



## Integration of J1939 System in Practice

Review of JEIM Event, Vector Congress 2010

# Agenda

## > Electrically/Electronically Systems

J1939 Electronics Integration Meeting (JEIM)

J1939 Modeling & Simulation

J1939 Data Exchange Process

J1939 Embedded Software Implementation

J1939 & OEM Network Testing

Outlook

- ▶ **Quality**

- ▶ Increased quality

- ▶ **Cost**

- ▶ Reduced development and maintenance cost
- ▶ Reduced product cost – high and low end products

- ▶ **Time**

- ▶ Reduced time to market

### ▶ **Features**

- ▶ Increased demand for features to be supported by the electrical system without increasing product cost

### ▶ **Complexity**

- ▶ Multi site development
- ▶ Multi brand development with high level of commonality
- ▶ Be able to meet both high end and low end products

### ▶ **New technologies**

- ▶ New & coming technology shifts need to be taken care of

### ▶ **Commonality**

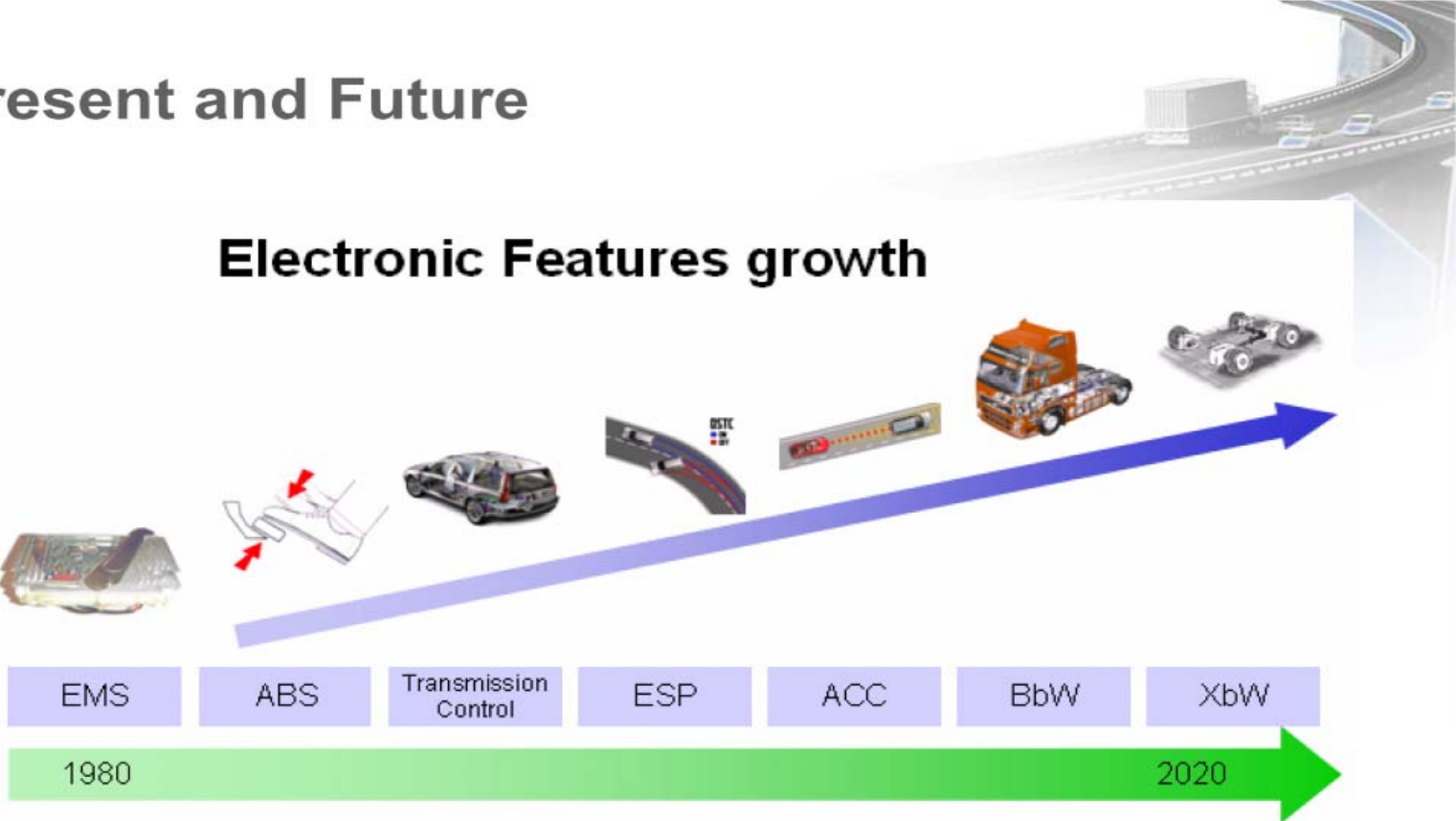
- ▶ Increased commonality (brands/markets)

