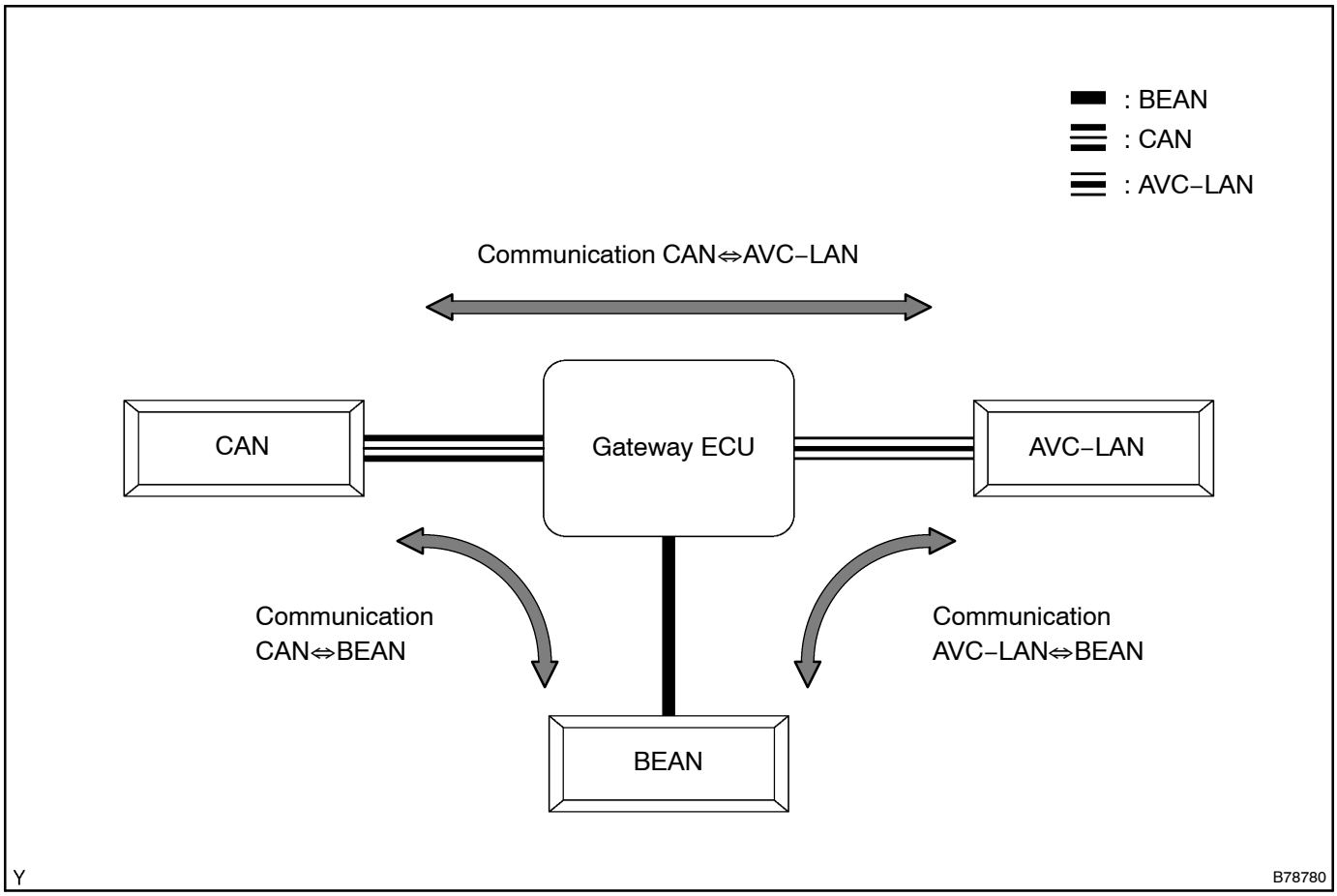
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