# SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-31 SEP2018

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Superseding J1939-31 APR2014

(R) Network Layer

## RATIONALE

This revision of SAE J1939-31 has been reviewed to comply with the SAE Five-Year Review policy. This revision includes minor grammatical updates and notation updates for decimal and hexadecimal values. Hexadecimal values are denoted with a subscript “h” instead of “0x” or subscript “16.” All subscript “10” has been removed. Numeric values without a subscript represent decimal values.

## 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 a network segment to intercommunicate with other ECUs on different network segments of the vehicle 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 J1939-71 | Vehicle Application Layer |
| SAE J1939-81 | Network Management |

#### 2.1.2 ISO Publications

Copies of these documents are available online at http://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 signaling |
| 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 J1939-01 On-Highway Equipment Control and Communication Network

SAE J1939-02 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

See SAE J1939 for definitions that are not defined 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 segments have separate address space, CAs on one segment cannot directly address individual CAs on the other segment.

### 3.1.2 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 might be a list of PGNs for filtering messages forwarded between network segments or the filtering mode to apply. Examples of status and statistical data might be 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.

### 3.1.3 FOREIGN MESSAGE TRANSPORT

Foreign Message Transport describes the functionality for transferring non-SAE J1939 messages (i.e., foreign messages) over an SAE J1939 network in an SAE J1939 compatible manner. Using special SAE J1939 PGs assigned by SAE J1939, the non-SAE J1939 message is encapsulated into the data field of the special SAE J1939 PG which can then be transported over the SAE J1939 network. The definition for how a Foreign Message is encapsulated into the data field 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. SAE J1939 source addresses shall be claimed and used when sending and receiving these special PGs over an SAE J1939 network. Any addressing that is a part of the foreign message will need to be included in the encapsulated data field content if necessary.

### 3.1.4 NETWORK

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

### 3.1.5 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.

### 3.1.6 PORT

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

### 3.1.7 PORT PAIR

A title that describes the two ports being discussed and the direction of data flow (from-to).

### 3.1.8 SEGMENT

A physical section of a vehicle communications network. The physical section is bounded by the ECUs connected to it and any NIECUs. All of the ECUs on a segment "see" the signal at the same time (i.e., there is no intermediate device between different sections of the network). Multiple segments can be connected together by NIECUs.

### 3.1.9 SUBNETWORK (SUBNET)

A subset of the vehicle network consisting of one or more network segments connected together. Subnetworks may include: Tractor, Trailer, Implement, and Braking System. Subnetworks are typically separated by a bridge, router, or gateway to help minimize bus traffic on each segment. Collectively the subnetworks are the Vehicle Network.

### 3.1.10 TRANSIT DELAY

The amount of time delay incurred when an NIECU forwards a received message 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.

### 3.1.11 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.

### 3.1.12 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

The Network Layer defines the requirements and services for NIECUs, which are the electronic devices that provide intercommunications between different segments of a vehicle-wide SAE J1939 network. An NIECU is an ECU with more than one port, or network connection, with a Controller Application that functions to transfer information from a port connected to one network segment to a port connected to another network segment. When the vehicle network has multiple segments and it is necessary to transfer information between devices on separate network segments, then an NIECU is needed to provide for the transfer of messages from one segment to another. The type of NIECU required between two segments of the network depends upon the needs of the system and the protocol of each network segment. For example, a bridge may isolate two segments of media and the bus traffic on each, but the network is still considered "one" network in terms of address space and identifiers. There are several different types of NIECUs, each providing different internetworking functions. The principle internetworking functions include:

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

An NIECU may 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. If an NIECU is intended to supply any of the Network Layer services, this document shall be the guide for proper implementation. 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 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 segment exceeds allowed lengths.
3. Electrical Interface Conversion, allowing such things as impedance differences between the segments. Note that 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 segments run at different rates. This may require the use of a Filtering system, as the lower-rate segment may not be able to handle the traffic of the higher rate segment.

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 segments.

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

### 4.3 Network Topology

The topology of the vehicle network must 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 bus 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 Layer provides for the potential of up to 254 unique Source Addresses on the network. If this Address Space is insufficient for a particular application, then a router may be used to provide one or more separate subnetworks, each with its own Address Space. Each subnetwork could be arranged with ECUs and messages related to a specific function (Braking, Suspension, Trailer, Implement, etc.) with a controller also serving as the router to move selected messages to and from the main SAE J1939 network.

#### 4.3.2 Off-Tractor Segment (Trailer or Implements)

In order to isolate and protect the tractor segment, an NIECU must exist between the tractor segment and any off-tractor segment. The type of NIECU will depend upon the design requirements. For example, a bridge permits the off-tractor segment to run at a different data rate and with reduced traffic by performing message filtering, while a Router permits the off-tractor 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.

#### 4.3.3 Proprietary Messages and Networks

SAE J1939 data link has provisions for communications with proprietary messages. If bus traffic and latency become an issue, a separate segment can be used to handle the proprietary messages. The supplier of this separate segment and its related devices must also provide any router/gateway function needed to share data with the main network.

#### 4.3.4 CAN 11-bit Identifier Interfacing

All SAE J1939 compliant ECUs must support the ISO 11898 29-bit identifier (CAN Extended Format). Separate subnetworks that use ISO 11898 11-bit identifier (CAN Base Format) will require a gateway to permit the transfer of data between the two segments. This device must also be responsible for any diagnostics of the subnetwork that need to be transmitted via SAE J1939. Component suppliers and OEMs must assume responsibility for assigning unique network IDs when using 11- bit identifiers since there is no means in this document to manage addresses or identifiers for those devices. Note that a CAN 11-bit subnetwork could actually reside on the same two-wire segment as the SAE J1939 main tractor network, but bus loading and reliability issues must be considered.

#### 4.3.5 SAE J1587 Interface

Devices requiring SAE J1587 for information or diagnostics must 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 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.