# Electrically/Electronically Systems

## Motivation

### Present and Future

#### Electronic Features growth

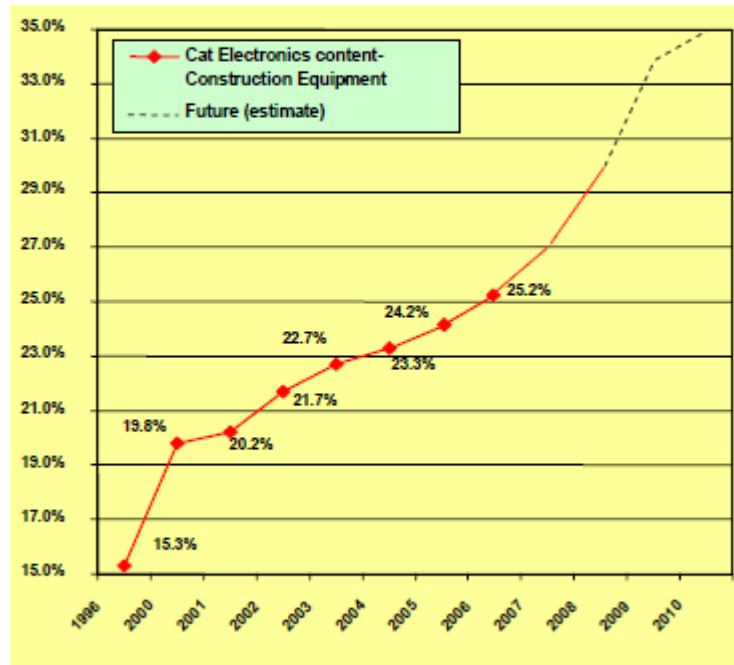


# Electrically/Electronically Systems

## Motivation

### Electrical/Electronics in CAT Products

#### Increasing Content



#### Increasing Demand

Year	Projects
2006	87
2007	92
2009	110
2011	177

#### Increasing Complexity

	Components	Lines of Code
2006 Machine	200	975,000
2009 Machine	325	2,600,000

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Source: **Jody Howard, SAE Conference:** Managing Rapid Electronics Growth and Complexity in Commercial/Off-highway Vehicles

# J1939 Electronics Integration Meeting (JEIM)

## JEIM Event Chicago

- ▶ JEIM event April 2010, Chicago (IL), USA
- ▶ Discussion of common integration issues
- ▶ 6 presentations
- ▶ Participants (OEMs)
  - ▶ AGCO
  - ▶ BAE Systems
  - ▶ Caterpillar Inc.
  - ▶ CNH America LLC
  - ▶ General Dynamics Land Systems
  - ▶ John Deere
  - ▶ Kenworth Truck
  - ▶ Navistar, Inc.
  - ▶ Oshkosh Corporation
  - ▶ Peterbilt Motors Company

# J1939 Electronics Integration Meeting (JEIM)

## How Did We Get Here?

- ▶ J1939 developed as a “plug & play” style network
- ▶ Early ECU J1939 integration activities were handled by a handful of suppliers (typically only engine, transmission & brakes)
- ▶ As more ECUs are added to the J1939 network, the integration responsibility has shifted to the OEM
- ▶ No “standard” has been agreed on within the industry for exchanging J1939 network information between OEMs & suppliers
- ▶ Much of the networking information is treated as “trade secrets”

# J1939 Electronics Integration Meeting (JEIM)

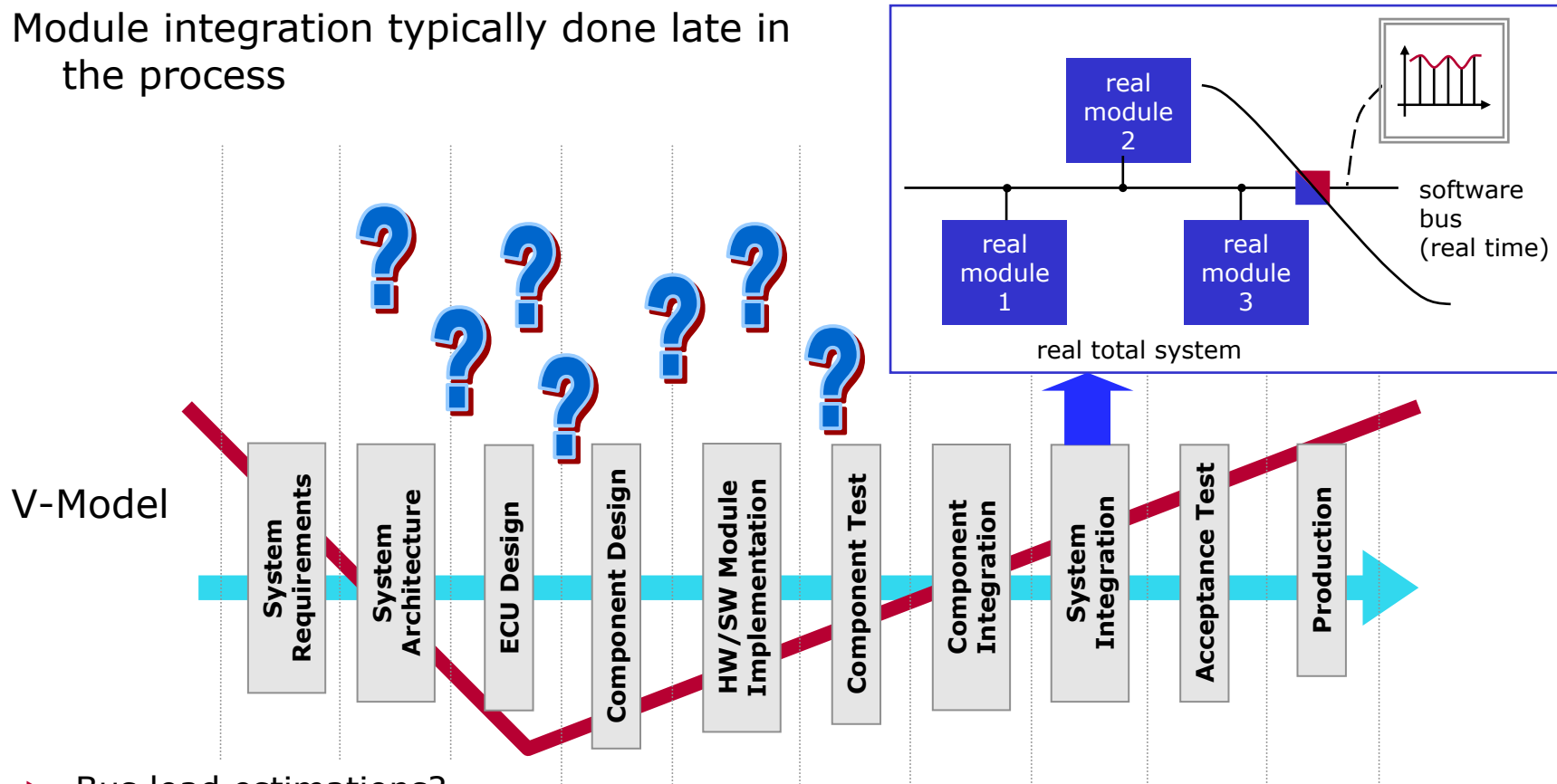
## What's Going on Right Now

- ▶ No standard method for exchanging J1939 network information between OEMs & suppliers
- ▶ Suppliers implement ECUs based on their individual interpretation of J1939 standards
- ▶ Integration and testing of ECUs on the J1939 network happens late in the process and changes are costly
- ▶ Network integration & testing getting more & more costly
- ▶ Field issues related to J1939 network “anomolies” are increasing (one OEM has said this is now their #1 field support issue)
- ▶ More ECUs using the J1939 network = more integration, more testing, more potential for failures...