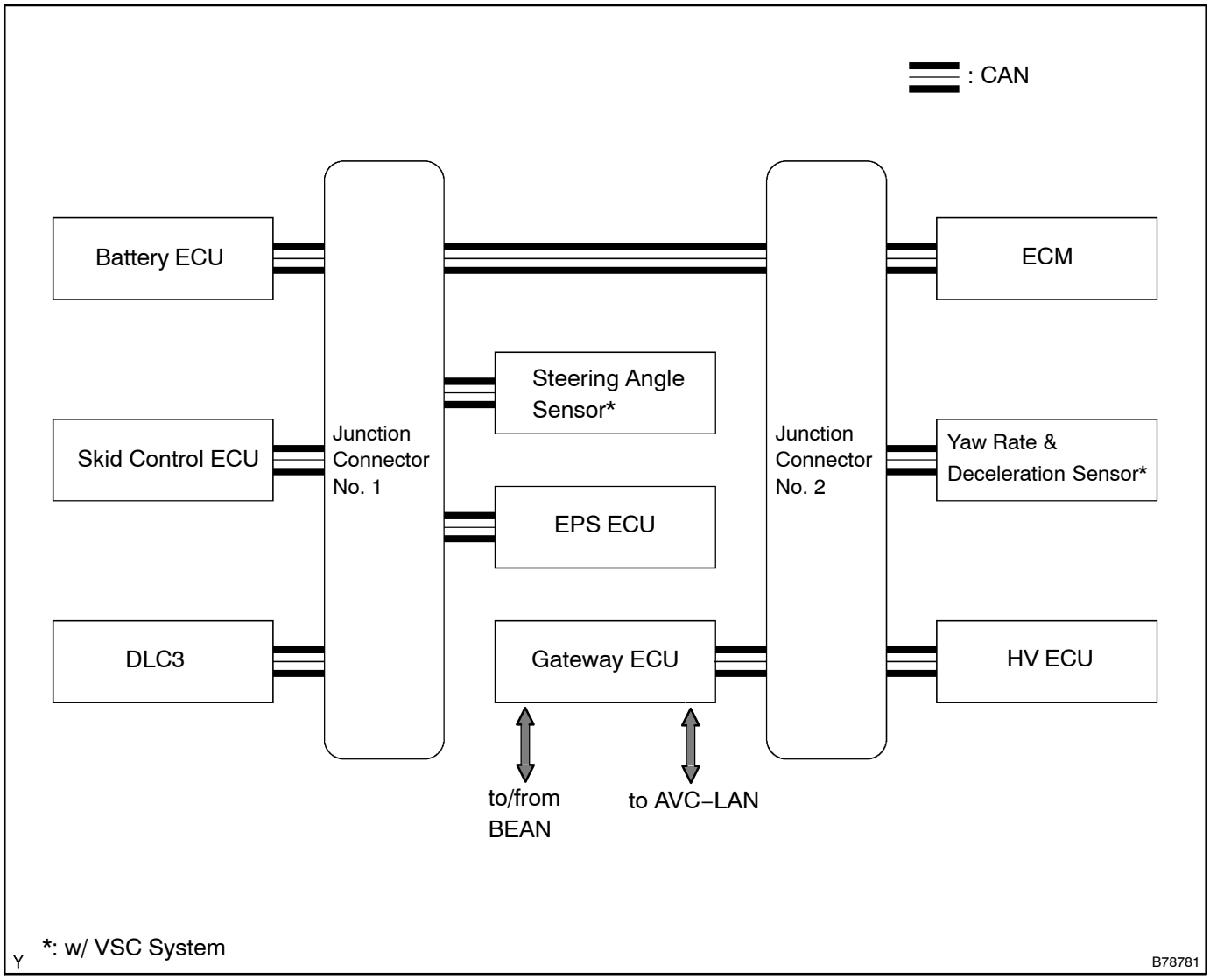
SYSTEM DESCRIPTION