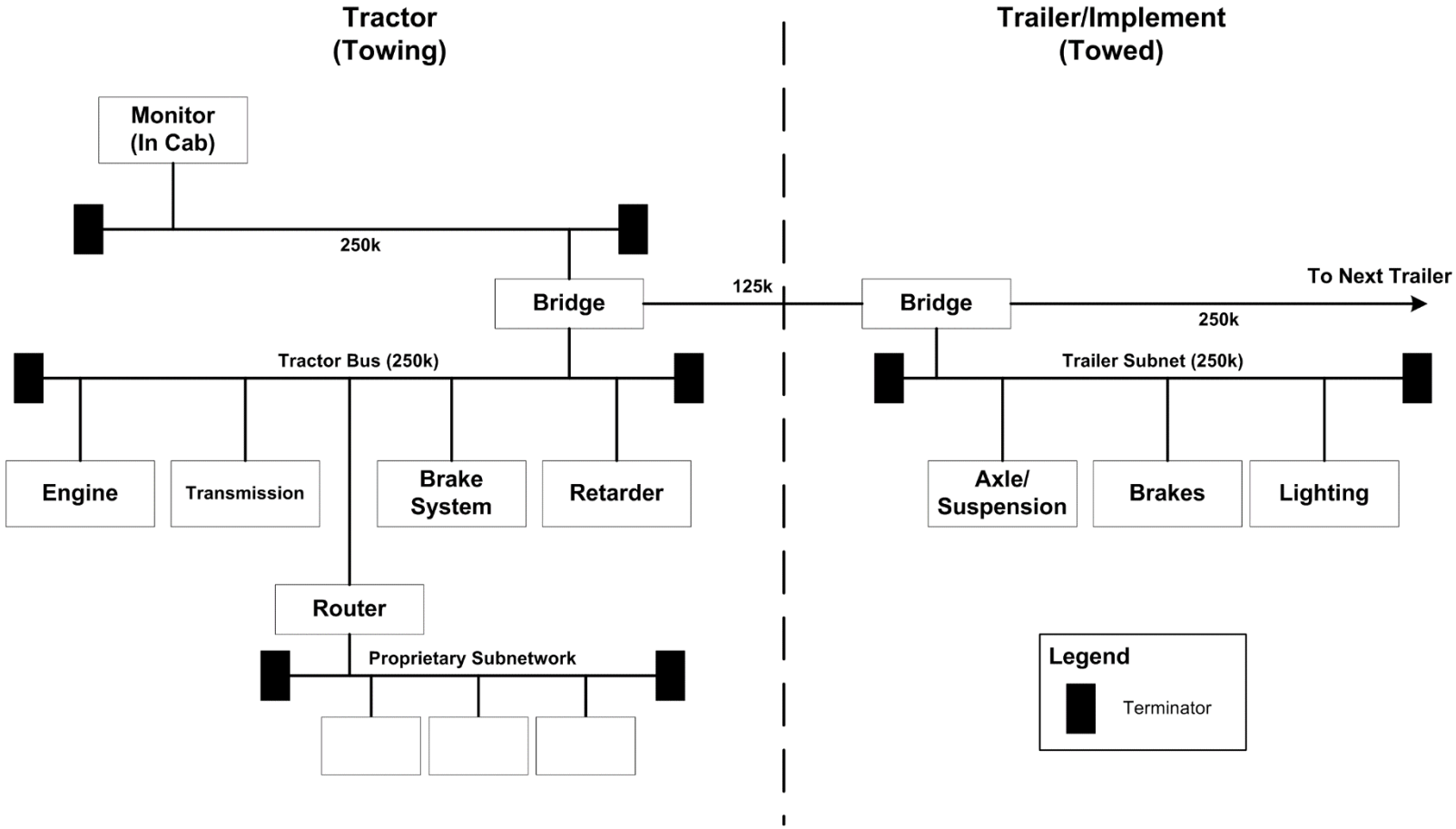



***Figure 1 - Example of SAE J1939 vehicle network for truck and bus***

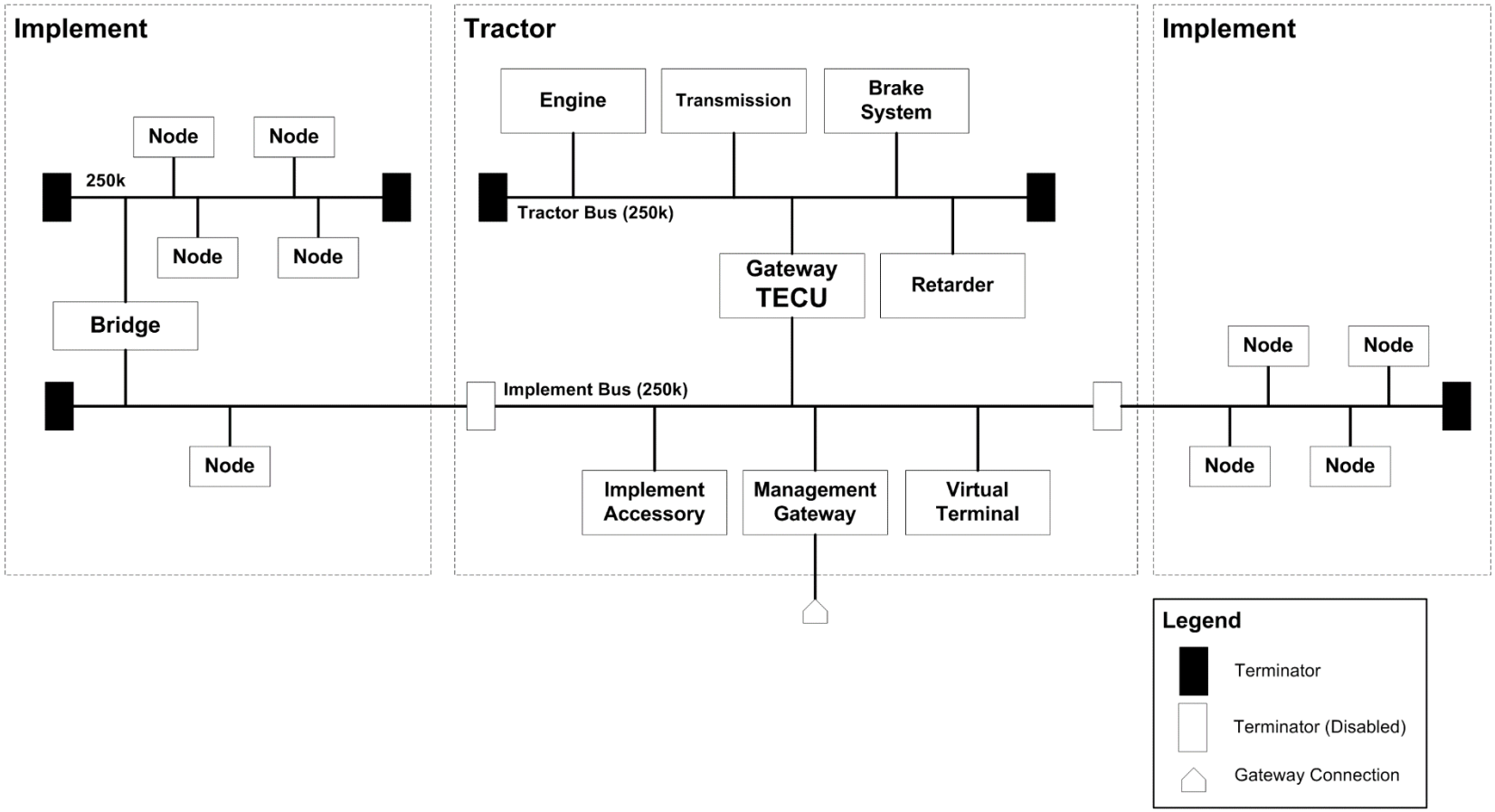



***Figure 2 - Example of SAE J1939 vehicle network for agricultural applications***

# 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 device used to extend the length or number of nodes that can exist on a single network by allowing it to be segmented physically. Repeaters are considered physical layer NIECU devices because they work at the physical layer of the OSI model, simply copying or forwarding bits 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 segments that are joined by a repeater. In general, these devices are specialized hardware that transfer the data with sub-bit time delays, while the more complex devices use software for their forwarding functions.

