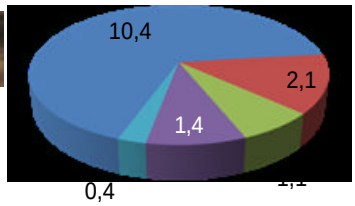
Software Testing at MAN Nutzfahrzeuge AG
HIL simulation with DSpace

Content

- MAN Group / MAN Trucks and Busses
- Development Process (V Model)
- Test Levels (Component Test, Integration Test, System Test, Acceptance/Validation Test)
- Aspects of HIL Tests

MAN Group

Trucks and Buses



Heavy Diesel Engines

Turbo Machinery

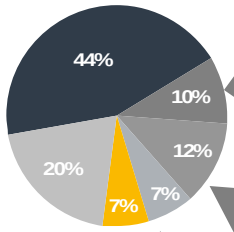
Others (e.g. Renk Gearboxes)

Industry Services and Finance

Introduction : The MAN Nutzfahrzeuge AG

Sales in 2007 : € 10.4 Billion

Heavy trucks



Light and medium-weight trucks

After-Sales/ Services

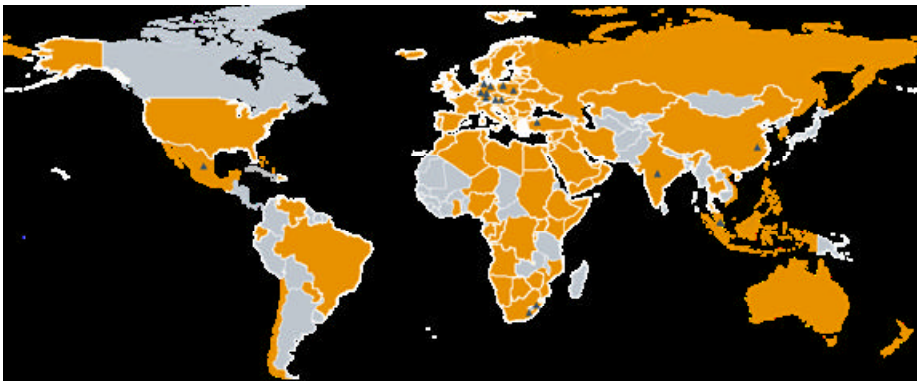
Components

MAN | Diesel

Used vehicles

Buses and Coaches

Introduction : MAN Nutzfahrzeuge Worldwide



	Europe	Worldwide
MAN sales regions	7	10
Importers	16	77
After-sales workshops	1,100	1,230