- The PRIUS primarily uses the 3 types of multiplex communication systems described below.
  - The Controller Area Network (CAN) is a network of the vehicle control systems (engine electrical, chassis electrical, and hybrid system) and maintains communication between the ECUs.
  - The Body Electronics Area Network (BEAN) is a network of the ECUs of the body electric system control and maintains communication between the ECUs.
  - The Audio Visual Communication–Local Area Network (AVC–LAN) is a network of the ECUs of the audio visual system and the audio visual devices, and maintains communication between the devices and the ECUs.
- These 3 types of multiplex communication systems are connected to the gateway ECU. The gateway ECU, which is provided with communication circuits that support the 3 types of multiplex communication systems, enables communication among the multiplex communication systems that are connected to the gateway ECU.
  For example, to enable air conditioning control, the air conditioning ECU receives the engine coolant temperature signal that is input into the ECM via the CAN, gateway ECU and BEAN.



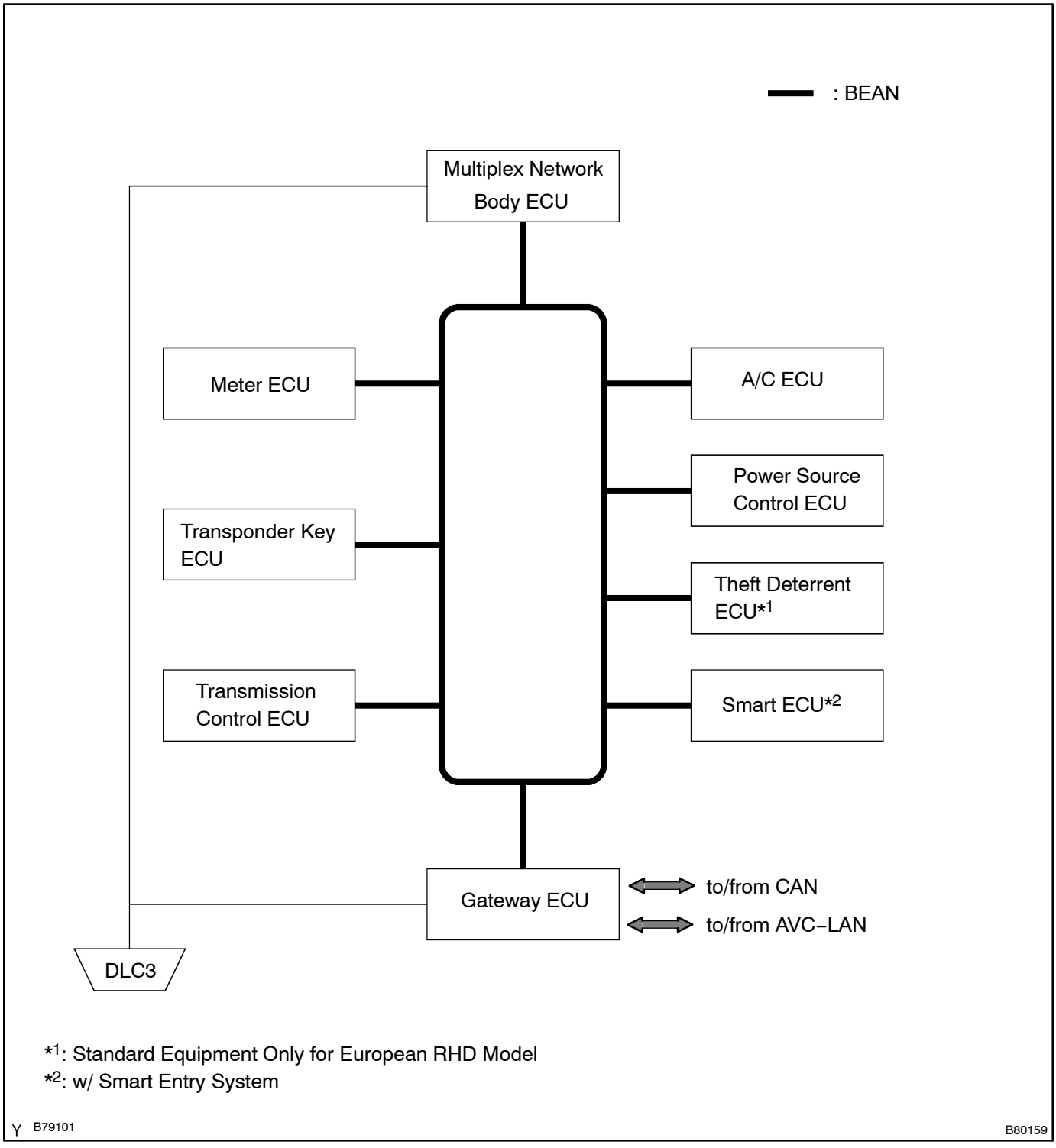
- The CAN in the PRIUS is established among the Hybrid Vehicle Control ECU (HV ECU), battery ECU, EPS ECU, ECM, skid control ECU, steering angle sensor*, yaw rate & deceleration sensor*, gateway ECU and DLC3.

