Source Addresses (SA).
Given:
a = Network Message Control Byte
b = Port
c = Number of SA/NAME Pairs
d = Source Address
e = NAME associated with SA
PG data will be as follows: a, b, c, d, e, d, e .... etc.

NOTE 2: If there are zero SA/NAME pairs to report, then PG data shall be 8 bytes long with byte 4 to byte 8 in the PG data set to FF_h, as specified in 7.2.

7.5 NIECU General Parametric Data Services (N.GP)

The NIECU general parametric data services (N.GP) are a set of Network Message messages to get NIECU performance and operation status and statistics data. The general parametric data services provide the status and statistics data for the NIECU without regard to a specific port pair. Services for accessing similar parametric data for a specific port pair are provided through the network message services detailed in 7.6. The first byte of the PG data for each N.GP message is the Network Message Control Byte value that identifies the parametric data service. The remaining PG data bytes for each N.GP message are dependent on the Network Message Control Byte value.

The list of available parameters is defined in Table 4. Some of the parametric data is applicable for a given NIECU, for a specific port pair, or for both.

An NIECU is not require to support reporting parameter data for every NIECU Parameter Number; however, an NIECU shall know the data byte length for all NIECU parameters which have a NIECU Parameter Number that is less than the highest NIECU Parameter Number supported or known by the NIECU. This is required so the NIECU can report the correct number of bytes of FF_h for unsupported parameters.

7.5.1 NIECU General Parametric Data Request (N.GP_Request)

The N.GP_Request message used to request general status and statistics parametric data for the NIECU. SAE J1939 recommends the request always be for Parameter Number 0, which returns the data for the entire list of parameters. The PG data contains a list of one or more NIECU Parameter Numbers where each NIECU Parameter Number identifies data being requested. When two or more NIECU Parameter Numbers are requested, the parameter numbers shall be listed in ascending numerical order in the PG data.

N.GP_Request Message (Network Message Control Byte = 128)

Transmission Repetition Rate: As Required
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 128	5592	7.1.1
2	1 byte	NIECU Parameter Number	5597	7.7.6

NOTE 1: The PG data contains a list of one or more Source Addresses (SA).
Given:
a = Network Message Control Byte
b = NIECU Parameter Number
PG data will be as follows: a, b, b, b .... etc.

NOTE 2: When fewer than 7 NIECU Parameter Numbers are included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.5.2 NIECU General Parametric Data Response (N.GP_Response)

The N.GP_Response message is used to provide the general status and statistical parametric data for the NIECU, in response to a N.GP_Request. The NIECU Parameter Data content is dependent upon the N.GP_Request.

- When the N.GP_Request is for Parameter Number 0 (zero), the NIECU Parameter Data in the PG Data for the N.GP_Response shall contain the parameter data for all parameter numbers, in numerical order.
- When the N.GP_Request is for a list of parameter numbers, the NIECU Parameter Data in the PG Data for the N.GP_Response shall contain the parameter data for the specified parameter numbers, in the same order the parameter numbers are listed in the N.GP_Request.
- The PG data for an unsupported parameter shall be filled with FF_h. This is necessary because the interpretation of the NIECU Parameter Data is based upon the data byte position since the NIECU Parameter Data consists of only the parametric data values.
- If the NIECU Parameter Data is shorter than expected by the requesting ECU, it means the NIECU has no knowledge of additions to the parameter list and stopped with the last known parameter.

N.GP_Response Message (Network Message Control Byte = 129)

Transmission Repetition Rate: On Request
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 129	5592	7.1.1
2 to n		NIECU Parameter Data	5598	7.7.7

NOTE 1: The PG data contains a list of data for one or more NIECU parameters.
Given:
a = Network Message Control Byte
b = NIECU Parameter Data
PG data will be as follows: a, b, b, b .... etc.

7.5.3 NIECU General Parametric Data Reset Request (N.GP_Reset)

The N.GP_Reset message is used to reset the data for all of the resettable statistical parametric data for the NIECU. The items in Table 4 with “Yes” in the “Able to be Reset” column are the statistical parametric data that are resettable.

Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.GP_Reset Message (Network Message Control Byte = 130)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 130	5592	7.1.1
2 to 8	1 byte	Fill each byte with FF_h		

7.6 NIECU Specific Port Pair Parametric Data Services (N.SP)

The NIECU specific port pair parametric data services (N.SP) are a set of Network Message messages to get NIECU operation status and statistics parametric data for a specific port pair. Services for accessing similar parametric data for the NIECU without regard to a specific port pair are provided through the network message services detailed in 7.5. The first byte of PG data for each N.SP message is the Network Message Control Byte value that identifies the port pair parametric data service. The second byte of PG data for each N.SP message is the port pair. The remaining data bytes in the PG data for each N.SP message is dependent on the Network Message Control Byte value.

The list of available parameters is defined in Table 4.

7.6.1 NIECU Specific Port Pair Parametric Data Request (N.SP_Request)

The N.SP_Request message is used to request status and statistics parametric data for a specific port pair of the NIECU. SAE J1939 recommends the request always the data for be for Parameter Number 0, which returns the entire list of parameters. The PG data contains a list of one or more NIECU Parameter Numbers where each NIECU Parameter Number identifies data being requested. When two or more NIECU Parameter Numbers are requested, the parameter numbers shall be listed in ascending numerical order.

N.SP_Request Message (Network Message Control Byte = 131)

Transmission Repetition Rate: As Required
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 131	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3	1 byte	NIECU Parameter Number	5597	7.7.6

NOTE 1: The PG data contains a list of data for one or more NIECU parameters.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = NIECU Parameter Number
PG data will be as follows: a, b, c, c, c .... etc.

NOTE 2: When fewer than 6 NIECU Parameter Numbers are included in the PG data, then bytes of FF_h shall be appended to the PG data content to attain a length of 8 bytes, as specified in 7.2.

7.6.2 NIECU Specific Port Pair Parametric Data Response (N.SP_Response)

The N.SP_Response message is used to provide the status and statistical parametric data for a specific port pair for the NIECU, in response to a N.SP_Request. The NIECU Parameter Data content is dependent upon the N.SP_Request.

- When the N.SP_Request is for Parameter Number 0 (zero), the NIECU Parameter Data in the PG Data for the N.SP_Response shall contain the parameter data for all parameter numbers, in numerical order.

- When the N.SP_Request is for a list of parameter numbers, the NIECU Parameter Data in the PG Data for the N.SP_Response shall contain the parametric data for the specified parameter numbers, in the same order the parameter numbers are listed in the N.SP_Request.

- The PG data for an unsupported NIECU Parameter shall be filled with bytes of FF_h. This is necessary because the interpretation of NIECU Parameter Data is based upon the data byte position since NIECU Parameter Data consists of only the parametric data values.

- If the NIECU Parameter Data is shorter than expected by the requesting ECU, it means the NIECU has no knowledge of additions to the parameter list and stopped with the last known parameter.

N.SP_Response Message (Network Message Control Byte = 132)

Transmission Repetition Rate: On Request
Data Length: 8 to 1785 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 132	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3 to n		NIECU Parameter Data	5598	7.7.7

NOTE 1: The PG data contains a list of data for one or more NIECU parameters.
Given:
a = Network Message Control Byte
b = To Port and From Port
c = NIECU Parameter Data
PG data will be as follows: a, b, c, c, c .... etc.

7.6.3 NIECU Specific Port Pair Parametric Data Reset Request (N.SP_Reset)

The N.SP_Reset message is used to reset the data for all of the resettable statistical parameters for a specific port pair of the NIECU. The items in Table 4 with "Yes" in the "Able to be Reset" column are the statistical parameters that are resettable.

Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

N.SP_Reset Message (Network Message with Control Byte = 133)

Transmission Repetition Rate: As Required
Data Length: 8 bytes
Parameter Group Number: 60672

Start Position	Length	Parameter Name	SPN	
1	1 byte	Network Message Control Byte = 133	5592	7.1.1
2.1	4 bits	To Port	5594	7.7.3
2.5	4 bits	From Port	5595	7.7.4
3 to 8	1 byte	Fill each byte with FF_h		

7.7 Network Message Parameter Definitions

The definition of the parameters used within the many different functions of the network message.

7.7.1 Port Numbers and Port Pair

7.7.1.1 Port Numbers

A Port Number is a numerical reference to a port of an NIECU that is the connection point to a network segment. SAE J1939 uses a nibble (4 bits) for representing a port number in the Network Message. Port numbers 0 and 15 have assigned meanings. Port numbers 1 through 14 are available for use or assignment as appropriate for the system or NIECU design. Port number assignments associated with particular network segment are specific to the NIECU or the system design. The port number assignments are defined in Table 2.

