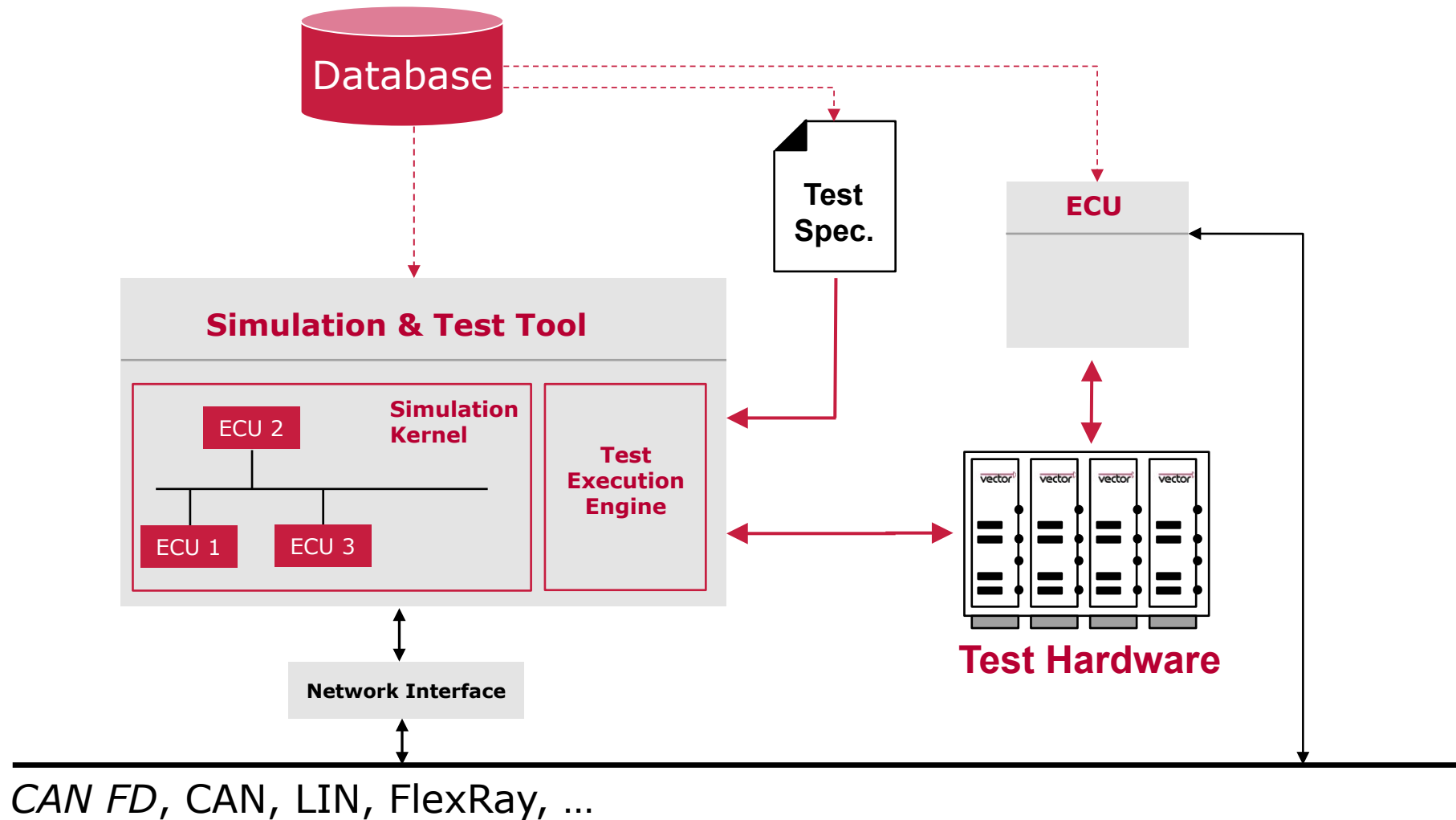


## CAN FD - Flexible Tools for Flexible Data Rates

Peter Decker

