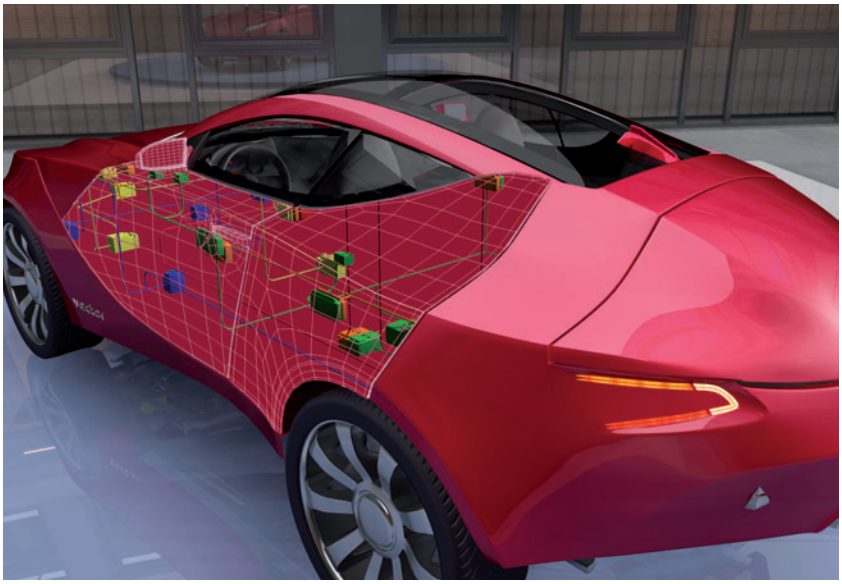
Network Development across LIN Bus Systems

Tools for Efficient Network Design and Conformance Testing



The transition from the current LIN Version 2.0 to LIN 2.1, consistent LIN network design and efficient test strategies were key topics at the 3rd LIN Symposium hosted by Vector Informatik GmbH in February 2008 in Stuttgart.
Over 150 participants from Germany and across the globe learned about the latest developments and trends related to the LIN bus, and shared their experiences on efficient use of simulation, design and test tools.

Apart from minor changes and clarifications, significant functional improvements were made with the LIN 2.1 protocol version released in November 2006 for event-triggered frames, Slave identification and Slave configuration as well as for diagnostics over LIN users are now awaiting the LIN consortium's release of LIN 2.1 conformance test specification in the second quarter of 2008. This document specifies tests for validating the conformance of LIN devices according to the different parts of the LIN 2.1 specification.

LIN Network Design

Prior to the development and test phases, many network design challenges must first be mastered. These range from defining the system topology and cycle times to creating LIN frames and schedule tables as well as routing relationships with other bus systems. LIN communication design needs to be completely error-free and consistent, since the resulting LIN Description File (LDF) is used for all subsequent development steps: embedded software generation, network analysis, conformance testing, system and integration tests, etc. (Figure 1).

The choice of network topology depends on various factors. For example, it may be possible to define a single LIN network rather than separate networks for left and right door systems. In some cases, a function-oriented approach is more appropriate, e.g. a dedicated LIN network for climate control. It may also be necessary to make a distinction between networks designed by the OEM and subsystems developed completely by the OEM's supplier.

Efficient Design across Networks

Network design can be significantly simplified by directly routing signals between networks. This requires defining unique signal names for both CAN and LIN signals. Using this routing method, the ECU's application code is relieved of routing tasks, which also considerably simplifies the code development process. Since LIN supports only "unsigned signals", globally defined signals must also be unsigned. This limitation can usually be accepted by the CAN networks.

Without the appropriate tool support for network design, it is very difficult to consider all design and quality requirements. Extensive experience acquired during series projects for various OEMs has contributed to the success of version 2.0 of the DaVinci Network Designer LIN (Figure 2). For example, initial schedule tables can be automatically generated by simply defining the frame cycle times. The schedule timings can then be easily optimized and refined depending on, for example, the performance of each LIN Slave. The design tool from Vector also helps the user to implement design rules such as naming conventions for meaningful identifiers and signal types as well as for uniform encoding of physical parameters.

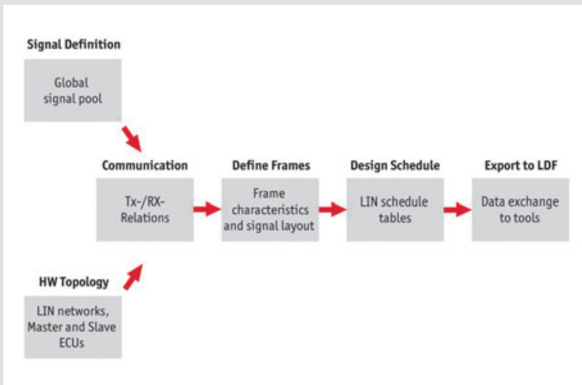


Figure 1:
Typical workflow for LIN network design

Design elements can be easily reused, and consistency checks are automatically performed. Especially important for the efficient network design across bus systems is the uniform management of all signals in a global signal pool. DaVinci Network Designer is capable of importing existing network descriptions via standardized data exchange formats such as LDF, NCF, DBC or FIBEX. This avoids in many cases the re-entering of signal and encoding definitions.

From Multibus Tool to Data Backbone

A future trend is the increasing movement towards global network design across CAN, LIN, MOST and FlexRay bus systems. The central management of all data and information at the vehicle or model level is becoming indispensable. Multibus design tools not only require access to a common, global signal pool, but must also support multiple user access and rights. The eASEE Tool Suite from Vector provides a data backbone that not only manages all engineering data for network designs, but can also support the management of project plans, storage of test data, coordinated data maintenance or archiving of defined version states before delivery to partner companies.