Table 2 - Port number assignments

Port Number	Definition
0	Local
1-14	Assignable
15	Global (all ports)

Port number 0 is the reference to the local port. The local port is a reference to the NIECU port for the network segment that physically connects the NIECU and an ECU. The local port number allows the ECU to interact with the NIECU about the local network segment without requiring the ECU to know the port number used by the NIECU for this network segment.

Port number 15 is the global port number, the reference for all ports of the NIECU. The global port number allows the ECU to interact with the NIECU about all of the NIECU ports without requiring the ECU to know the number of ports available on the NIECU. The global port number allows the ECU to interact with the NIECU about all of the NIECU ports rather than the ECU having to repeat the same interaction with the NIECU for each individual NIECU port.

The use of the global port number (port number 15) for the "to port" and/or the "from port" in a Network Message may result in multiple Network Message responses from the NIECU for each specific port pair combination.

7.7.1.2 Port Pair

Port pair is a reference to two ports of an NIECU with a specific direction of message activity between those ports. A port pair is specified by the port number for the “From Port” and the port number for the “To Port” and refers to the activities and attributes of the NIECU for messages going from the “From Port” to the “To Port.” The port pair of “from 2 and to 3” is not interchangeable with the port pair of “from 3 and to 2.” While these two port pairs reference the same ports of the NIECU, they refer to opposite directions of messages passing between these ports. The port pair “from 2 and to 3” refers to NIECU message activity received on port 2 and targeted for port 3; whereas the port pair “from 3 and to 2” refers to NIECU message activity received on port 3 and targeted for port 2.

When the Network Message service requires port pair information in the PG data, the port pair shall be placed into a single byte with the “from port” number positioned in the upper nibble (bits 8 to 5) of the byte and the “to port” number positioned in the lower nibble (bits 4 to 1) of the byte.

7.7.2 NIECU Port (SPN 5593)

Identifies a specific port of the NIECU without context of messaging direction through the port. The port number assignments are shown in Table 2 and discussed in 7.7.1.1.

Data Length:	4 bits	
Resolution:	1 / bit, 0 offset	
Data Range:	0 to 15	Operational Range: Same as Data Range
Type:	Status	
PGN reference:	60672	

7.7.3 To Port (SPN 5594)

Identifies the destination port, or send port, of messages being moved through the NIECU. The port number assignments are shown in Table 2 and discussed in 7.7.1.1.

Data Length:	4 bits	
Resolution:	1 / bit, 0 offset	
Data Range:	0 to 15	Operational Range: Same as Data Range
Type:	Status	
PGN reference:	60672	

7.7.4 From Port (SPN 5595)

Identifies the origination port, or receive port, of messages being moved through the NIECU. The port number assignments are shown in Table 2 and discussed in 7.7.1.1.

Data Length:	4 bits	
Resolution:	1 / bit, 0 offset	
Data Range:	0 to 15	Operational Range: Same as Data Range
Type:	Status	
PGN reference:	60672	

7.7.5 Filter Mode (SPN 5596)

Identifies the mode of filtering operation applied for messages being passed from one port to another port. The filter mode value assignments are shown in Table 3.

Data Length:	1 byte	
Resolution:	1 / bit, 0 offset	
Data Range:	0 to 250	Operational Range: Same as Data Range
Type:	Status	
PGN reference:	60672	

Table 3 - Filter mode values

Filter Mode	Definition
0	Block list filter mode (see 6.2.1)
1	Pass list filter mode (see 6.2.2)
2-250	Reserved for future assignment by SAE
251-255	Defined by SAE J1939-71

7.7.6 NIECU Parameter Number (SPN 5597)

The NIECU parameter number identifies a specific status or statistical parameter associated with an NIECU, a specific port pair of the NIECU, or both. The list of available parameters and the assigned parameter number is shown in Table 4. The data definitions for each of these parameters is detailed in Section 8.

Parameter Number 0 is used to indicate a request for all parameters. Parameter Number 0 shall only be used in an NIECU parametric data request message. Parameter Number 0 shall not be used in an NIECU parametric data response message. The “request all parameters” parameter number allows an ECU to request the parameter data for all parameters without having to explicitly call out each parameter number in the request.