MAN markets
Production

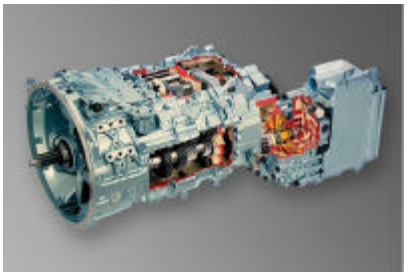
Applications for Electronic Control 1

ACC Adaptive Cruise Control

ESP Electronic Stability Program

Applications for Electronic Control 2

MAN PriTarder



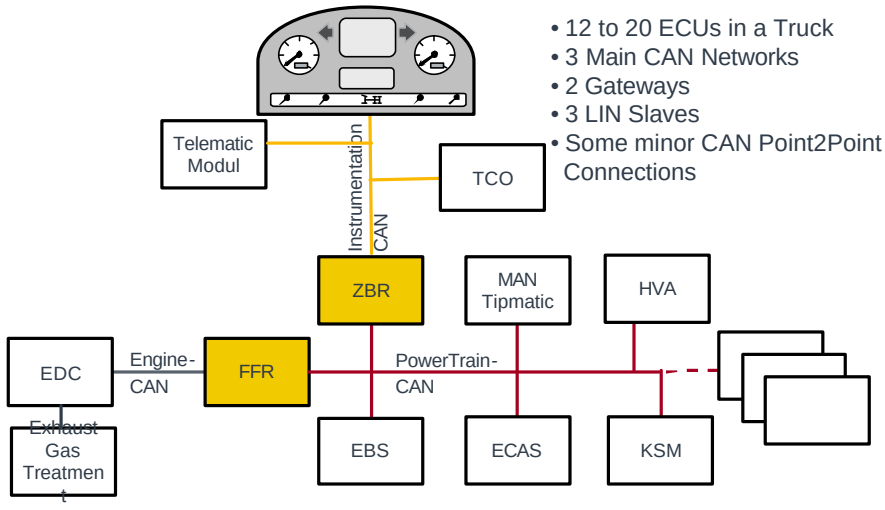
MAN TipMatic

Applications for Electronic Control 3

MAN HydroDrive

MAN Multifunction Steering Wheel and Instrumentation

MAN Electronic Network

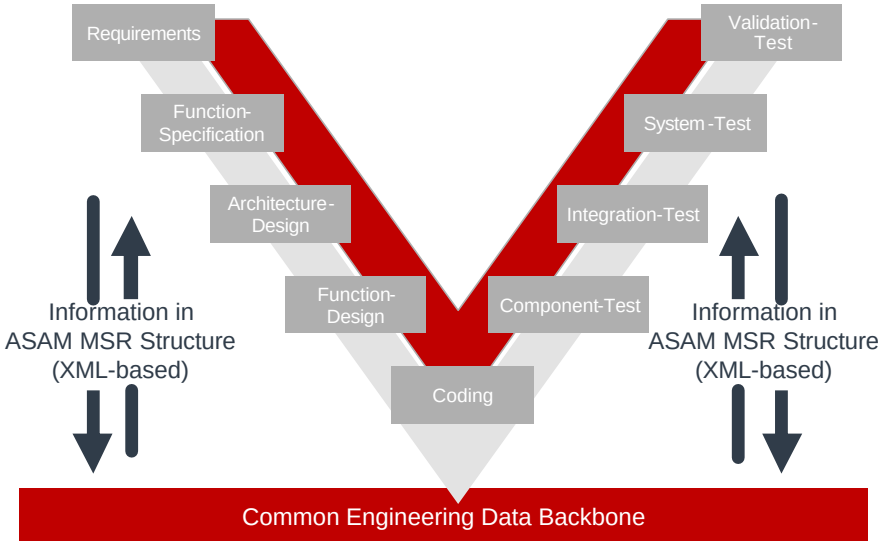


- 12 to 20 ECUs in a Truck
- 3 Main CAN Networks
- 2 Gateways
- 3 LIN Slaves
- Some minor CAN Point2Point Connections

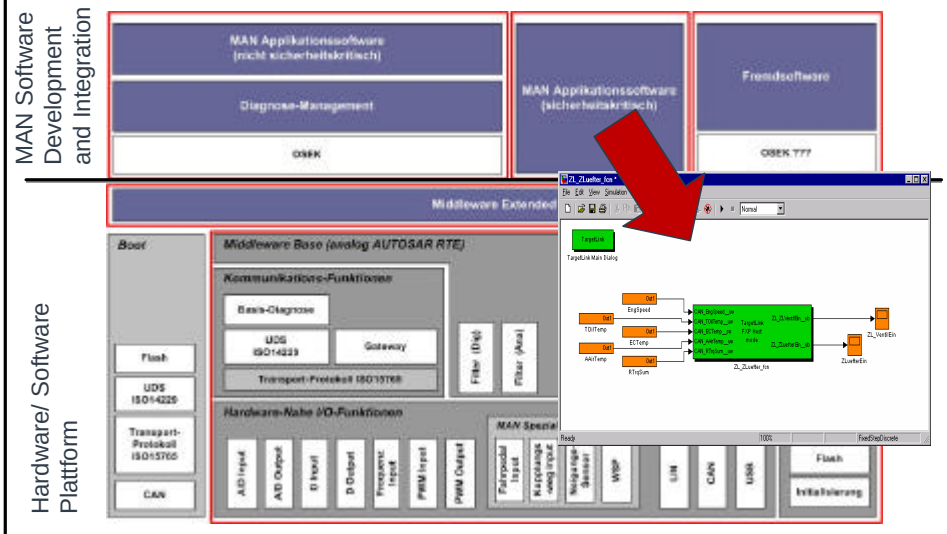
MAN Key Activities in Electronics

- Design of Software Applications
  - Development of Product Features
  - Prototyping and Series Software
- Integrated Solutions
  - Bringing Electronic and Mechanic together
- Integration into the Product (Truck)
  - Integrate Electronics and Mechanics into the Truck