# J1939 Modeling & Simulation

## Current Situation

Module integration typically done late in the process

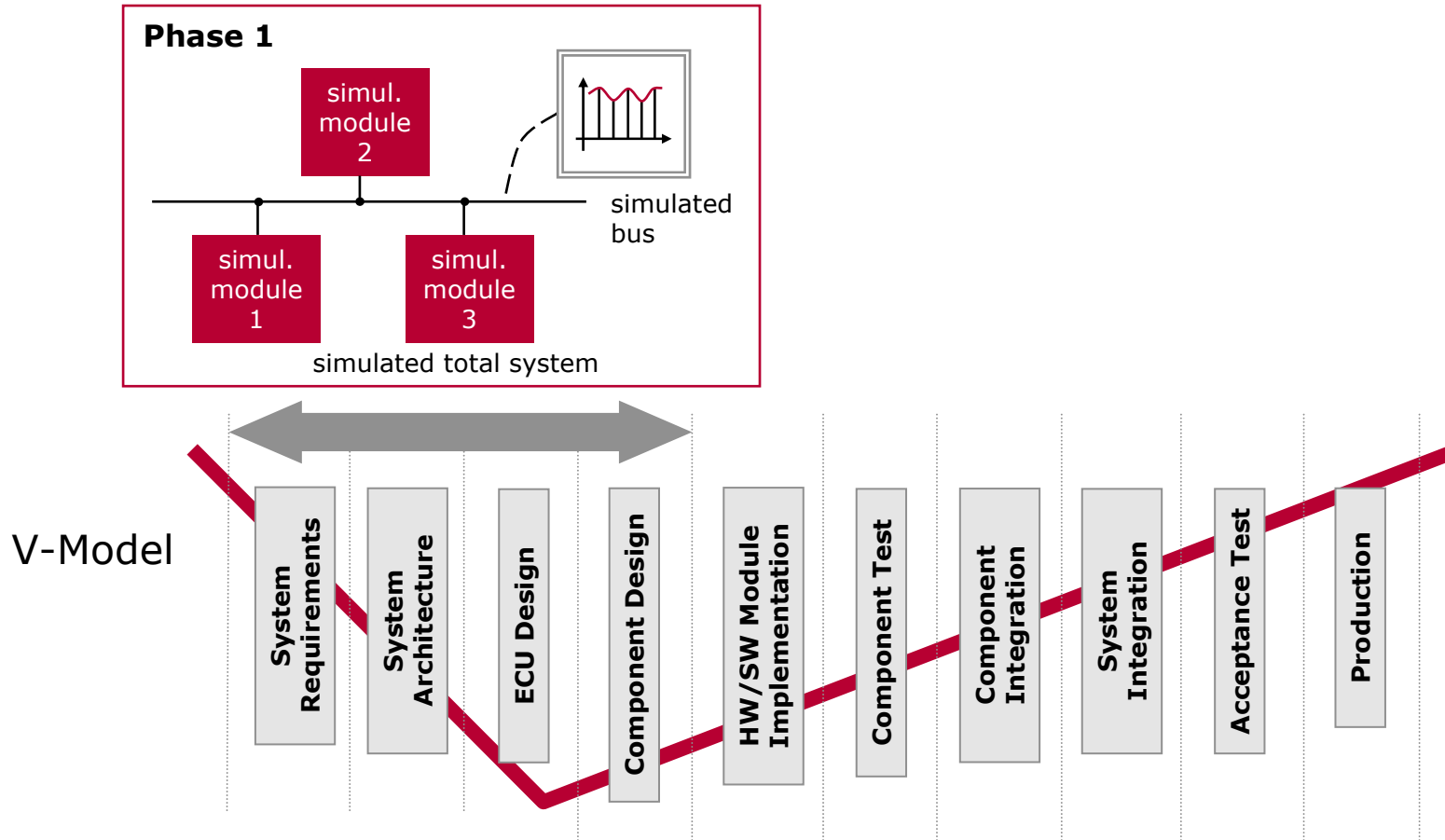


- ▶ Bus load estimations?
- ▶ ECU partitioning between multiple network segments?
- ▶ All send / receive signals accounted for?
- ▶ Network management functionality? (incl. wake up & sleep performance?)
- ▶ Gateway design requirements? (message handling, throughput, etc.)