2. Bridge: A device used to transfer messages between two or more network segments that have the same address and data link protocol. The transfer of messages between the network segments is typically performed by storing and forwarding entire data link messages. A bridge permits changes in the media and data rate between segments (i.e., physical layer), but the network segments must have the same address and data link protocol. A bridge can provide filtering to limit which messages are transferred from one network segment to another. A bridge is frequently used where Data Rate changes are needed, but does no Address or Protocol Translation.

3. Router: A device for transferring messages between two or more network segments where the protocol is the same on the network segments but each network may have separate address spaces, so address translation must be performed as the message is transferred between network segments. 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 must have the same transport layer, but may 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 all segments.

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 may make changes to the packaging and presentation of the data, including combining data from multiple messages into one.

If viewed as an ordered list, 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 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 messages; the ECU that contains the “Router” function of Address Translation also contains an instance of the “Bridge” function of Message Forwarding. It may 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 device which regenerates the data signal to and from another segment of media. This permits the network to cover a greater distance (area), to connect more electrical loads (devices) onto the bus, or to connect to another type of media (physical layer expansion). The data rate, protocol (data link layer), and address space are the same on both sides of the repeater. A repeater usually implements message forwarding at the bit level, without storing and forwarding, and therefore does no re-ordering of messages by priority.

The principle function provided by a repeater is message forwarding between bus segments which are all running at the same data rate. This is achieved by regenerating the signal from one segment onto another at the physical layer of the network, not by storing and forwarding complete CAN data 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 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 message forwarding by copying each bit from one network segment to another network segment. Each bit is copied between network segments with sub-bit-time delay. When a Repeater forwards a message onto another segment, it uses the identical source address of the originator. Forwarding is discussed in more detail in 6.1.

### 5.1.2 Bridge

A device which stores and forwards messages between two or more network segments. This permits changes in the media and data rate between segments. The Protocol and Address Space remain the same on both sides of the bridge. Note that a bridge may selectively filter messages going across it so that the bus load is minimized on both segments.

The principle function provided by a bridge is message forwarding and filtering between bus segments. This is achieved by storing, filtering, and forwarding messages at the data link layer of the network. By filtering messages, the bridge can effectively reduce the amount of bus traffic present on each segment of the network. The bridge is essentially transparent to any ECU on the vehicle network. Note that 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 forwarding by storing the complete message from one segment before transmitting that message on another network. When a Bridge forwards a message onto another segment, it uses the identical source address of the originator. Forwarding is discussed in more detail in 6.1.

##### 5.1.2.1.2 Filtering

A bridge may filter any, all, or none of the messages 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 that the Database Management function be supported 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 device which allows segments with independent Address Spaces, data rates, and media to exchange messages. This permits each segment to operate with minimum bus loading yet still obtain critical messages from remote segments. The protocol remains the same across all segments. Note that the router must have look up tables to permit the translation and routing of a message with address X on segment 1 to address Y on segment 2. This also permits a vehicle system like a tractor, trailer, or implement to appear as a single device to another portion of the vehicle.

The principle operation provided by a router, in addition to those provided by a bridge, is address remapping (message routing). This permits a given vehicle subsystem to appear as a single address to another portion of the vehicle, thus extending the address space of the Data Link. This can potentially simplify the development of ECUs because they do not require specific knowledge of other individual ECUs (addresses) on the vehicle subsystem. Note that Address Claim messages do not cross through a router.

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

#### 5.1.3.1 Router Networking Functions

##### 5.1.3.1.1 Address Translation

In addition to forward and filter functions, a Router may remap addresses from one port (bus segment) to another port (bus segment). Address Translation is discussed in more detail in 6.3.

##### 5.1.3.1.2 Message Filtering

The Message Filter Database is typically configured for Pass List mode (1). All messages are then blocked unless a specific entry on the List exists to pass a message through. In addition, a lookup table must exist which provides the address translation map. Filtering is discussed in more detail in 6.2.

##### 5.1.3.1.3 Router Database Management

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

### 5.1.4 Gateway

This device permits data to be transferred between two networks with different protocols or message sets. The gateway can also provide a means to repackage parameters into new message groups when transferring messages from one 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 principle operation provided by a gateway, in addition to those 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.

Once operational, the gateway should be essentially transparent to any ECUs on the vehicle network. Note that 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. The Message Filter Database is typically configured for Pass List mode (1). All messages are blocked unless a specific entry exists to pass a message through. In addition, a message building function must exist which contains a database for repackaging messages. Message Repackaging is covered in more detail under Protocol Translation in 6.4.

##### 5.1.4.1.2 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. Otherwise, all messages being forwarded to a specific port could be excessively delayed. This requirement prohibits the use of a simple First-In-First-Out (FIFO) queue for message forwarding. Repeaters are exempt from this requirement.

4. An NIECU may begin to forward messages from one 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 segment where the message was originally received.

6. An NIECU shall not go bus off due to CAN arbitration problems when forwarding an Address Claim message. When an NIECU forwards a 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 could 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 Claim message is forwarded onto a segment where another ECU is simultaneously transmitting an Address Claim message for the same address. In this very low probability case, the NIECU must 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 may 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. Shall specify a guaranteed filtering rate and forwarding rate.

2. 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. If this rate is exceeded due to average or peak bus loads, the NIECU may lose messages.

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 could be for a message to be transmitted by an ECU and received by another ECU on a different bus segment.

## 6. NETWORK INTERCONNECTION FUNCTIONS

The principle 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 principle functions (excluding Database Management) are provided as services without the need for a specific request by the ECUs to use them.

### 6.1 Message Forwarding

Forwarding is the networking function of transferring individual messages, with minimal delay, between two or more network segments. The forwarding function allows physical and electrical extension of the network. Forwarding may 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, the address space is continuous between the network segments and the protocol (e.g., SAE J1939) must be identical on the both sides of these types of NIECU devices.