CAN System Diagram



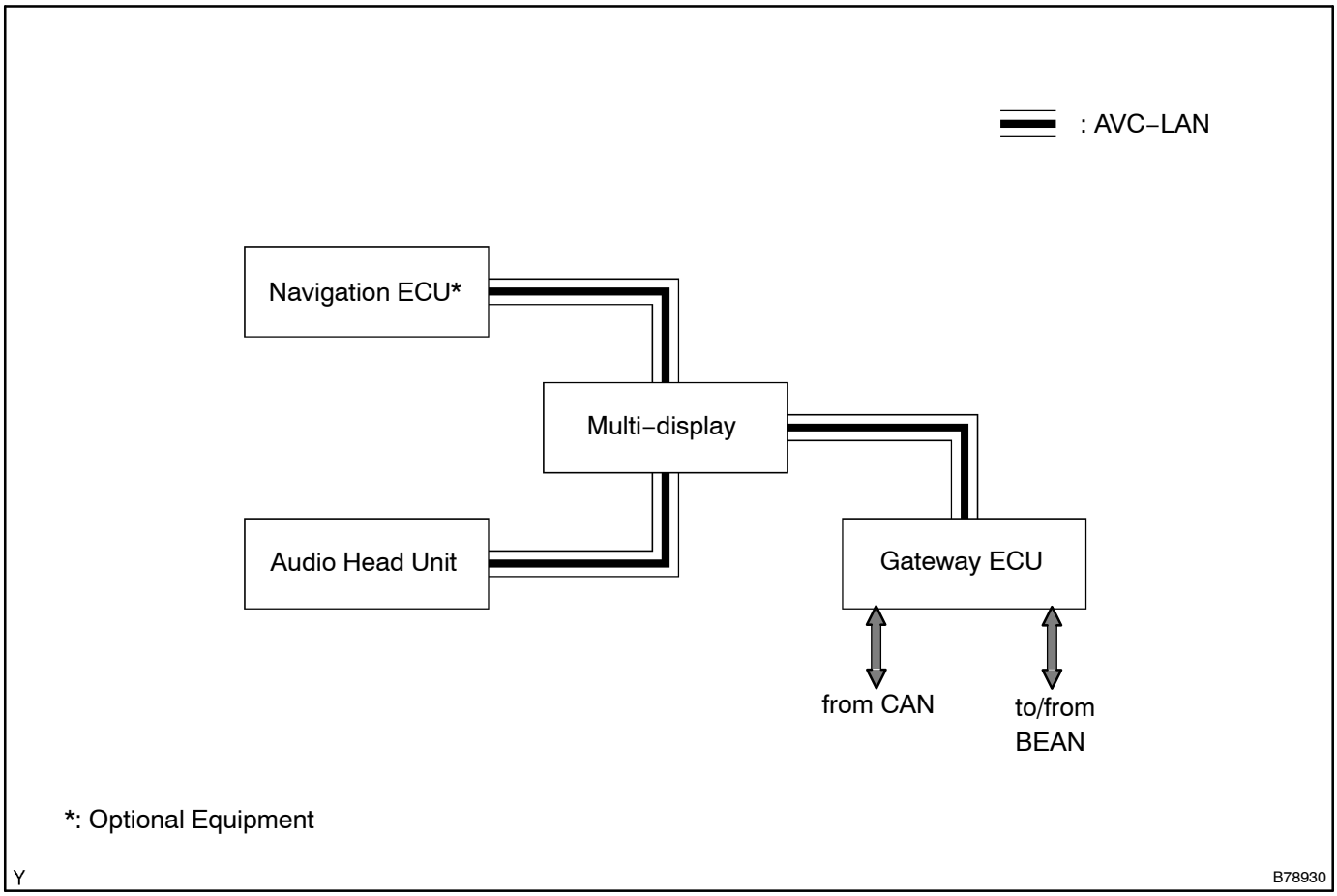
- The BEAN in the PRIUS is established among the body ECU, meter ECU, A/C ECU, transponder key ECU, power source control ECU, transmission control ECU, theft deterrent ECU*1 smart ECU*2 and gateway ECU.

BEAN System Diagram



- The AVC–LAN is established among the multi–display, audio head unit, navigation ECU* and gateway ECU.