Vector Informatik GmbH

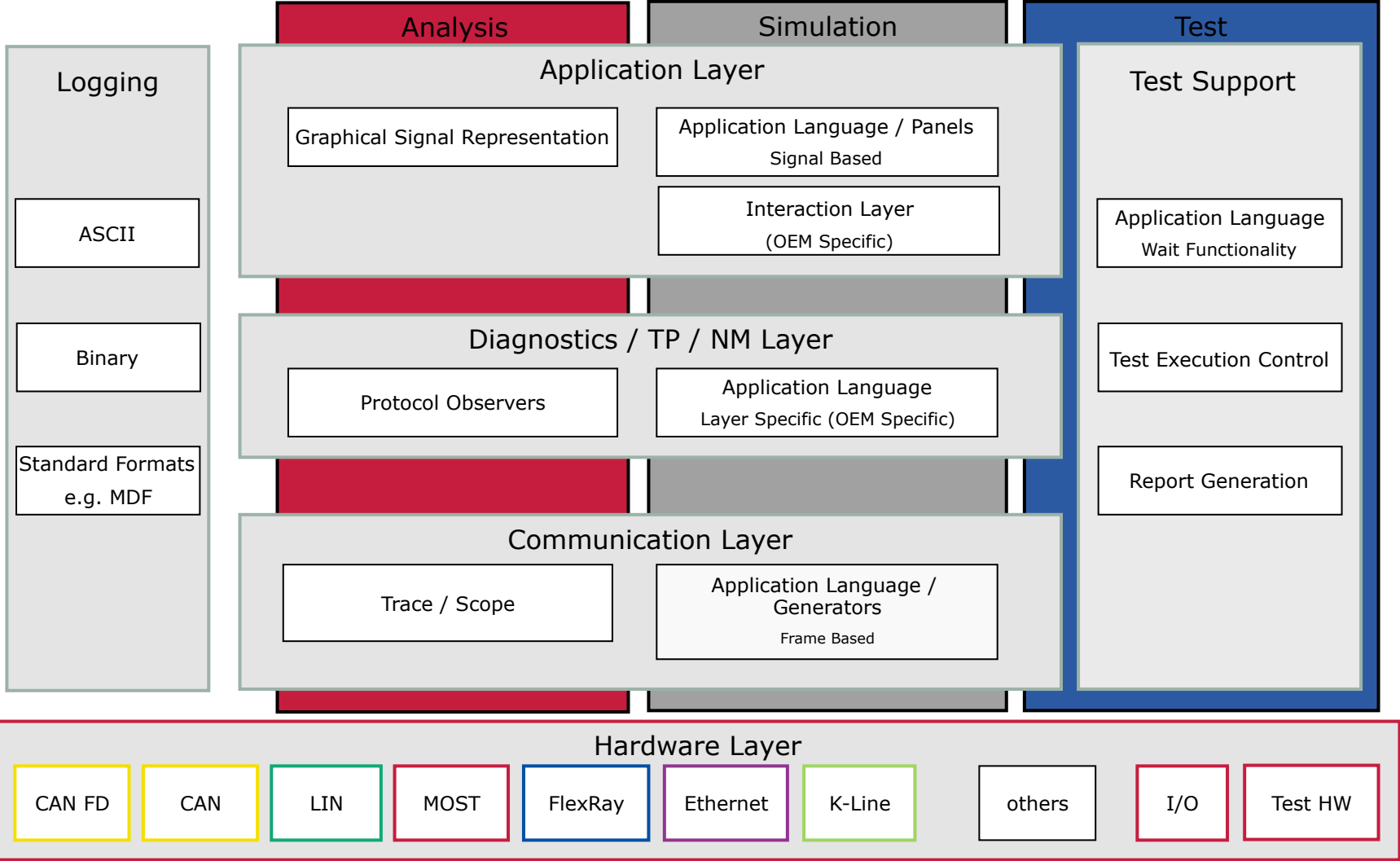
# Simulation & Test Environment for Automotive Networks