# J1939 Modeling & Simulation

## Best Practice

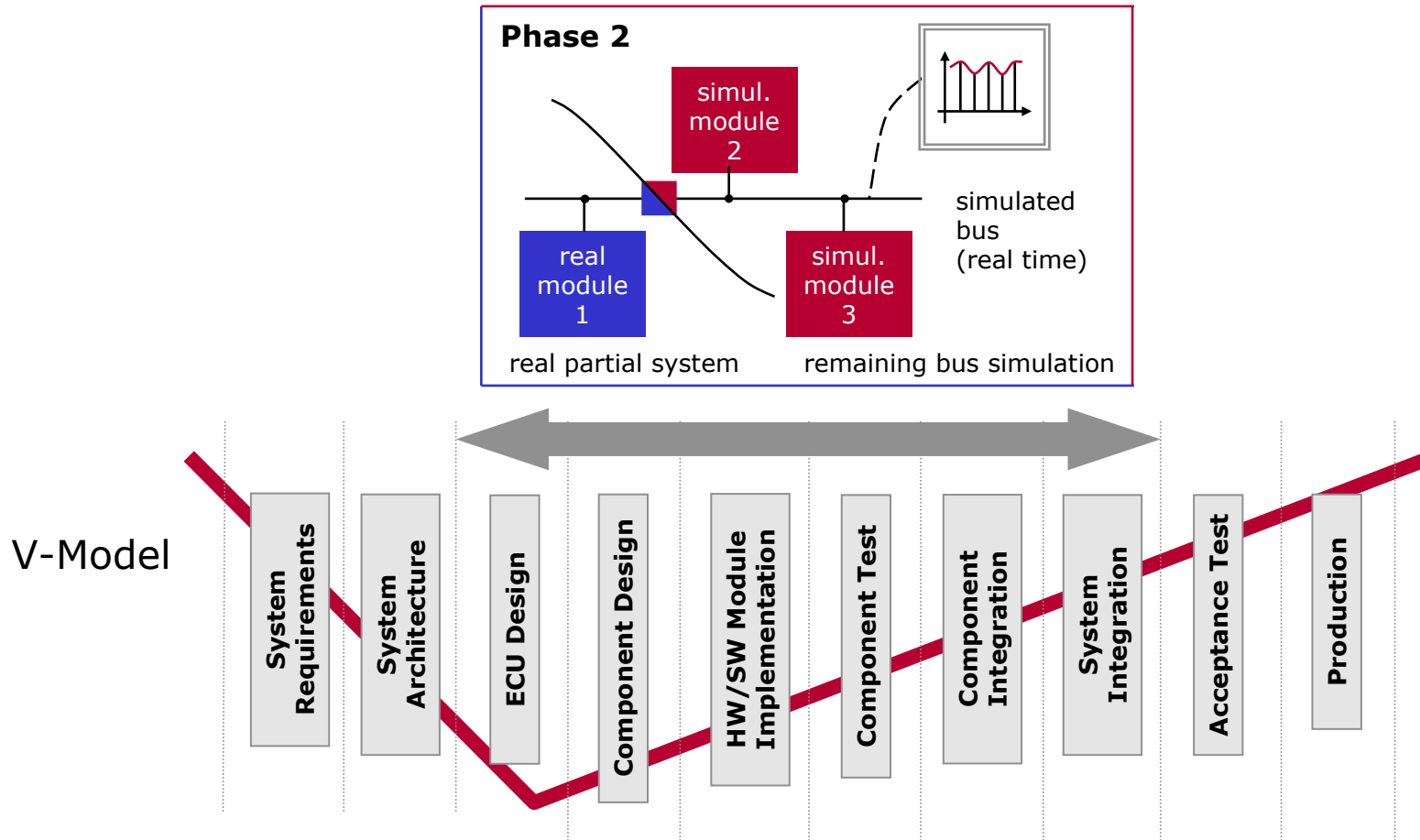
Network simulation done early in development



# J1939 Modeling & Simulation

## Best Practice

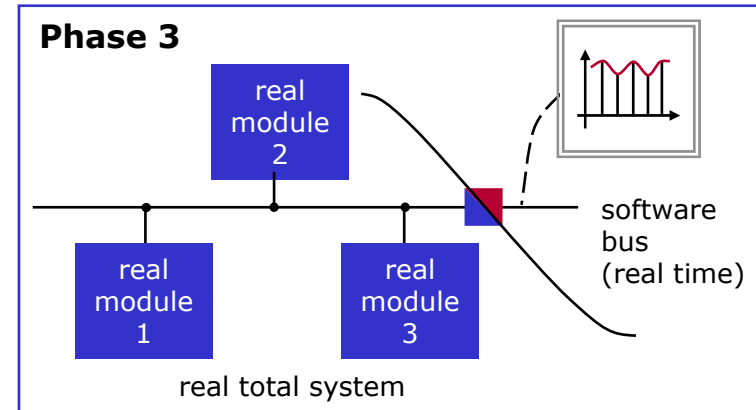
Combination of simulations & real ECUs used during middle stages