Software Application Development Process at MAN : Development-Process



Software-Architecture of ECU



Validation Test

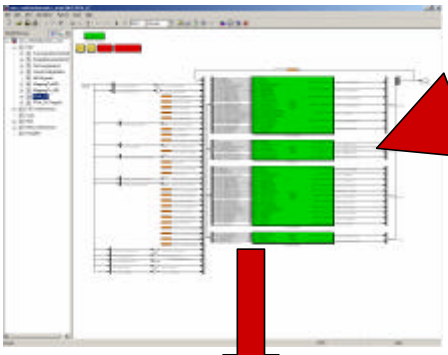
- Driving the truck under different conditions
- Testing customer requirements
- Reliability, usability and life time tests
- Focus on whole system
- Real conditions
- Oldest test level, no special focus on software

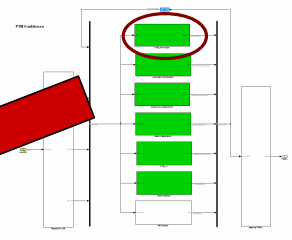
Validation Test – Software Extensions

- Tuning and evalution of controllers (e.g. CC/ACC)
- Tuning of software parameters in general
- Evaluation of system requirements that are implemented in software
- Usability test of software based interfaces
- Performance test of software based functions
- Validation of papid prototypes
- Software test know how (Certified Tester FL ISTQB)

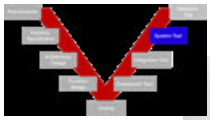
Validation Test – Software Extensions

Target Link Functions of Cruise Controller





System Test



Start 1997
8 interacting ECUs

Two systems for different truck models

Truck virtual reality

Goals :
- Test of interaction of distributed SW functions

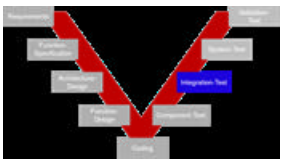
System Test

- Highly complex and demanding
- Only feasible with a very high standard in software quality of single ECUs, documentation process and development process
- Cost intensive in aquisition and maintenance
- Highly complex real time models of the truck are required
- System can be used for
  - Standard regression test of user functions
  - Verification of complex interacting SW before driving in real truck
  - Test in difficult and complex driving situations where a variation of influences and a reproduction of test situations is needed
  - Substitue for expensive prototype variants

System Test

- Test automation is very difficult because of
  - high complexity
  - restricted focus of expected result. The software bug at system test level often results in unexpected results and is not specific.
- The goal to improve software quality by HIL system test is not feasible
  - System HIL is a cost intensive method to find bugs
- Needs very advanced top down system design, documentation and requirement management