AVC–LAN System Diagram

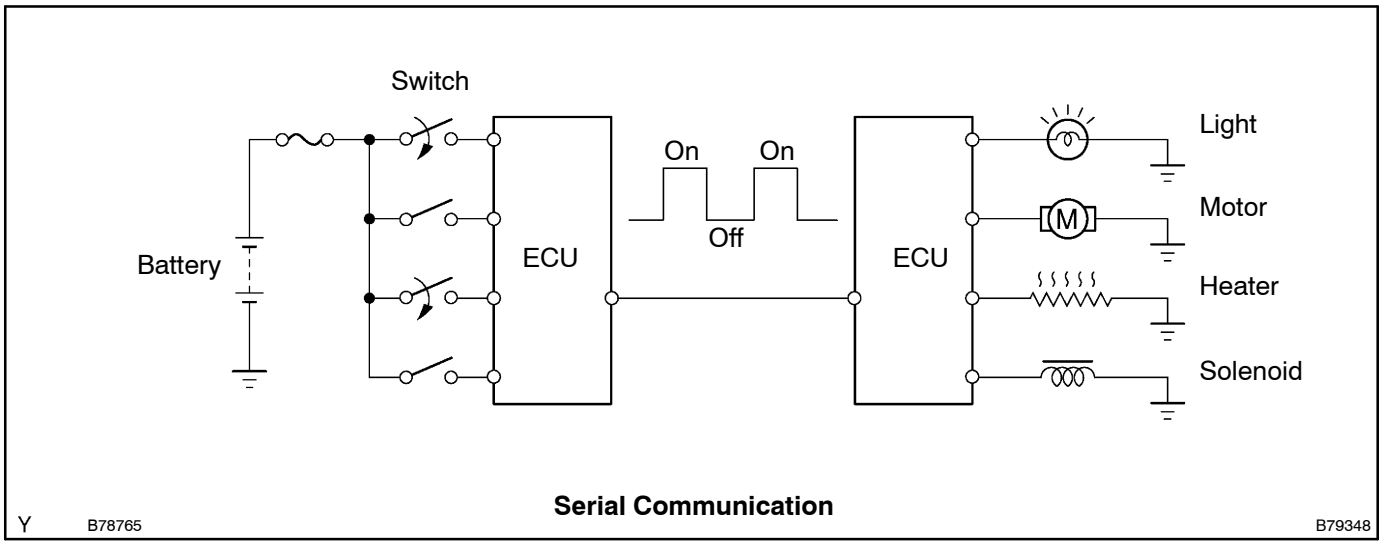


BASIC OF MPX (Multiplex Communication)

1. GENERAL

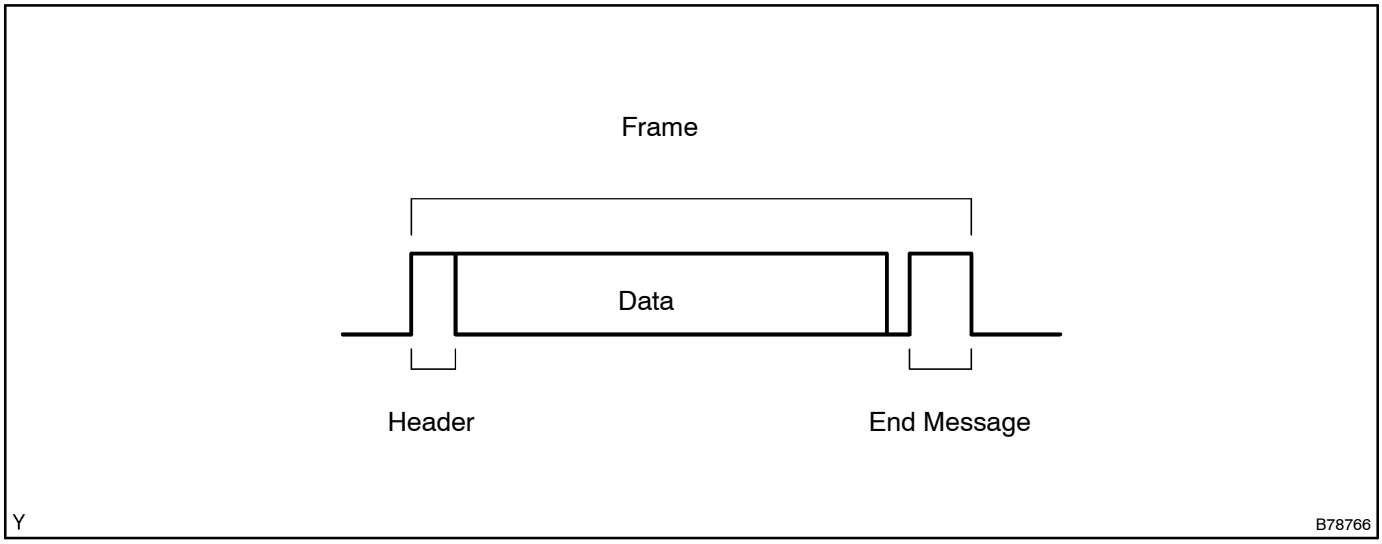
The PRIUS multiplex communication system uses serial communication, which converts multiple pieces of information into serial communication data. As a result, they can be transmitted through a single communication wire.