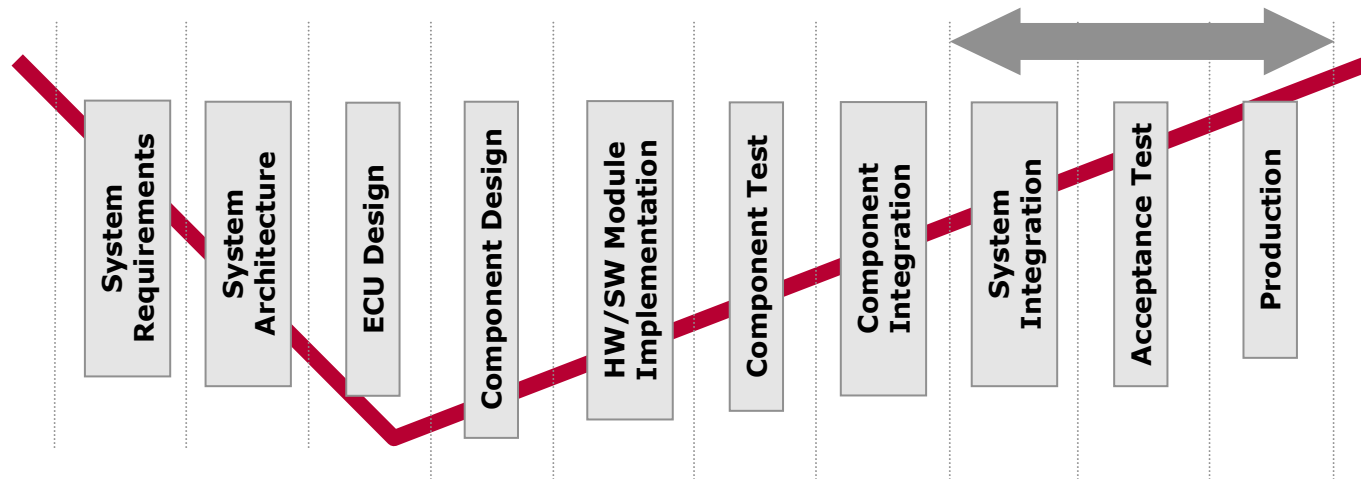
# J1939 Modeling & Simulation

## Best Practice

Final systems integration & testing done with all physical ECUs



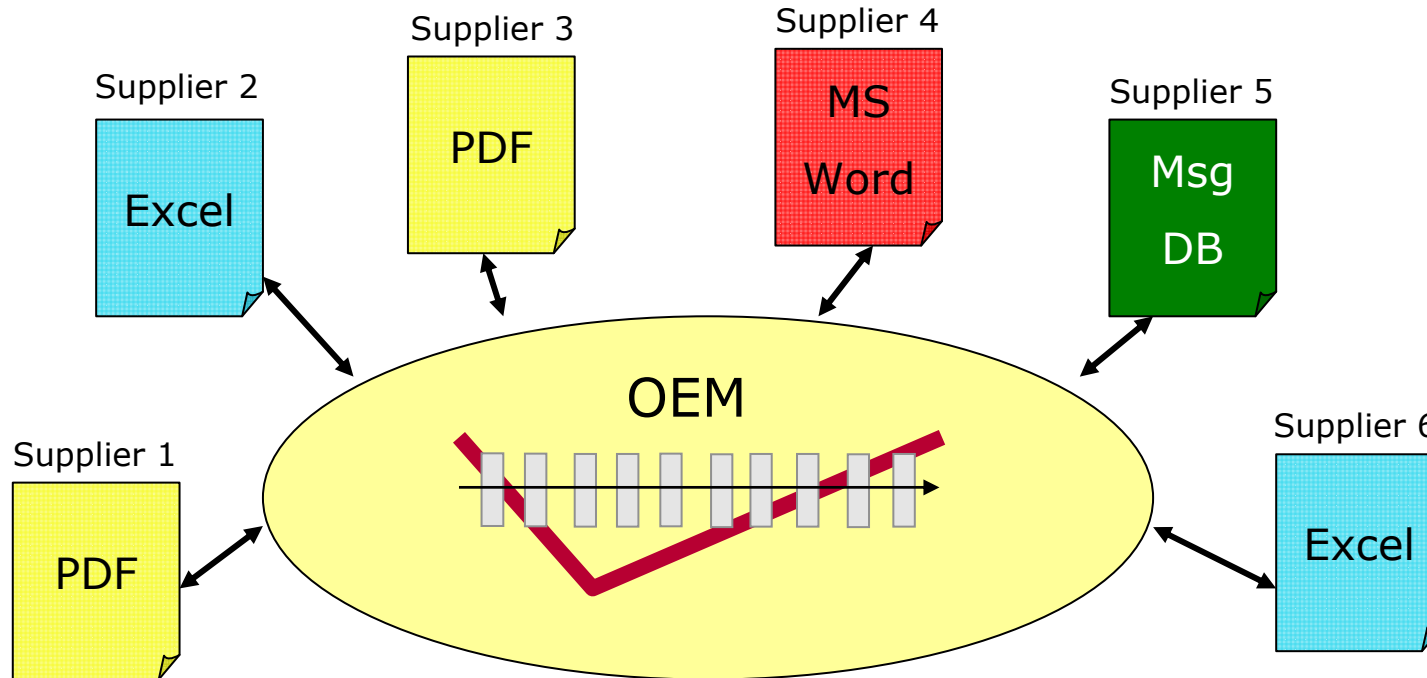
V-Model



# J1939 Data Exchange Process

## Current Situation

Typical: J1939 data received in many different formats

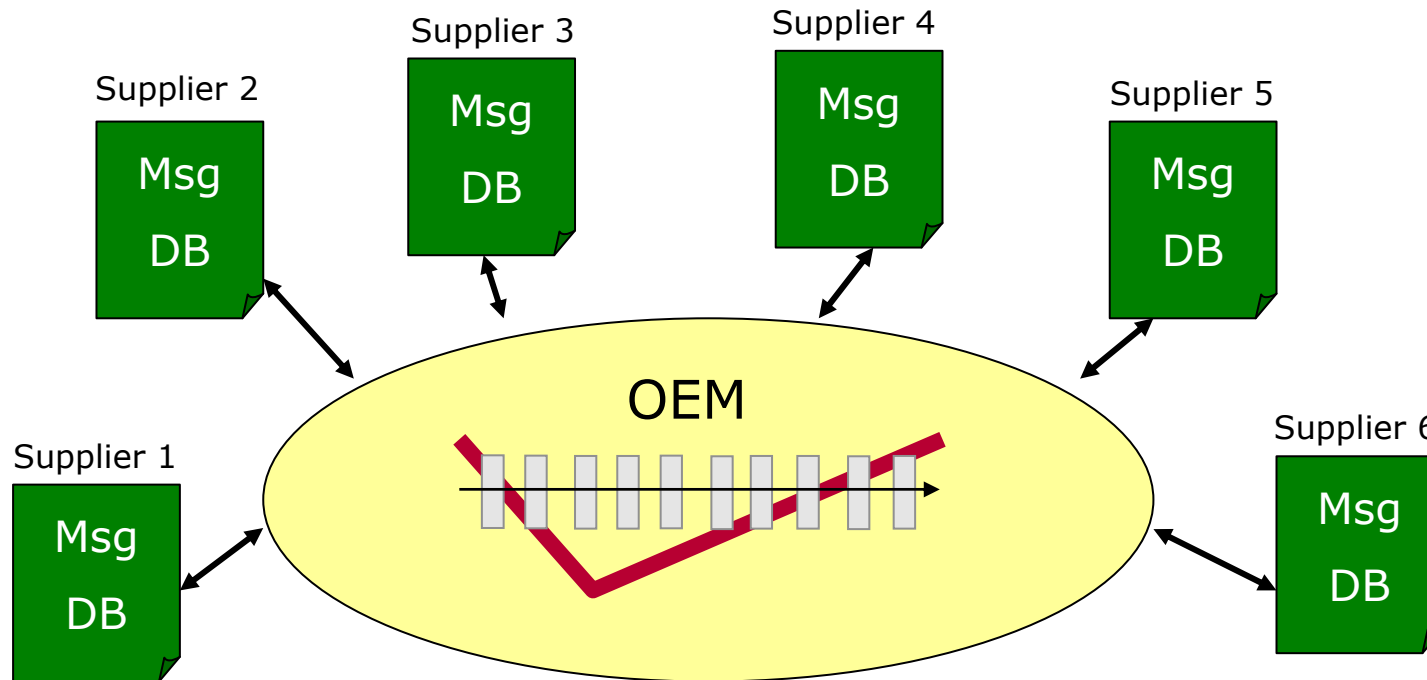


- ▶ Data must be re-created for tool usage