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.

There are two basic modes of operation for the filtering process within an NIECU: Block List or Pass List. 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 List Filter Mode

In the Block List filter mode, the NIECU transfers all messages that are not on the Block List. The default behavior in Block List filter mode shall be to transfer all messages. If there are no entries in the Block List, then all messages are transferred and bus utilization (traffic) may be higher on each bus 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. The Block List contains the list of PGNs that are not to be passed from one specific port to another specific port. This is the preferred mode of operation for SAE J1939 bridges. Block List entries are typically made during initial vehicle build and configuration, and should be retained in nonvolatile memory.

#### 6.2.2 Pass List Filter Mode

In the Pass List filter mode, the NIECU only transfers messages that are on the Pass List. An entry must exist with a specific identifier (PGN value) for each particular 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 List filter 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 filter mode 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 filter mode may 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.

### 6.3 Address Translation

Address Translation is the networking function of changing the address data for a message as it is passed from one network segment to another network 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 must be based upon NAME and not simply source addresses.

An NIECU may also provide Address Translation for particular messages, 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 must identify the associated source or destination address. The NIECU must 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 may provide services to extract data from another communication protocol and make it available to the 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 cannot provide more specific rules for Protocol Translation.

### 6.5 Database Management

Database Management is the networking 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 PGNs to filter or association of addresses between network segments. The Network Message, detailed in 7.2, provides services for reading and configuring the Database Management information.

#### 6.5.1 Database Configuration Options

The filter database that exists within an NIECU may 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 may 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 may not adequately 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

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

NIECU reconfiguration at any time by any ECU on the network. Note that a separate security procedure to enable the modification of the database may also have to exist. Restrictions on which ECUs may 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 may 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 may 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 encapsulating a foreign message (from one network protocol) into the data field of a message for second network protocol and carrying the encapsulated message over the second network. SAE J1939 refers to this networking function as "Foreign Message Transport" (FMT) because it allows 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. This is different from forwarding of PG defined in ISO 11783 that use the standard SAE J1939 protocols without transport requirements.

SAE J1939 supports tunneling of particular foreign protocols, or non-SAE J1939 protocols, through the assignment of SAE J1939 PG to specific foreign protocols. The definition for how the foreign protocol message is encapsulated into the data field of the SAE J1939 PG is defined elsewhere, such as within ISO 11992 or ISO 15765. Examples of some of the FMT PG assigned by SAE J1939 are PGNs 512, 768, 51968, 52736, 55808, 56064, 57600, 57856, etc.

The SAE J1939 FMT messages are SAE J1939 messages, and must comply with and abide by the SAE J1939 CAN Identifier construction rules and the SAE J1939 Addressing methods to assure they can be transported without conflict. Only the data portion of these messages belongs to the foreign protocol; the CAN Identifier must conform strictly to the SAE J1939 Recommended Practice.

Since 11-bit and 29-bit CAN messages 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 CAN messages 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.

Figures 3 and 4 illustrate the use 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 must exist at each end of the SAE J1939 network segment to tunnel the foreign protocol messages within FMT messages over the SAE J1939 network. For a foreign protocol message going from ECU1 to ECU2, NIECU1 receives the message from ECU1 and encapsulates the foreign protocol message into the appropriate FMT messages. Next, NIECU1 sends the FMT messages over the SAE J1939 network to NIECU2 using the SAE J1939 SA for NIECU2 as the Destination Address for each FMT message. NIECU2 extracts the foreign protocol message from the FMT message and forwards it to ECU2. Figure 4 illustrates the messaging sequence involved in a ISO 15765 request and response transaction between ECU1 and ECU2.

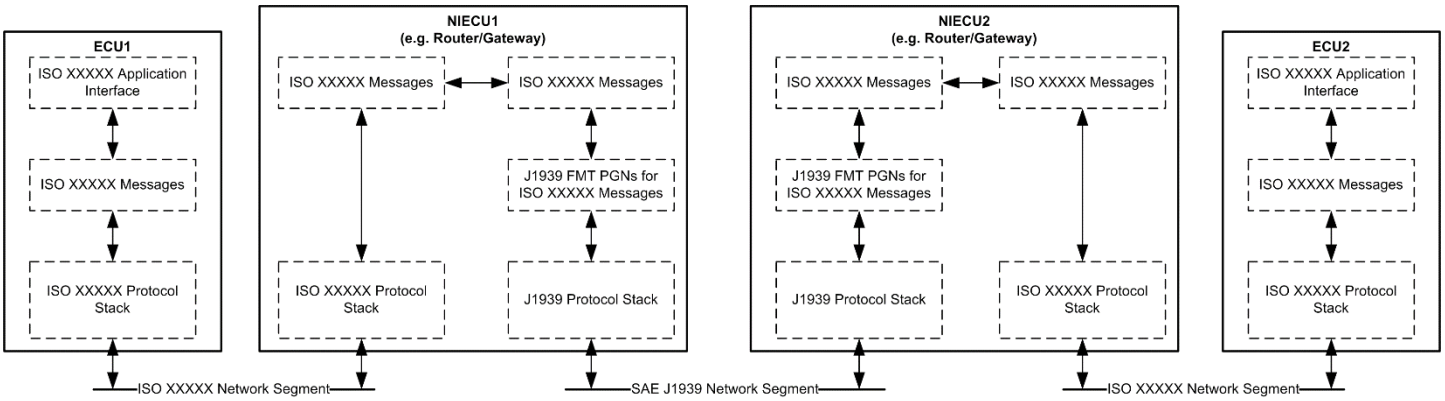
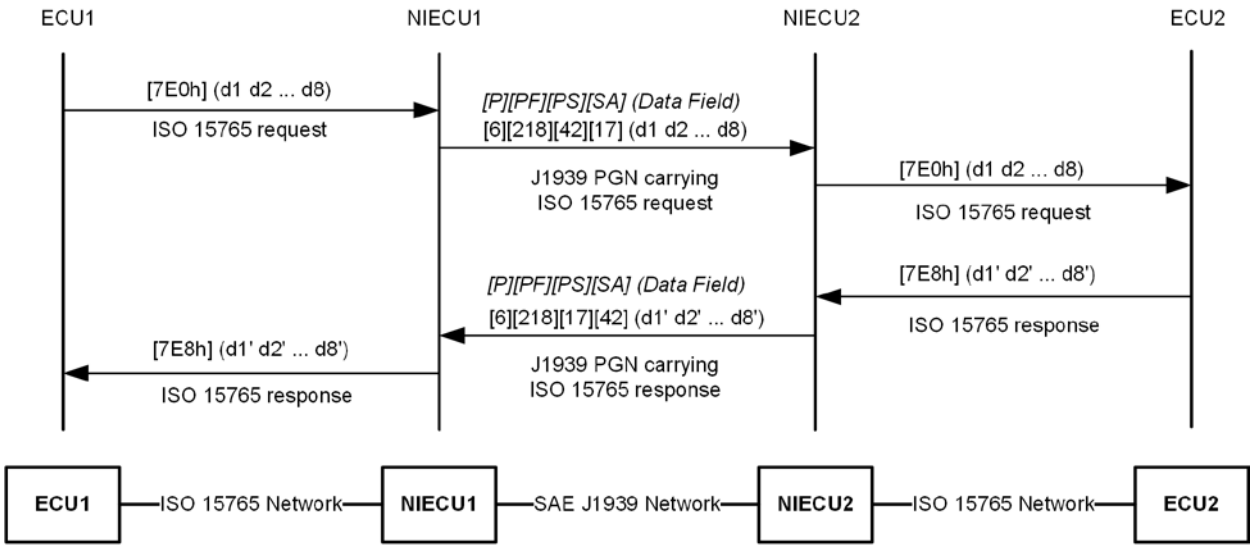