Conceptual Drawing



Serial Communication

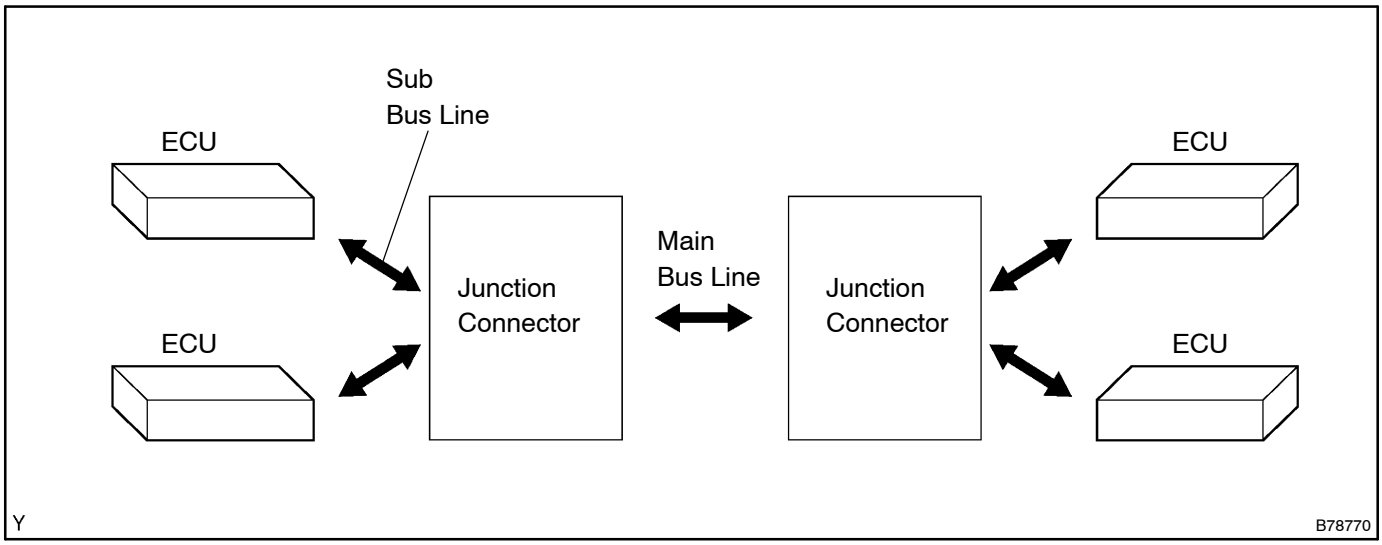
- Serial communication data consists of bits and frames. A bit is the basic unit that represents the amount of information. A bit is represented by binary values ”0” or ”1”. A frame is a body of data that is transmitted together. A frame contains a ”header” that indicates the beginning of the data and an ”end” message that indicates the end of the data.