- ▶ Inconsistent data detail

# J1939 Data Exchange Process

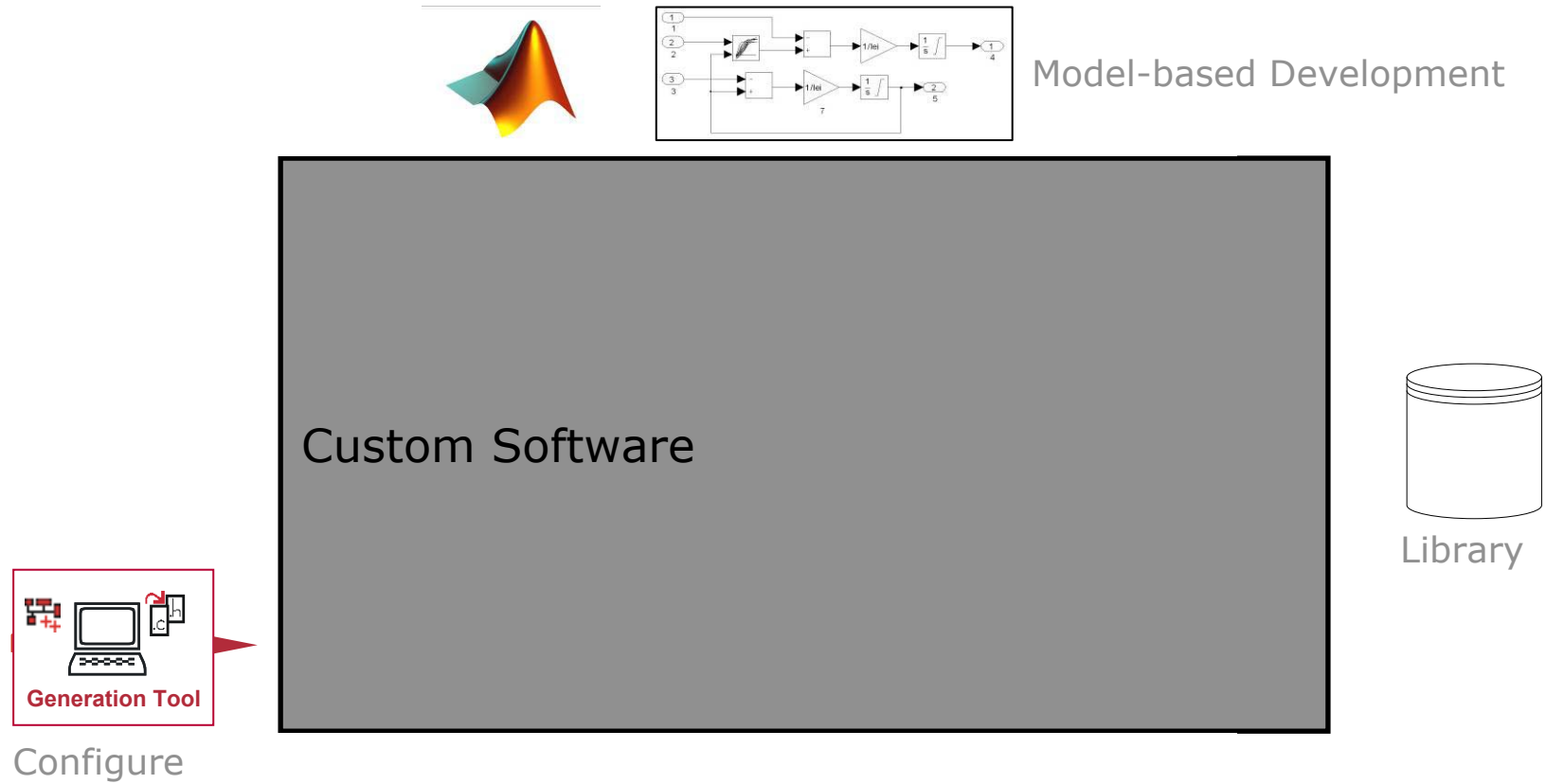
## Best Practice

Optimal: J1939 data provided in consistent format



- ▶ Electronic data format for direct use by development tools
- ▶ Consistent data from all suppliers
- ▶ Easy sharing between development teams

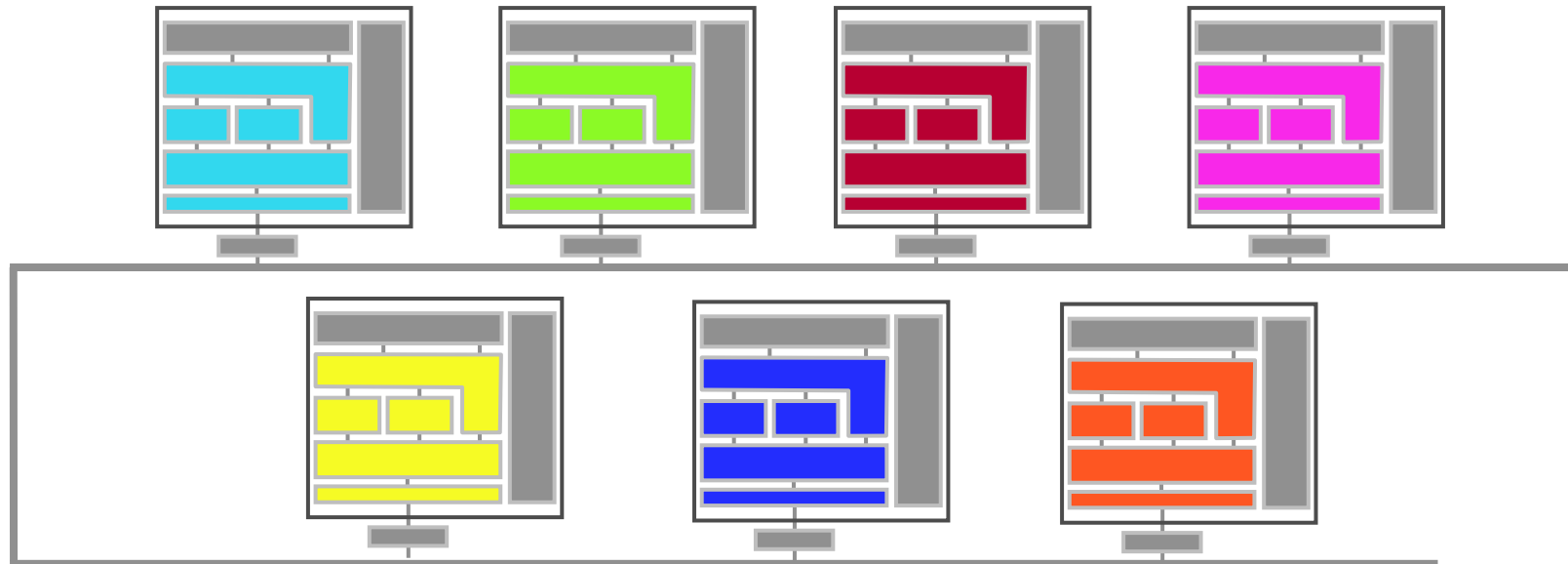
# J1939 Embedded Software Implementation