***Figure 3 - Foreign message transport example 1 - logical model***




*NOTE: For illustrative purposes only. Refer to ISO 15765-2 for use of J1939 PGNs 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 and the other 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 appropriate FMT message(s). Next, NIECU1 sends the FMT messages over SAE J1939 network to ECU2 using the SAE J1939 SA of ECU2 as the Destination Address for each FMT message. ECU2 extracts the foreign protocol message from the FMT message and uses it in its application. For a message going from ECU2 to ECU1, ECU2 must know that ECU1 is accessed via NIECU1 using the FMT messages for a particular foreign protocol. ECU2 builds and encapsulates the foreign protocol message into the appropriate FMT messages and sends the FMT message over SAE J1939 using the SAE J1939 SA of the NIECU1 as the Destination Address for each FMT message. NIECU1 extracts the foreign protocol message from the FMT message and forwards it to ECU1.

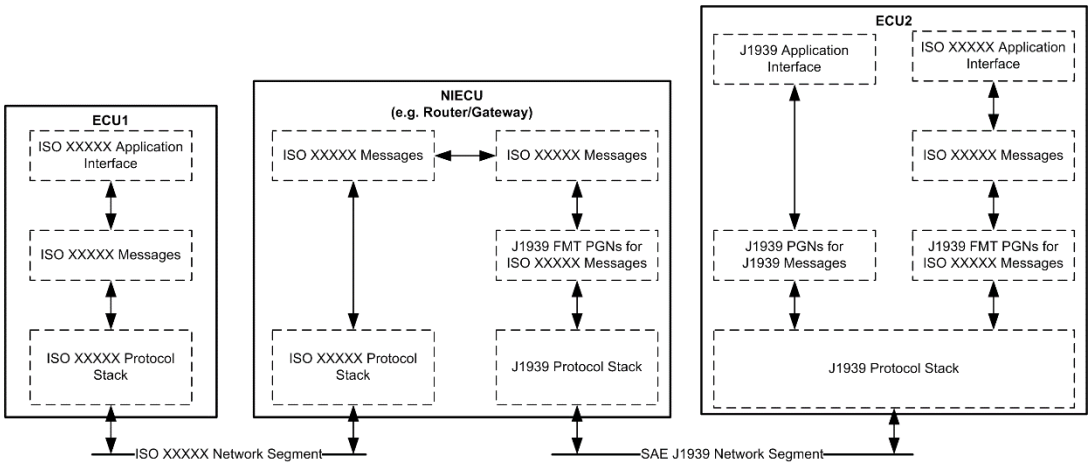



***Figure 5 - Foreign message transport example 2***

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. For a foreign protocol message going from ECU1 to ECU2, ECU1 must know that ECU2 is accessed over the local SAE J1939 network using the particular FMT messages. ECU1 builds and encapsulates the foreign protocol message into the appropriate FMT message and sends the FMT message over the SAE J1939 network to ECU2 using the SAE J1939 SA of ECU2 as the Destination Address for each FMT message. ECU2 extracts the foreign protocol message from the FMT message and uses it in its application.

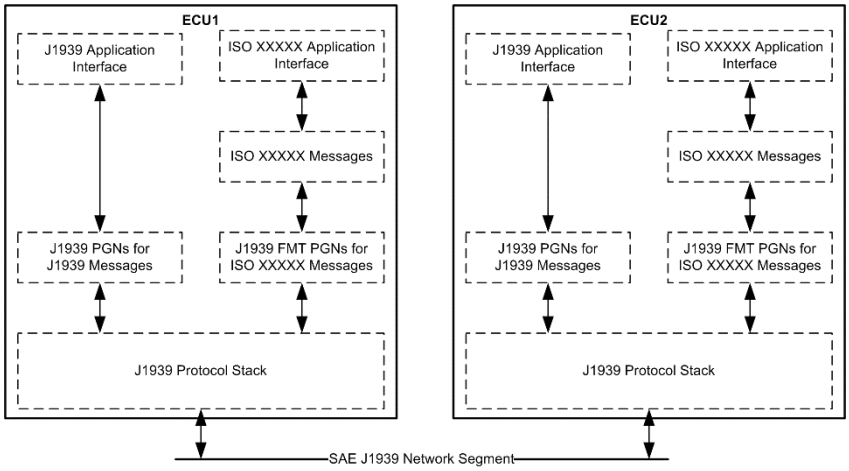



***Figure 6 - Foreign message transport example 3***

# 7. NETWORK INTERCONNECTION ECU DATABASE MANAGEMENT MESSAGE

The Network Message provides the means to use J1939 messaging to configure the networking function databases and access the parametric data and network topology information from an NIECU. The 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. The 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

The first byte of every Network Message data field is the Network Message Control Byte that identifies the service or function of that instance of Network Message. The data content in the remaining Network Message data field bytes depends upon the Network Message Control Byte value. Some instances of the Network Messages are multipacket.

## 7.1 General Network Message Requirements

1. If the length of the data content for the Network Message is less than 8 bytes, then unused bytes shall be filled with $FF_h$ to a data field length of 8 bytes.

2. An ECU shall respond when the ECU supports the Network Message and the Network Message was sent using a destination specific address.

3. An ECU shall respond when the ECU supports the Network Message and the Network Message was sent to the global destination address, except when the particular Control function is not supported or could not be performed by the ECU.

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 the negative acknowledge response if the particular Control Byte function is not supported or could not be performed. When the Acknowledgement PG is used to respond to a Network Message request or command, the Acknowledgement data field shall contain the Network Message PG (PGN 60672) in the bytes for the Parameter Group Number parameter and the Network Message Control Byte value from Network Message in the Group Function Value parameter bytes. Refer to SAE J1939-21 Data Link Layer 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.