Data Length: 1 byte
Resolution: 1 / bit, 0 offset
Data Range: 0 to 253 Operational Range: Same as Data Range
Type: Status
PGN reference: 60672

Table 4 - NIECU status and statistics parameter numbers

Parameter Number	Number of Bytes	Able to be Reset	Parameter Description	Data Definition
0	N/A	-	Request all parameters (not used in response message)	N/A
1	2	-	Buffer size	8.1
2	2	-	Maximum filter database size	8.2
3	2	-	Number of filter database entries	8.3
4	2	-	Maximum messages received per second	8.4
5	2	-	Maximum messages forwarded per second	8.5
6	2	-	Maximum messages filtered per second	8.6
7	2	-	Maximum transit delay time	8.7
8	2	Yes	Average transit delay time	8.8
9	2	Yes	Number of messages lost due to buffer overflow	8.9
10	2	Yes	Number of messages with excess transit delay time	8.10
11	2	Yes	Average messages received per second	8.11
12	2	Yes	Average messages forwarded per second	8.12
13	2	Yes	Average messages filtered per second	8.13
14	4	-	Uptime since last power on reset	8.14
15	1	-	Number of ports	8.15
16	1	-	Network interconnection type	8.16
17-253	N/A	-	Reserved for future assignment by SAE	N/A
254-255	N/A	-	Refer to SAE J1939-71 for definitions	N/A

7.7.7 NIECU Parameter Data (SPN 5598)

NIECU Parameter Data is the parameter data for an NIECU parameter, identified by NIECU parameter number. The parameter data shall be encoded with the data size specified by the parameter number definition in Section 8. The list of available parameters and a cross-reference to the parameter number definition is shown in Table 4.

The NIECU Parameter Data shall be filled with bytes of FF_h for unsupported NIECU parameters. This is necessary because the interpretation of NIECU Parameter Data is based upon the data byte position since NIECU Parameter Data consists of only the parametric data values. Consequently, an NIECU is required to know the parameter number and data size for NIECU parameters that it doesn't support so it is able to populate those data bytes in the NIECU Parameter Data.

Data Length: Parameter specific
Resolution: Parameter specific
Data Range: Parameter specific
Data Type: Parameter specific
PGN reference: 60672

7.7.8 PGN (Network Message) (SPN 5599)

The SAE Parameter Group Number (PGN) that identifies a specific SAE J1939 PG (message). The PGN reported in a Network Message shall be presented according to the definition for reporting a PGN as a 24-bit value, as detailed in the Parameter Group Number (PGN) section in SAE J1939-21 and SAE J1939-22.

Data Length: 3 byte
Resolution: 1 PGN/bit
Data Range: 0 to 131072 Operational Range: same as data range
Data Type: Status
PGN reference: 60672

7.7.9 Source Address (Network Message) (SPN 5600)

The SAE J1939 Source Address, as specified in SAE J1939-21 and SAE J1939-22, that is associated to the corresponding SAE J1939 NAME in an SA/NAME pair.

Data Length: 1 byte
Resolution: 1 SA/bit
Data Range: 0 to 255 Operational Range: same as data range
Data Type: Status
PGN reference: 60672

7.7.10 NAME (Network Message) (SPN 5601)

The SAE J1939 NAME associated to the corresponding Source Address in an SA/NAME pair. The SAE J1939 NAME reported in a Network Message shall be presented as an 8-byte parameter with the data bytes ordered according to the NAME definition in SAE J1939-81.

Data Length: 8 bytes
Resolution: As specified in SAE J1939-81
Data Range: 0 to 18446744073709551615 Operational Range: same as data range
Data Type: Status
PGN reference: 60672

7.7.11 Number of SA/NAME Pairs (SPN 5602)

The number of instances of source addresses and associated NAMEs included in the associated data content.

Data Length: 1 byte
Resolution: 1 / bit, 0 offset
Data Range: 0 to 250 Operational Range: 0 to 198
Data Type: Status
PGN reference: 60672

8. STATUS AND STATISTICS PARAMETER DEFINITIONS

This section provides the data definition details for the NIECU status and statistical parameters listed in Table 4. These data definitions shall be used when the data is reported in an NIECU parametric data response, such as N.GP_Response or N.SP_Response.

- Parameters with a data length greater than 1 byte shall conform to the SAE J1939 byte order convention described in the message format section of SAE J1939-71.
- The definition of the parameter ranges shall support the parameter ranges convention described in SAE J1939-71, unless explicitly noted otherwise in the parameter definition.
- Some of these parameters are applicable for a given NIECU, for a specific port pair, or for both.

8.1 Buffer Size (Parameter Number 1)

The size, in bytes, of the NIECU buffer.