- ▶ Do we need a PDU-abstraction for CAN FD?
  - ▶ Probably makes sense for payloads > 32 bytes
  - ▶ PDUs also allow additional data protection, e.g. CRC
  - ▶ Autosar System Description already supports PDUs

- ▶ **Should we treat CAN FD as a new bus system?**
  - ▶ Modeling CAN FD as a superset of CAN allows existing CAN systems to be easily migrated
    - ▶ Tool configurations need only slight modification  
e.g. baud rate for data phase
    - ▶ Test scripts and DBC databases can be reused
      - ▶ At least for CAN FD payloads up to 8 bytes
- ▶ **Which database format should we choose for CAN FD?**
  - ▶ DBC format already supports payloads of 64 bytes
  - ▶ Autosar System Description is a standardized alternative

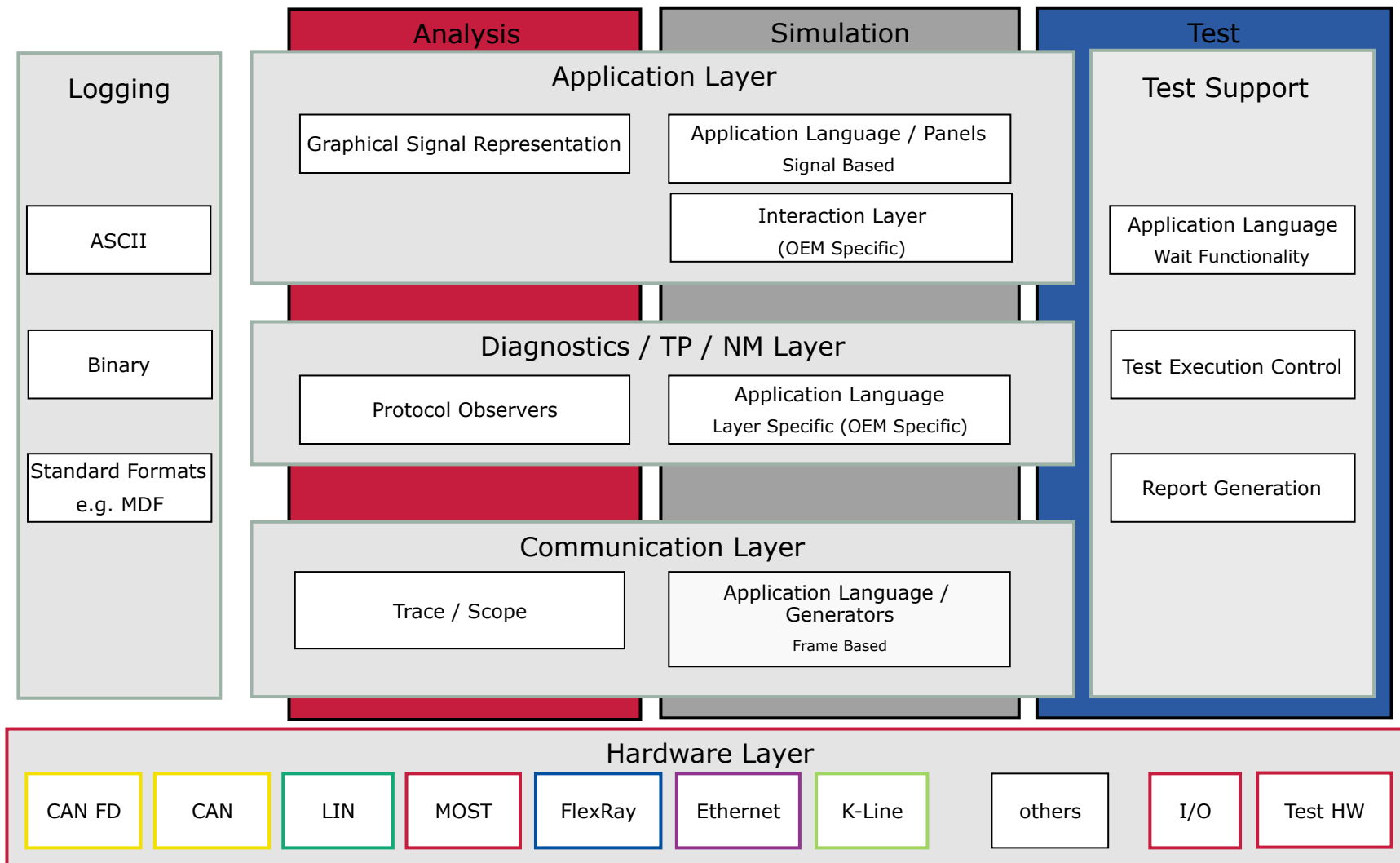
# Simulation and Test Tool for Automotive Networks