## 7.2 Network Message Definition

The basic definition of the Network Message is shown in Figure 7.

***PGN 60672 Network Message***

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 Length
Extended Data Page: 0
Data Page: 0
PDU Format: 237
PDU Specific: DA PGN Supporting Information:
Default Priority: 6
Parameter Group Number: 60672 ($00ED00_h$)

| Start Position | Length | Parameter Name | SPN | |
|---|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte | 5592 | 7.7.1 |
| 2 to n | 7 to 1784 bytes | Network Message Function-Specific Data Content | | |

***Figure 7 - Network message (PGN 60672) definition***

## 7.3 Message Filter Database Services (N.MFDB)

The Message Filter Database (N.MFDB) set of services of the Network Message provide methods for accessing and configuring the message filter database in the NIECU. The first byte in the data field of each N.MFDB message is the Control Byte code which identifies the function performed. The second byte of each N.MFDB message is the Port Pair data. The remaining data bytes in each N.MFDB message are dependent on the Control Byte function.

### 7.3.1 Filter Database Request (N.MFDB_Request)

The N.MFDB_Request is the Network Message used to request a copy of a Message Filter Database for the Port Pair specified in the Data Field. This message is sent from the ECU to the NIECU.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 0 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to 8 | 1 byte | Fill each byte with $FF_h$ | |

### 7.3.2 Filter Database Response (N.MFDB_Response)

The N.MFDB_Response is the Network Message used to provide the filter database entries, in response to a N.MFDB_Request. The Filter Database response identifies a list of PGNs and the Filter Mode applied to those PGNs when going from the “From Port” to the “To Port.” This message is sent from the NIECU to the ECU. The PGN List may contain zero, one, or more PGNs. If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 1 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 | 1 byte | Filter Mode | 7.7.6 |
| 4 to n | 3 bytes | PGN List | 7.7.9 |

EXAMPLE: The messages 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 for the filter mode and the list of PGNs that are being filtered 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 that 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 PGN 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 filter database access***

7.3.3 Add PGNs to Filter Database (N.MFDB_Add)

The N.MFDB_Add is the Network Message used to add one or more entries within the filter database. The message identifies the list of PGNs to be added to for the specified Port Pair. If the “To Port” is set to global, appropriate entry or entries will be made in the filter data base to affect the desired action on each Port Pair. An ECU using this function must 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. If the length of the message data is less than 8 bytes, then the unused data bytes are set to FF$_h$.

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

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 2 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to n | 3 bytes | PGN List | 7.7.9 |

7.3.4 Delete PGNs from Filter Database (N.MFDB_Delete)

The N.MFDB_Delete is the Network Message used to delete one or more PGN entries within the filter database. Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392). If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 3 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to n | 3 bytes | PGN List | 7.7.9 |

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

The N.MFDB_Clear is the Network Message used to clear the filter database entries for the Port Pair. Acknowledgment of the command is required using the Acknowledgment PG (PGN 59392).

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 4 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to 8 | 1 byte | Fill each byte with $FF_h$ | |

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

The N.MFDB_Create_Entry is the Network Message used to create a port pair entry within the filter database, specify the filter mode to apply to the port pair, and add PGNs to the filter for the port pair. If the “To Port” is set to global, multiple entries may be made in the filter database, one for each Port Pair containing the "From Port". Note that the filter mode is included with this command to explicitly indicate whether the new entry is for block or pass. If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

If an NIECU receives a N.MFDB_Create_Entry message and the NIECU filter database already has entries filter entries for the port pair, then SAE J1939 recommends that the NIECU return an error to the requester (i.e., send a negative Acknowledgement). The N.MFDB_Create_Entry service is not intended to be used to modify an existing a non-clear filter database for a port pair, such as changing the filter mode or adding PGNs to the filter. The N.MFDB_Add and N.MFDB_Delete services should be used to modify the PGNs 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 with Control Byte = 6)***

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 6 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 | 1 byte | Filter Mode | 7.7.6 |
| 4 to n | 3 bytes | PGN List | 7.7.9 |

## 7.4 Network Topology Information Services (N.NT)

The Network Topology Information Services (N.NT) are a set of services of the Network Message that provide the ability to get basic information about the nodes connected to other ports of the NIECU. The first byte in the data field of each N.NT message is the Control Byte code which identifies the function performed. The second byte of each N.NT message contains a single Port Number in the lower nibble. The Port Number is used to identify the NIECU port that the topology information is associated. The remaining data bytes in each N.NT message are dependent on the Control Byte function.

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 networks containing non-SAE J1939 Address Spaces is not defined in this document.

Note that if there are multiple bridges present on a given vehicle network, a bridge can only identify what port a source address is located on. A given source address may actually reside on a remote bus segment, so responses from each bridge must be compared to determine which local bus segment actually contains the given source address. A bridge may also have to perform a Request for Address Claim first in order to construct the list of source addresses associated with each port.

Note that Topology Information for networks containing non-SAE J1939 Address Spaces is not defined in this document.

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

The N.NT_Request is the Network Message used to request the list of source addresses found on a given NIECU port.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 64 | 7.7.1 |
| 2.1 | 4 bits | Port | 7.7.3 |
| 2.5 | 4 bits | Fill with $F_h$ | |
| 3 to 8 | 1 byte | Fill each byte with $FF_h$ | |

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

The N.NT_Response is the Network Message used to provide the list of source addresses found on an NIECU port, in response to an N.NT_Request. The “SA List” may contain zero, one, or more SAs. If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 65 | 7.7.1 |
| 2.1 | 4 bits | Port | 7.7.3 |
| 2.5 | 4 bits | Fill with $F_h$ | |
| 3 to n | 1 byte | SA List | 7.7.10 |

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

The N.NTX_Request is the Network Message used to request the list of 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 actual Address Claims of the Controller Applications on the network segment on the specified NIECU port, such as when the network segments are separated by a router. This message should be used only when the network segment on 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 with Control Byte = 66)***

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 66 | 7.7.1 |
| 2.1 | 4 bits | Port | 7.7.3 |
| 2.5 | 4 bits | Fill with $F_h$ | |
| 3 to 8 | 1 byte | Fill each byte with $FF_h$ | |

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

The N.NTX_Response is the Network Message used to provide the list of source addresses and associated NAMEs found on an NIECU port, in response to an N.NTX_Request. If the response has zero Source Address and NAME pairs to report, then the length of the message data shall be 8 bytes, with bytes 4 to byte 8 set to $FF_h$. The N.NTX_Response supports the reporting the SA/NAME pairs for a maximum of 198 source addresses on a network segment.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 67 | 7.7.1 |
| 2.1 | 4 bits | Port | 7.7.3 |
| 2.5 | 4 bits | Fill with $F_h$ | |
| 3 | 1 byte | Number of SA/NAME Pairs | 7.7.12 |
| 4 | 1 byte | Source Address (first) | 7.7.10 |
| 5 - 12 | 8 bytes | NAME (associated with first SA) | 7.7.11 |
| 13 | 1 byte | Source Address (second) | |
| 14-21 | 8 bytes | NAME (associated with second SA) | |

Repeat until all 9-byte SA and NAME pairs have been transmitted.