Data Length: 2 bytes
Resolution: 1 byte/bit, 0 offset
Data Range: 0 to 64255 bytes
Data Type: Status

8.2 Maximum Filter Database Size (Parameter Number 2)

The maximum size, in bytes, available for the message filter database in the NIECU.

Data Length: 2 bytes
Resolution: 1 byte/bit, 0 offset
Data Range: 0 to 64255 bytes
Data Type: Status

8.3 Number of Filter Database Entries (Parameter Number 3)

The number of entries in the NIECU message filter database.

Data Length: 2 bytes
Resolution: 1/bit, 0 offset
Data Range: 0 to 64255
Data Type: Status

8.4 Maximum Messages Received per Second (Parameter Number 4)

The performance capability for the maximum number of messages that the NIECU is capable of receiving per second.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Status

8.5 Maximum Messages Forwarded per Second (Parameter Number 5)

The performance capability for the maximum number of messages that the NIECU is capable of forwarding per second.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Status

8.6 Maximum Messages Filtered per Second (Parameter Number 6)

The performance capability for the maximum number of messages that the NIECU is capable of filtering per second.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Status

8.7 Maximum Transit Delay Time (Parameter Number 7)

The performance capability for the maximum transit delay time for a message moved through the NIECU.

Data Length: 2 bytes
Resolution: 1 ms/bit, 0 offset
Data Range: 0 to 64255 ms
Data Type: Status

8.8 Average Transit Delay Time (Parameter Number 8)

The average of the actual transit delay time for messages moved through the NIECU since this data was last reset.

Data Length: 2 bytes
Resolution: 1 ms/bit, 0 offset
Data Range: 0 to 64255 ms
Data Type: Measured

8.9 Number of Messages Lost due to Buffer Overflow (Parameter Number 9)

The number of messages lost by the NIECU due to buffer overflow since this data was last reset.

Data Length: 2 bytes
Resolution: 1 message/bit, 0 offset
Data Range: 0 to 64255 messages
Data Type: Measured

8.10 Number of Messages with Excess Transit Delay Time (Parameter Number 10)

The number of messages with excess transit delay since this data was last reset.

Data Length: 2 bytes
Resolution: 1 message/bit, 0 offset
Data Range: 0 to 64255 messages
Data Type: Measured

8.11 Average Messages Received per Second (Parameter Number 11)

The average number of messages received per second since this data was last reset.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Measured

8.12 Average Messages Forwarded per Second (Parameter Number 12)

The average number of messages forwarded per second since this data was last reset.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Measured

8.13 Average Messages Filtered per Second (Parameter Number 13)

The average number of messages filtered per second since this data was last reset.

Data Length: 2 bytes
Resolution: 1 message/second/bit, 0 offset
Data Range: 0 to 64255 messages/second
Data Type: Measured

8.14 Uptime Since Last Power on Reset (Parameter Number 14)

The total uptime for the NIECU since the last power on reset of the device.

Data Length: 4 bytes
Resolution: 1 second/bit, 0 offset
Data Range: 0 to 4 211 081 215 seconds
Data Type: Measured

8.15 Number of Ports (Parameter Number 15)

The number of ports on the NIECU. All values states are used for valid data for this parameter, except for F_h, which is reserved for “not available,” or the parameter data has no meaning.

Data Length: 1 byte
Resolution: 1 port/bit, 0 offset
Data Range: 0 to 14 ports
Data Type: Status

8.16 Network Interconnection Type (Parameter Number 16)

The declaration of the type of network interconnection device. It is possible for an NIECU to indicate different NIECU types for each port pair. The NIECU type value assignments are shown in Table 5.

Data Length: 1 byte
Resolution: 256 states/8 bits, 0 offset
Data Range: 0 to 250
Data Type: Status

Table 5 - NIECU type assignments

NIECU Type	Definition
0	None (no interaction for the given port pair)
1	Repeater
2	Bridge
3	Router
4	Gateway
5	Tractor ECU (ISO 11783 Part 9)
6-249	Reserved for future assignment by SAE
250	Multiple (used with general parametric data responses if NIECU performs different NIECU roles for different port pairs)
251-255	Defined by SAE J1939-71

9. NOTES

9.1 Revision Indicator

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 SAE TRUCK BUS CONTROL AND COMMUNICATIONS NETWORK COMMITTEE

APPENDIX A - STATUS AND STATISTICS PARAMETER DEFINITIONS

Content moved to Section 8.