# J1939 Embedded Software Implementation

## Current Situation

Different interpretations & implementations of J1939

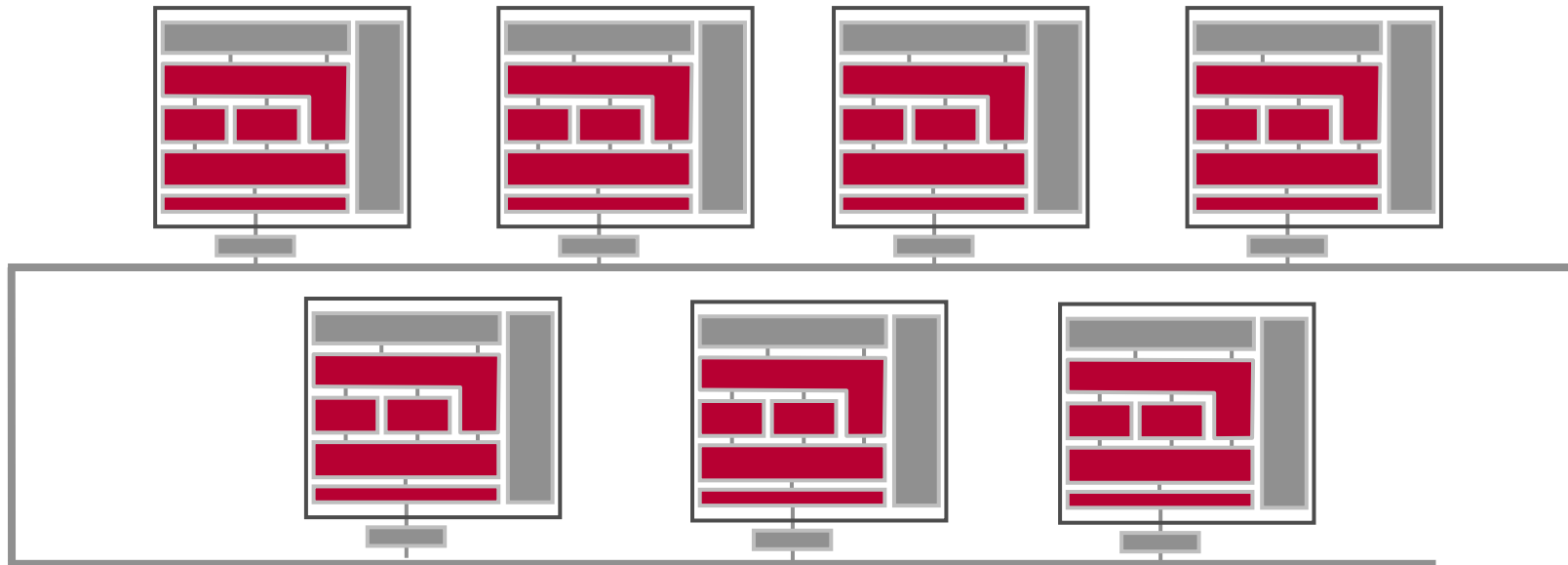


- ▶ Indeterminate wake up & sleep operation (i.e power management)
- ▶ Potential network conflicts & error frames
- ▶ Unknown network operational characteristics in some circumstances