## 7.5 NIECU General Parametric Data Services (N.GP)

The NIECU General Parametric Data Services (N.GP) are a set of services of the Network Message that provide the ability to get NIECU performance and operation status and statistic data. The General Parametric Data services provide the status and statistic 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 in the data field of each N.GP message is the Control Byte code which identifies the function performed. The remaining data bytes in each N.GP message are dependent on the Control Byte function.

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

### 7.5.1 Request the NIECU General Parametric Data (N.GP_Request)

The N.GP_Request is the Network Message used to request general status and statistic parametric data for the Network Interconnection Unit. **The SAE J1939 Subcommittee recommends the request always be for Parameter Number 0, which returns the entire list.** The “Parameter Number List” may contain one or more Parameter Numbers.

- If requesting a specific list of parameters, then the Parameter Numbers shall be listed in ascending numerical order.
- If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 128 | 7.7.1 |
| 2 to n | 1 byte | NIECU Parameter Number List | 7.7.7 |

### 7.5.2 NIECU General Parametric Data Response (N.GP_Response)

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

- If the response is to a N.GP_Request with Parameter Number 0 (zero), then the NIECU Parametric Data shall contain parameter data for all Parameter Numbers, in numerical order.
- If the response is to a N.GP_Request with a list of specific parameters, then the NIECU Parametric Data shall contain the parametric data values for the specific parameters in the same order as the parameter numbers are ordered in the N.GP_Request.
- The data bytes for unsupported parameters shall be filled with $FF_h$. This is necessary because the interpretation of specific bytes of the NIECU Parametric Data is based upon the data byte position since data consists of only the parametric data values.
- If the returned list of parameters 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.
- If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 129 | 7.7.1 |
| 2 to n | 1 byte | NIECU Parameter Data | 7.7.8 |

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

The N.GP_Reset is the Network Message 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 with Control Byte = 130)***

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 130 | 7.7.1 |
| 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 services of the Network Message that provide the ability to get NIECU operation status and statistic 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 in the data field of each N.SP message is the Control Byte code, which identifies the function performed. The second byte in the data field of each N.SP message is the Port Pair data. The remaining data bytes in each N.SP message are dependent on the Control Byte function.

The list of available parameters is defined in Table 4.

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

The N.SP_Request is the Network Message used to request status and statistic parametric data for a specific port pair of the NIECU. **It is recommended that the request always be for Parameter Number 0, which returns the entire list.** The “Parameter Number List” may contain one or more Parameter Numbers.

- If requesting a specific list of parameters, then the Parameter Numbers shall be listed in ascending numerical order.
- If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 131 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to n | 1 byte | NIECU Parameter Number List | 7.7.7 |

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

The N.SP_Response is the Network Message used to provide the status and statistical parametric data for a specific port pair for the NIECU, in response to a N.SP_Request.

- If the response is to a N.SP_Request with Parameter Number 0 (zero), then the NIECU Parametric Data shall contain parameter data for all Parameter Numbers, in numerical order.
- If the response is to a N.SP_Request with a list of specific parameters, then the NIECU Parametric Data shall contain the parametric data values for the specific parameters in the same order as the parameter numbers are ordered in the N.SP_Request.
- The data bytes for unsupported parameters shall be filled with $FF_h$. This is necessary because the interpretation of specific bytes of the NIECU Parametric Data is based upon the data byte position since data consists of only the parametric data values.
- If the returned list of parameters is shorter than expected, it means the NIECU has no knowledge of additions to the parameter list and stopped with the last known parameter.
- If the length of the message data is less than 8 bytes, then the unused data bytes are set to $FF_h$.

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

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

| Start Position | Length | Parameter Name | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 132 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to n | 1 byte | NIECU Parameter Data | 7.7.8 |

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

The N.SP_Reset is the Network Message 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 | |
|---|---|---|---|
| 1 | 1 byte | Network Message Control Byte = 133 | 7.7.1 |
| 2.1 | 4 bits | To Port | 7.7.4 |
| 2.5 | 4 bits | From Port | 7.7.5 |
| 3 to 8 | 1 byte | Fill each byte with $FF_h$ | |

## 7.7 Network Message Data Definitions

The definition of the parameters used within the many different functions of the Network Message.

### 7.7.1 Network Message Control Byte (SPN 5592)

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

***SPN 5592 Network Message Control Byte***

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

Data Length: 8 bits
Resolution: 256 states/8 bit, 0 offset
Data Range: 0 to 255 Operational Range: same as data range
Type: Status
Supporting Information:
PGN reference: 60672

***Table 1 - Network message control byte values***

| Control Byte Value | Function Description | Function Direction | Reference |
|---|---|---|---|
| 0 | Request the filter database | ECU to NIECU | 7.3.1 |
| 1 | Response with the filter database | NIECU to ECU | 7.3.2 |
| 2 | Add PGNs to an existing filter entry in the filter database | ECU to NIECU | 7.3.3 |
| 3 | Delete PGNs from an existing filter entry in the filter database | ECU to NIECU | 7.3.4 |
| 4 | Clear an existing port pair filter entry from the filter database | ECU to NIECU | 7.3.5 |
| 5 | Obsolete, not to be used | N/A | N/A |
| 6 | Create a new port pair filter entry in the filter database | ECU to NIECU | |
| 7 to 63 | Reserved for future assignment by SAE | N/A | N/A |
| 64 | Request the list of source addresses on a network | ECU to NIECU | 7.4.1 |
| 65 | Response with the list of source addresses on a network | NIECU to ECU | 7.4.2 |
| 66 | Request the Source Address and NAMEs on a network | ECU to NIECU | 7.4.3 |
| 67 | Response with the Source Address and NAMEs on a network | NIECU to ECU | 7.4.4 |
| 68 to 127 | Reserved for future assignment by SAE | N/A | N/A |
| 128 | Request the general parametric data for the NIECU | ECU to NIECU | 7.5.1 |
| 129 | Response with the general parametric data for the NIECU | NIECU to ECU | 7.5.2 |
| 130 | Command to reset the general parametric data for the NIECU | ECU to NIECU | 7.5.3 |
| 131 | Request the parametric data for a specific port pair | ECU to NIECU | 7.6.1 |
| 132 | Response with parametric data for a specific port pair | NIECU to ECU | 7.6.2 |
| 133 | Command to reset the parametric data for a specific port pair | 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 |

### 7.7.2 Port Numbers and Port Pair

#### 7.7.2.1 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 Messages. 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 bus 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.