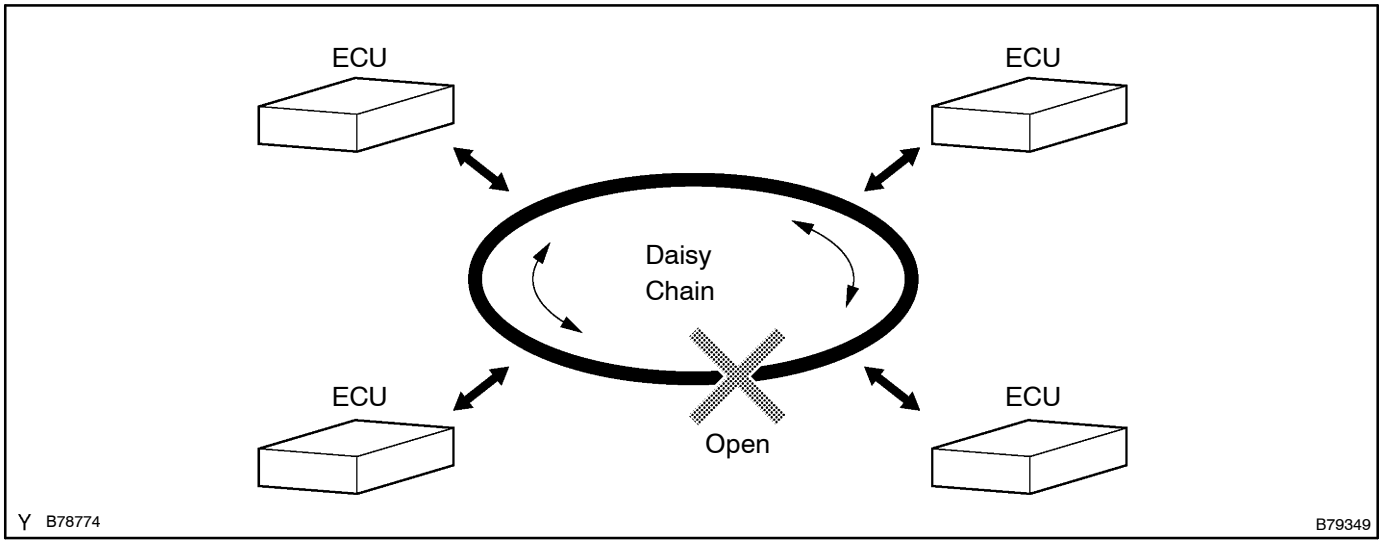
2. NETWORK STYLE

Based on serial communication, various ECUs are connected on a network to exchange various pieces of information. Such a system is called a multiplex communication system.

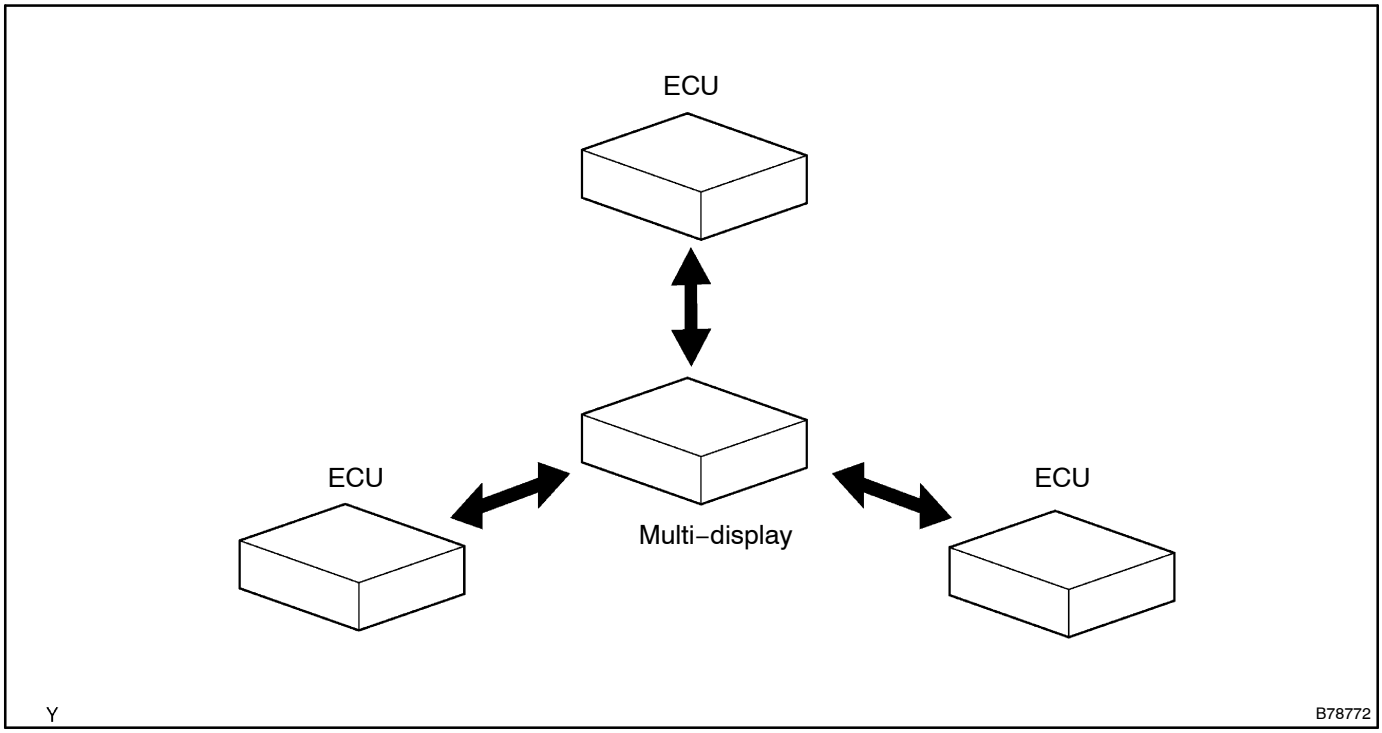
- The CAN communication on the PRIUS uses the multi star style bus connection. In this style of network, the ECUs are connected in a star shape. The ECUs cannot establish communication with other ECUs without passing through the master ECUs. For the Prius, the 2 junction connectors are the master ECUs and they are connected with main bus lines. Each of the junction connectors extends sub bus lines and communicates between all the connected ECUs.