Test Strategies

The primary method for guaranteeing the quality of LIN networks is to apply the LIN conformance tests to each ECU. A black test implementation of such tests has the key advantage that the interfaces used for simulation and verification are exclusively ECU external interfaces. White or gray box tests, on the other hand, always require access to internal ECU interfaces. The Slave conformance test provided with the development and test tool CANoe.LIN (Figure 3) is implemented almost entirely as a black box test. The Master conformance test, on the other hand, is implemented a gray box test i.e. as a combination of black and white box test. A special test-LDF and test application is required to stimulate the Master. The LIN bus is used for verification.

Prototype of a Black Box Master Conformance Test

Although a gray box implementation allows the Master conformance test to be fully automated, it can only be applied a the start of the V-model development process. This is mainly because the required test LDF and test application are not identical to real LDF and application of the Master ECU. On request of an OEM, the LIN specialists from Vector have specified a prototype black box Master conformance test. By extending the Master driver to provide eleven test services, it was proved possible to perform the current LIN2.0 Master conformance test during all phases of development using the real LDF and application. The Vector concept is not only fundamentally extendable; it can also be easily standardized.

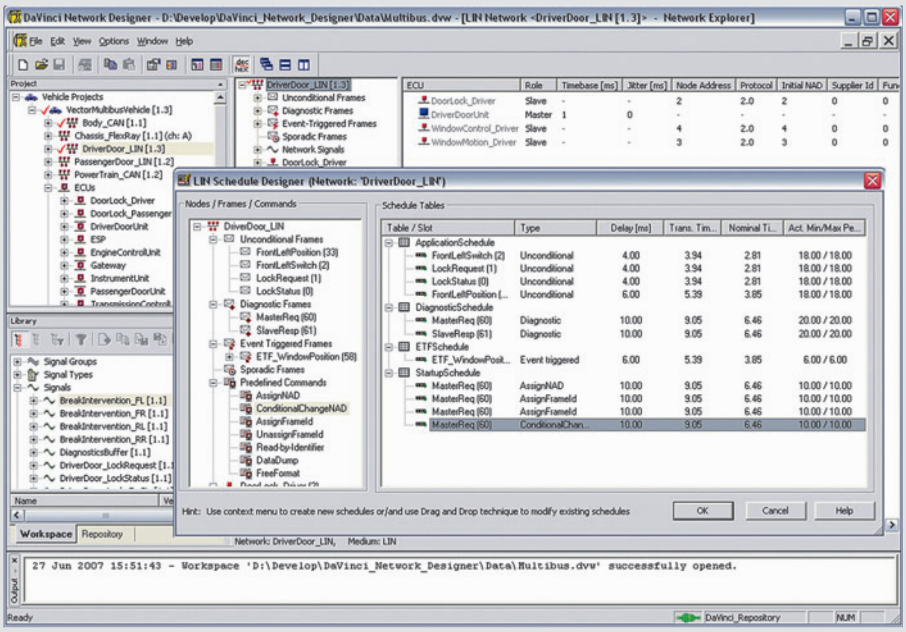


Figure 2:
Design of the LIN Schedule with DaVinci Network Designer LIN

OEM-standardized LIN-Portfolio

Last year, Audi, BMW, Daimler, Porsche and VW created a document for suppliers, which describes the requirements for the development of OEM-independent “LIN portfolio”. This document was first presented to LIN consortium members at the All-Members Meeting in October 2007 and in February this year to the rest of the LIN community at Vector’s LIN Symposium. The main objective of this initiative is to reduce development and production costs through maximum reusability. The standardization of the physical layer requirements across different OEMs does not end with the choice of transceiver, but must also include specifications for connectors, filter circuits, operating and installation conditions. A current example for such a LIN device, is an intelligent battery sensor developed for several OEMs. A wiper motor and mirror adjuster are also in development. In order to increase the size of the “LIN portfolio”, each OEM developing a LIN device in cooperation with a supplier, harmonizes the specifications with other OEMs in technical committees.

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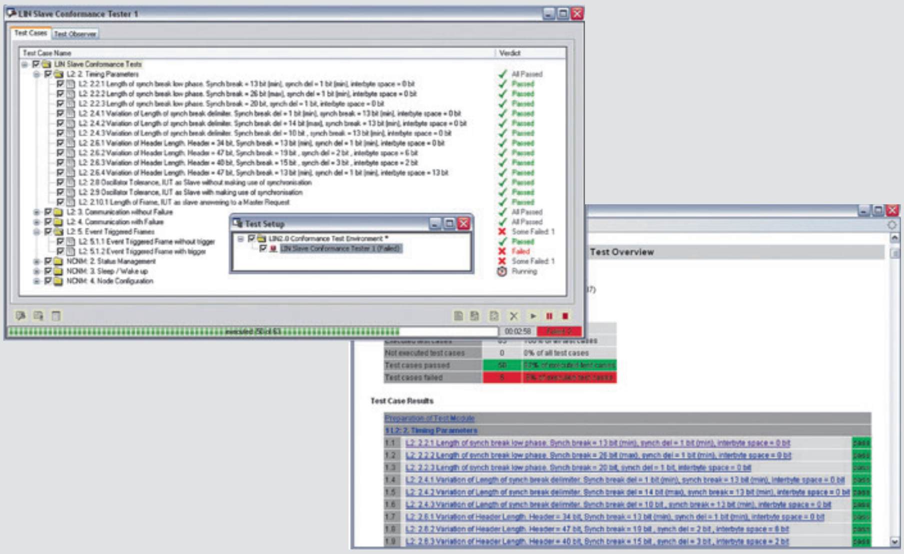

Figure 3:
Using the Slave Conformance Test Module, LIN conformance tests can be easily integrated into your own CANoe test configurations.