7.7.2.2 Port Pair

Port Pair is a reference to a data collection that identifies the two ports of an NIECU and the direction of message activity between the ports. A Port Pair data consists of the port number for the “From Port” and the port number for the “To Port,” and identifies 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.” These two Port Pairs reference the same ports of the NIECU but specify opposite directions of message passing between these ports through the NIECU. The Port Pair of “From 2 and To 3” identifies the NIECU message activity that is received on Port 2 and targeted for Port 3; whereas, the Port Pair of “From 3 and To 2” identifies the NIECU message activity that is received on Port 3 and targeted for Port 2.

When the Network Message function requires Port Pair information in the data, the Port Pair shall be placed into one byte containing the “From Port” number and the “To Port” number. The “From Port” number shall be positioned in the upper nibble (bits 8 to 5) of the byte and the “To Port” number shall be positioned in the lower nibble (bits 4 to 1) of the byte.

7.7.3 Port (SPN 5593)

***SPN 5593 NIECU Port***

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 7.7.2.1.

Data Length: 4 bits
Resolution: 16 states/4 bit, 0 offset
Data Range: 0 to 15 Operational Range: same as data range
Type: Status
Supporting Information:
PGN reference: 60672

7.7.4 To Port (SPN 5594)

***SPN 5594 To Port***

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 7.7.2.1.

Data Length: 4 bits
Resolution: 16 states/4 bit, 0 offset
Data Range: 0 to 15 Operational Range: same as data range

Type: Status
Supporting Information:
PGN reference: 60672

7.7.5 From Port (SPN 5595)

***SPN 5595 From Port***

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 7.7.2.1.

Data Length: 4 bits
Resolution: 16 states/4 bit, 0 offset
Data Range: 0 to 15 Operational Range: same as data range
Type: Status
Supporting Information:
PGN reference: 60672

7.7.6 Filter Mode (SPN 5596)

***SPN 5596 Filter Mode***

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

Data Length: 8 bits
Resolution: 256 states/8 bit, 0 offset
Data Range: 0 to 250 Operational Range: same as data range
Type: Status
Supporting Information:
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 |

7.7.7 NIECU Parameter Number (SPN 5597)

The Parameter Number List is a collection of zero, one, or more Parameter Numbers, where each instance of a Parameter Number conforms to the definition below.

***SPN 5597 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 APPENDIX A.

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: 8 bits
Resolution: 256 states/8 bit, 0 offset
Data Range: 0 to 253 Operational Range: same as data range
Type: Status
Supporting Information:
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 | A.1 |
| 2 | 2 | - | Maximum Filter Database Size | A.2 |
| 3 | 2 | - | Number of Filter Database Entries | A.3 |
| 4 | 2 | - | Maximum Messages Received per second | A.4 |
| 5 | 2 | - | Maximum Messages Forwarded per second | A.5 |
| 6 | 2 | - | Maximum Messages Filtered per second | A.6 |
| 7 | 2 | - | Maximum Transit Delay Time | A.7 |
| 8 | 2 | Yes | Average Transit Delay Time | A.8 |
| 9 | 2 | Yes | Number of Messages lost due to Buffer Overflow | A.9 |
| 10 | 2 | Yes | Number of Messages with Excess Transit Delay Time | A.10 |
| 11 | 2 | Yes | Average Messages Received per second | A.11 |
| 12 | 2 | Yes | Average Messages Forwarded per second | A.12 |
| 13 | 2 | Yes | Average Messages Filtered per second | A.13 |
| 14 | 4 | - | Uptime since last power on reset | A.14 |
| 15 | 1 | - | Number of Ports | A.15 |
| 16 | 1 | - | Network Interconnection Type | A.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 |

7.7.8 NIECU Parameter Data (SPN 5598)

Each instance of parameter data associated with an NIECU Parameter Number shall be encoded and of the size defined for the Parameter Number in APPENDIX A. The NIECU Parameter Data is a collection of zero, one, or more instances of parameter data for each of the requested Parameter Numbers. The list of available parameters and a cross-reference to the Parameter Number definition is shown in Table 4.

7.7.9 PGN (SPN 5599)

Each instance of a PGN listed a Network Message data field shall be presented as a 3-byte parameter and ordered according to the PGN definition in SAE J1939-21 Section 5.1.2 and SAE J1939-21 Table 2. For Network Messages, a PGN List is a series of zero, one, or more PGNs. The list of PGNs is commonly used in Network Messages to identify the messages that the filtering mode applies.

7.7.10 Source Address (SA) (SPN 5600)

Each instance of a Source Address (SA) listed a Network Message data field shall be presented as a 1 byte, as specified in SAE J1939-21. For Network Messages, an SA List is a series of zero, one, or more SAE J1939 Source Addresses.

7.7.11 NAME (SPN 5601)

Each instance of a NAME, i.e., SAE J1939 NAME, listed a Network Message data field shall be presented as an 8-byte parameter and ordered according to the NAME definition in SAE J1939-81.

7.7.12 Number of SA/NAME Pairs (SPN 5602)

***SPN 5602 Number of SA/NAME Pairs***

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 SA/NAME Pairs
Data Type: Status

8. NOTES

8.1 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 THE SAE TRUCK BUS CONTROL AND COMMUNICATIONS NETWORK COMMITTEE (J1939) OF THE TRUCK AND BUS ELECTRICAL / ELECTRONIC STEERING COMMITTEE

# APPENDIX A - STATUS AND STATISTICS PARAMETER DEFINITIONS

This Appendix 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 may be applicable for a given NIECU, for a specific Port Pair, or for both.

## A.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

## A.2 MAXIMUM FILTER DATABASE SIZE (PARAMETER NUMBER 2)

The maximum size, in bytes, available for the Filter Database in the NIECU.

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

## A.3 NUMBER OF FILTER DATABASE ENTRIES (PARAMETER NUMBER 3)

The number of entries in the NIECU filter database.

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

## A.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

## A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.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

### A.16 NETWORK INTERCONNECTION TYPE (PARAMETER NUMBER 16)

The declaration of the type of network interconnection device. It is possible for the NIECU indicate different NIECU types for each port pair. The NIECU Type value assignments are shown in Table A1.

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

***Table A1 - 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 |