Integration Test

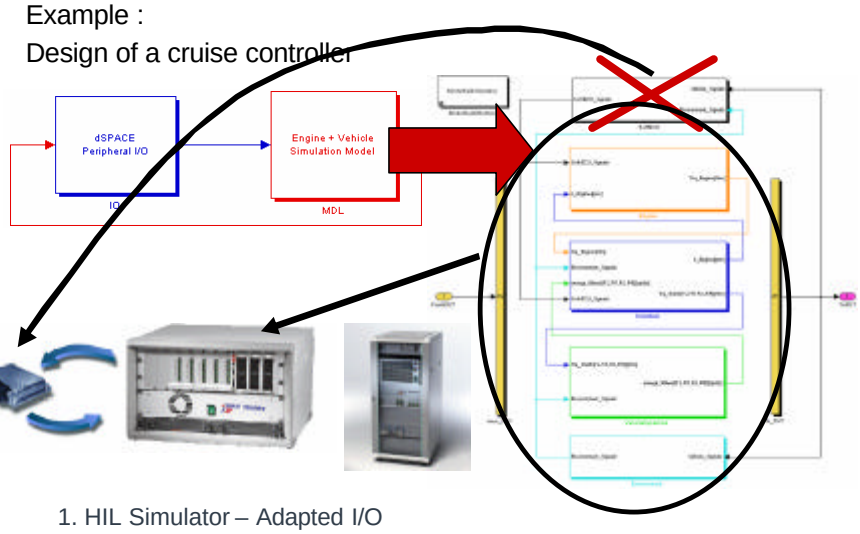


- Test of a single ECU in a virtual Environment
- Test of Software Integration
  - To Hardware
  - To Low Level Software
  - To Middleware Interface
  - To Error Memory
  - To Operation System
  - To Software Architecture
  - Application Integration
  - Test of Functional Requirements
  - Test of Performance, Robustness, Reliabilty
- 3 Units in Operation for 6 ECUs

Integration Test

Example :

Design of a cruise controller



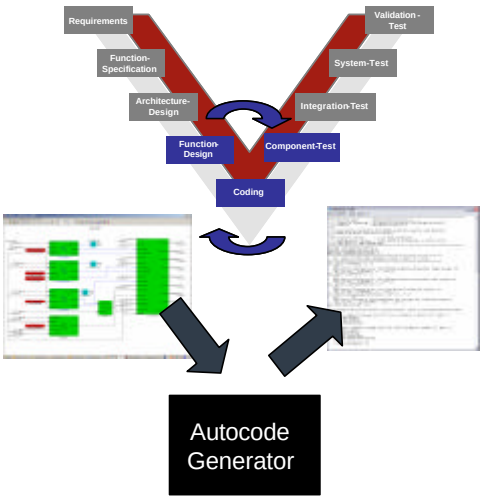
1. HIL Simulator – Adapted I/O

Integration Test

HIL Integration Test :

- has a acceptable complexity
- is much more specific to software issues than HIL system test
- offers a better relation bug/€ than HIL system test
- can be automated for dedicated tests with resonable effort (Test Types)
- works fine with medium quality development process
- benefits very fast from improvements in documentation and requirement management
- can be positioned very close to development units
- strong influence in design for test / testability

Component Test

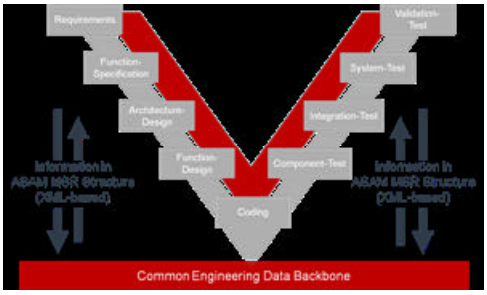


- Test of single models
- Functional test with different methods
- MIL / SIL / PIL Test
- Formal identity test of MIL and SIL
- Formal Verification of safety critical requirements
- Run on PC or target plattform

Component Test

- Component tests are an efficient way to improve software by testing
- The component test is located directly in the development and can directly influence the development processes -> higher SW quality
- Component tests can be out sourced with resonable effort and success
- Component tests find bugs that do not have to be found at another test levels
- Direct influence to design for test / testability -> quality improvement

Right Side of V Model



- Testing starts with project
- Clear processes are needed
- Results have to be checked at each level
- Data/Version/ Configuration Management
- Documentation Management

Conclusion

- HIL is most efficent in Integration Test Level
- HIL in System Test Level is only reasonable if :
  - The development process is on a very high level
  - Top down system documentation and requirements are available
  - The HIL Integration Test is on a high level
  - The Component Test is on a high level
  - The Validation Test considers software test aspects and prototyping
  - The system HIL has to be reduced to the important aspects of the system under test
  - A strong coordination process between all test levels are established and system HIL test should focus only on specialised topics