# Simulation of CAN FD

- ▶ Which communication layers need to be modified/extended for CAN FD?
  - ▶ Hardware Layer, i.e. Network Interface
  - ▶ Communication Layer
  - ▶ Higher Layers e.g. TP or NM

# Simulation of CAN FD – Hardware Layer



# Simulation of CAN FD – Hardware Layer

## ► How can a network interface for CAN FD be realized?

| Solution   | Controller Available | Limited Function | Cost Intensive |
|------------|----------------------|------------------|----------------|
| FPGA       | No                   | No               | Yes            |
| Controller | Yes                  | Yes              | No             |





# Simulation of CAN FD – Hardware Layer

- ▶ Can a network interface also be flexible?
  - ▶ An FPGA based solution provides wide implementation flexibility
  - ▶ It is suitable for real-time requirements
  - ▶ Allows future extensions like 64 byte support for CAN FD
  - ▶ Short driver update cycles with new features and bug fixes are possible

# Simulation of CAN FD – Hardware Layer

- ▶ Does CAN FD require new transceivers?
  - ▶ It is a goal of CAN FD to reuse existing transceivers
  - ▶ Existing transceivers are suitable for up to 8 Mbit/s
  - ▶ For higher baud rates new transceivers are required



# Simulation of CAN FD – Hardware Layer

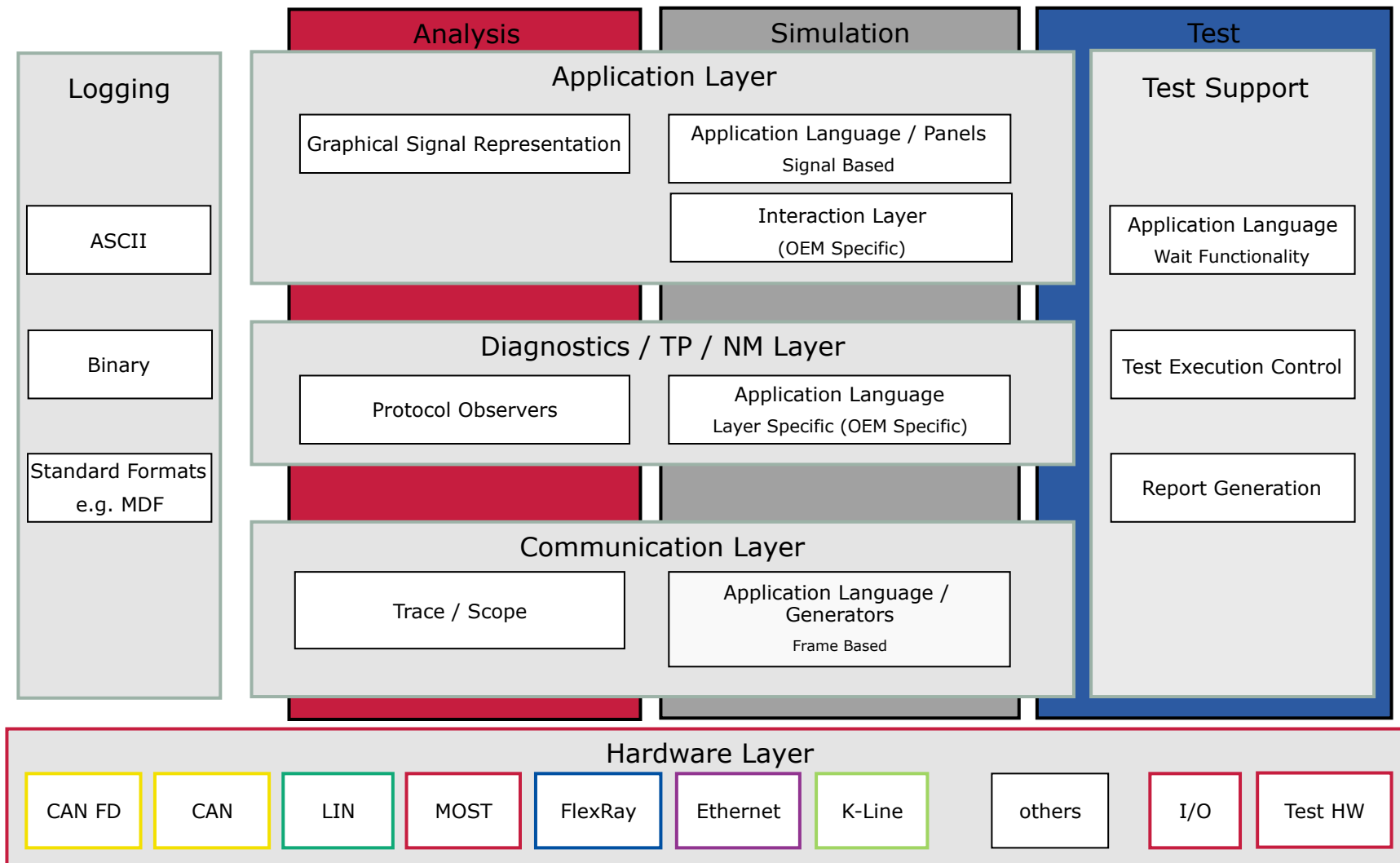
- ▶ How can different transceivers be supported?
  - ▶ A piggy-back based solution allows the support of different transceivers
  - ▶ New transceivers can easily be provided for existing bus interfaces