- The BEAN on the PRIUS uses the ring and bus styles of networks to connect ECUs. The connection method is called a daisy chain. In a daisy chain, communication can be maintained even if there is an area that has an open circuit. The ECUs are connected in a ring form, which enables a signal that is output by a transmitting ECU to circle the ring and return to its original ECU. This ring also functions as a single common communication wire. The transmitting ECUs output signals through a common communication wire and the receiving ECUs input data through a common communication wire.



- The AVC–LAN in the PRIUS uses a star style. This style is centered on a master ECU, which holds a central control function. The ECUs are connected in a star shape. The ECUs cannot establish communication with other ECUs without passing through the master ECU. For the Prius, the multi–display or audio head unit functions as a master ECU.



3. DIFFERENCE OF CAN, BEAN AND AVC–LAN

Data for respective protocols (CAN, BEAN and AVC–LAN) are arranged differently. Therefore, it is not possible to exchange data between different protocols. For this reason, data arrangement must be converted before transferring data to communication bus (CAN, BEAN and AVC–LAN). This conversion is called gateway function, which is performed by the gateway ECU.

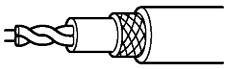
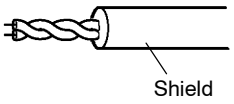
Control	Chassis Electrical System Control	Body Electrical System Control	Body Electrical System Control
Protocol	CAN (ISO Standard)	BEAN (TOYOTA Original)	AVC–LAN (TOYOTA Original)
Communication Speed	500 k bps (Max. 1 M bps)	Max. 10 k bps	Max. 17.8 k bps
Communication Wire	Twisted–pair Wire	AV Single Wire	Twisted–pair Wire
Drive Type	Differential Voltage Drive	Single Wire Voltage Drive	Differential Voltage Drive
Data Length	1 – 8 Byte (Variable)	1 – 11 Byte (Variable)	0 – 32 Byte (variable)

*: ”bps” stands for bit per second.

Although BEAN and AVC–LAN communicate at almost the same speed, the CAN communication speed is much faster than BEAN or AVC–LAN. When the vehicle control system uses BEAN or AVC–LAN, which have a slower communication speed than CAN, it means that the system control could be delayed by the slow speed. For this reason, the vehicle control system uses CAN, which can send and receive a large volume of data at one time, in addition to being able to transmit at a faster speed.

4. COMMUNICATION WIRE

A single, automobile vinyl (AV) wire is used for BEAN communication. A twisted–pair wire is used for CAN and AVC–LAN communication.

Function	Outline
AV Single Wire	Lightweight single communication wire that consists of single core line surrounded by insulation. Voltage is applied to this line in order to drive communication. This system is called ”single wire voltage drive”.
Twisted–pair Wire for AVC–LAN 	Pair of lines is twisted together and covered with insulation. Communication is driven by applying positive (+) and negative (–) voltage to two lines in order to send single signal. This system, which is called ”differential voltage drive”, can reduce noise.
Twisted–pair Wire for CAN 	Pair of lines is twisted. Communication is driven by applying 1.5 to 2.5 V and 2.5 to 3.5 V of voltage to two lines in order to send single signal. This system, which is called ”differential voltage drive”, can reduce noise.

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