Multiplexed Vehicle Electronics

A modern high-end car often contains 2 km of wiring!

The large amount of wires has been a problem for a long time with bad produceability and reliability as drawbacks. For this reason and due to requirements for better functionality in cars, the multiplex technology has become one of the most important technologies for vehicle electronics.

What is Multiplexed Vehicle Electronics?

One definition is: "To transmit multiple signals on a single shared media"

In vehicles this means:

Several signals are read by "Node A"

Signals are transferred multiplexed to another node, "Node B"

"Node B" recreates the original signals

Consequences are:

All information is digitized

Functions are determined by a program in a microprocessor, not by the circuit diagram

Today, multiplex is associated with a lot more than the basic motivation and definition above. For example, multiplex may be more motivated by functional improvements of the vehicle rather than reduced wiring. Further, multiplex in its pure definition is simply communication, but in practice it leads to a completely new way of looking upon vehicle electronics. For further information on this topic, see Vehicle Electrical Architectures.

Multiplexed systems are often categorized in three classes according to SAE:

Class A

A multiplex system whereby vehicle wiring is reduced.

Class A is normally used for on/off control of power loads with low demands on speed and response times (typically 10 kbits/s).

Class B

A multiplexed system whereby data is transferred between nodes to eliminate redundant sensors and other system elements.

Class B is normally used for information sharing and subsystem interaction with medium-high demands on capacity and response times

Class C

A multiplexed system whereby high data rate signals typically associated with real-time control systems, such as engine control and anti-lock brakes, are sent over the signal bus to facilitate distributed control and further reduce vehicle wiring.

Class C is used for distributed real-time control with high demands on speed and response time

The above definitions are somewhat "fuzzy" and cannot be used as a stringent categorization. However, they reflect the large span of applications and principles of multiplexed systems, and can be used as guidance.

In practice Class B and C systems are the most common. The reason is that Class A systems have a number of disadvantages:

The number of wires increases (cost is normally associated with the number of wires not total length)

The number of connectors increases with degeneration of reliability as a result

new electronic "nodes" or Electronic Control Units, ECUs, must be added which will add to the cost

These problems do not normally show up in class B and C systems.

New applications not covered by the SAE definitions are emerging and new classes are probably necessary to define. Two of the most important categories are:

High speed buses mainly motivated by "infotainment" applications including graphic information, video, etc. An infotainment bus may be based on optical fibres and run at 10-100 Mbit/s

High dependability buses motivated by safety critical applications such as airbag, ABS, stability control and active steering