# J1939 Embedded Software Implementation

## Best Practice

Common implementation of J1939 std components by all ECUs on the network

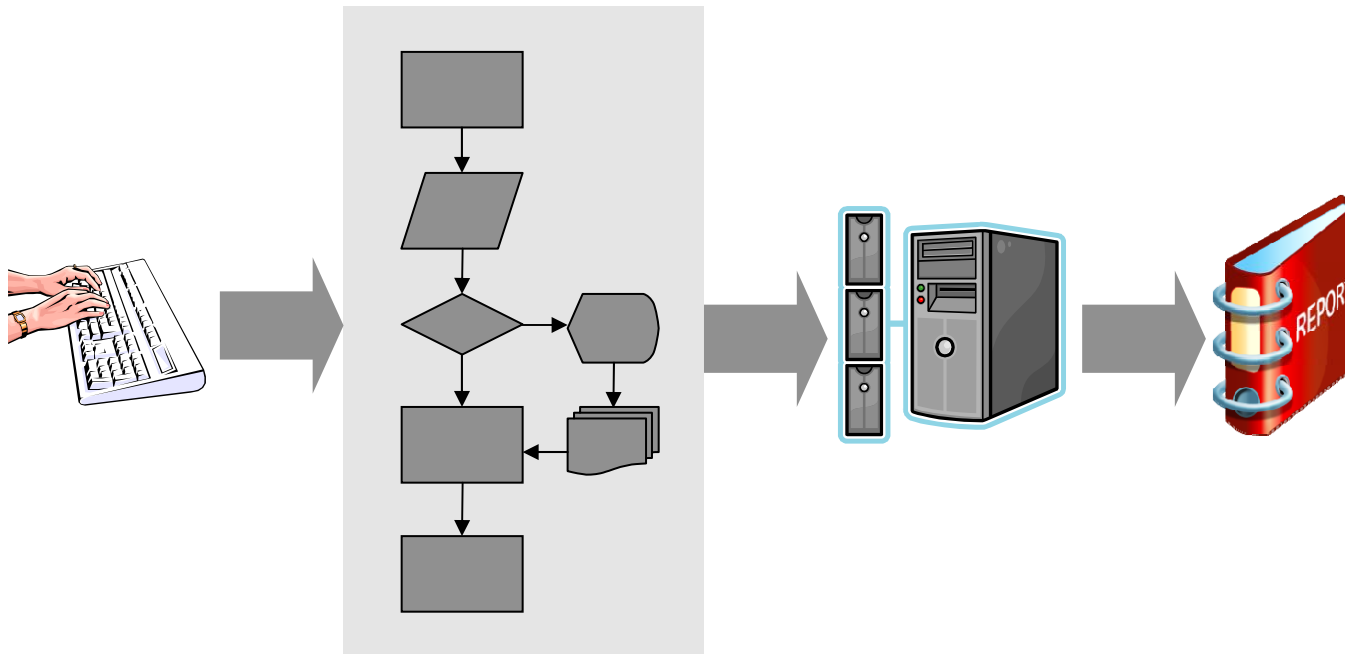


- ▶ Guaranteed compatibility between J1939 network implementations
- ▶ Minimize network integration issues & field problems

# J1939 & OEM Network Testing

## Current Situation

More ECUs = More complex manual test development

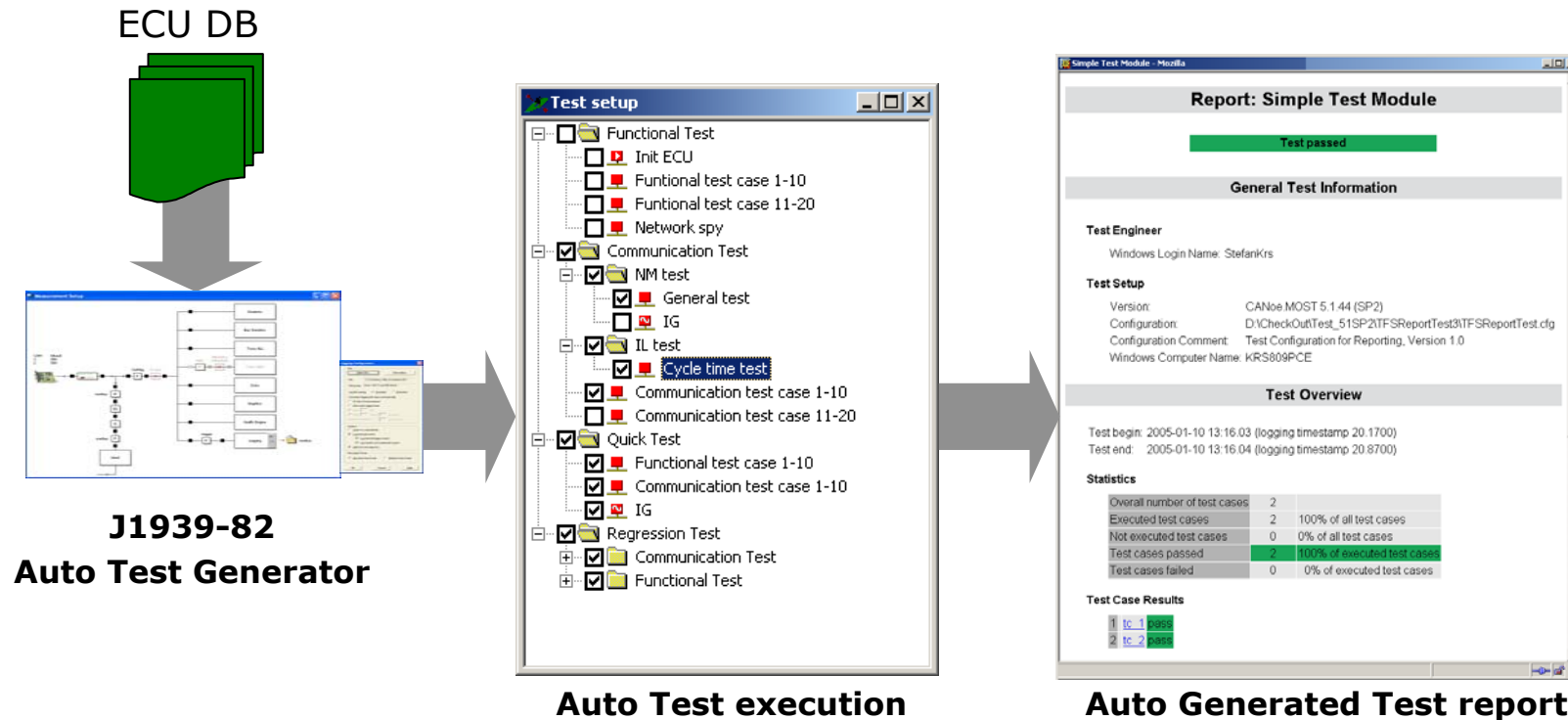


- ▶ Inconsistent testing methodologies don't ensure ECU compatibility
- ▶ Manually generated tests are time consuming & costly
- ▶ Interpretation of test results are difficult

# J1939 & OEM Network Testing

## Best Practice

J1939-82 + device testing + integration testing of all ECUs on network



- ▶ Ensure conformance of all ECUs to J1939 network standards
- ▶ Ensure compatibility of all ECUs on OEM specific network implementation

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## > Outlook

# Outlook

## Improvements to the J1939 Standard

- ▶ Define device profiles
  - ▶ Clear interfaces (software and hardware)
  - ▶ Leads to clear behavior and ...
  - ▶ ... makes components automatically testable
- ▶ Official conformance test
  - ▶ Independent and **final** interpretation of the written standard
- ▶ Logo program
  - ▶ Motivation to perform conformance test
  - ▶ Independent quality statement



Thank you for your attention.

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