VN8900 Interface



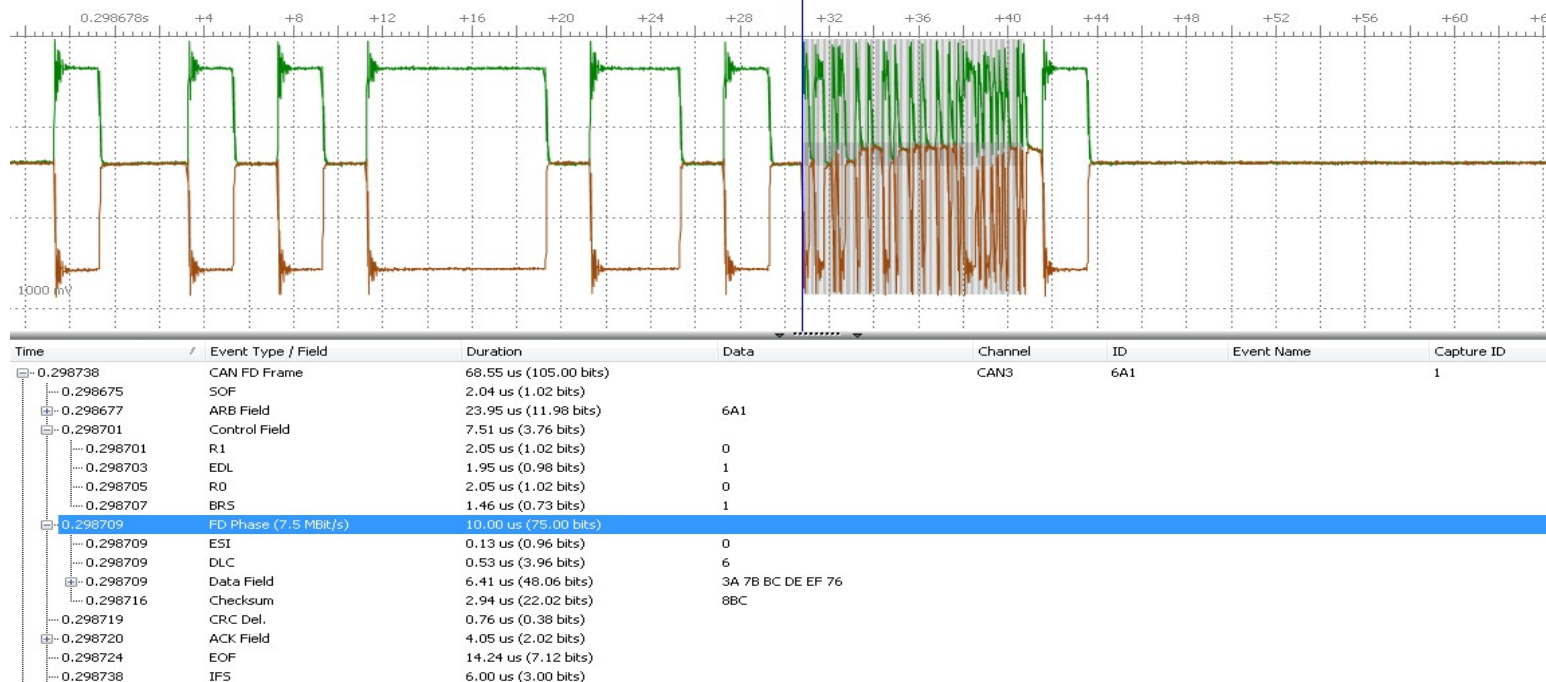
Piggies for CAN/LIN/FR/IO

# Simulation of CAN FD – Communication Layer



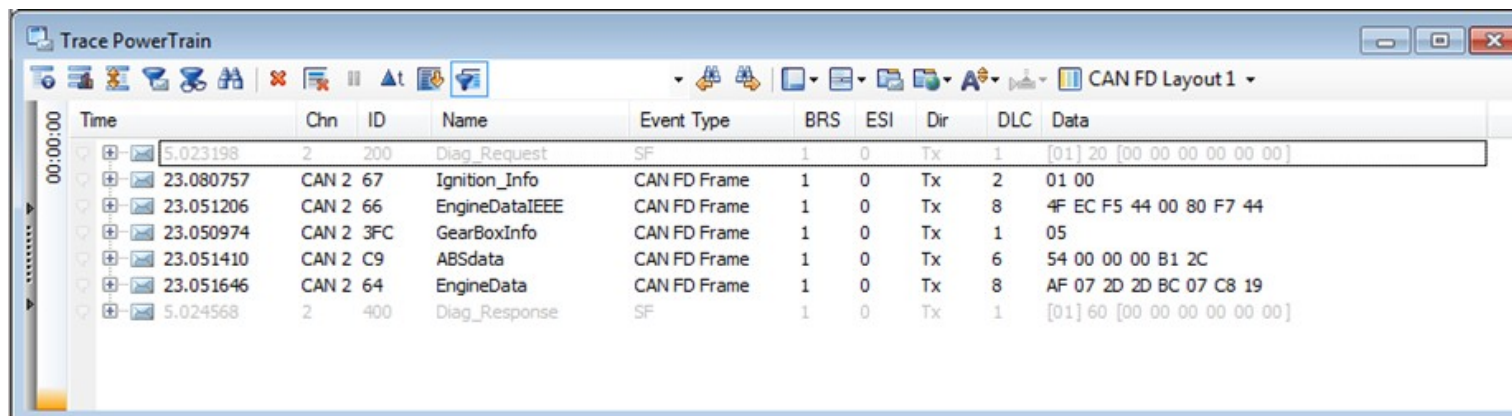
# Simulation of CAN FD – Communication Layer

- ▶ Why does the communication layer need to be modified for CAN FD?
  - ▶ Due to additional CAN FD bits e.g. ESI
  - ▶ Due to the extended payload of up to 64 bytes



# Simulation of CAN FD – Communication Layer

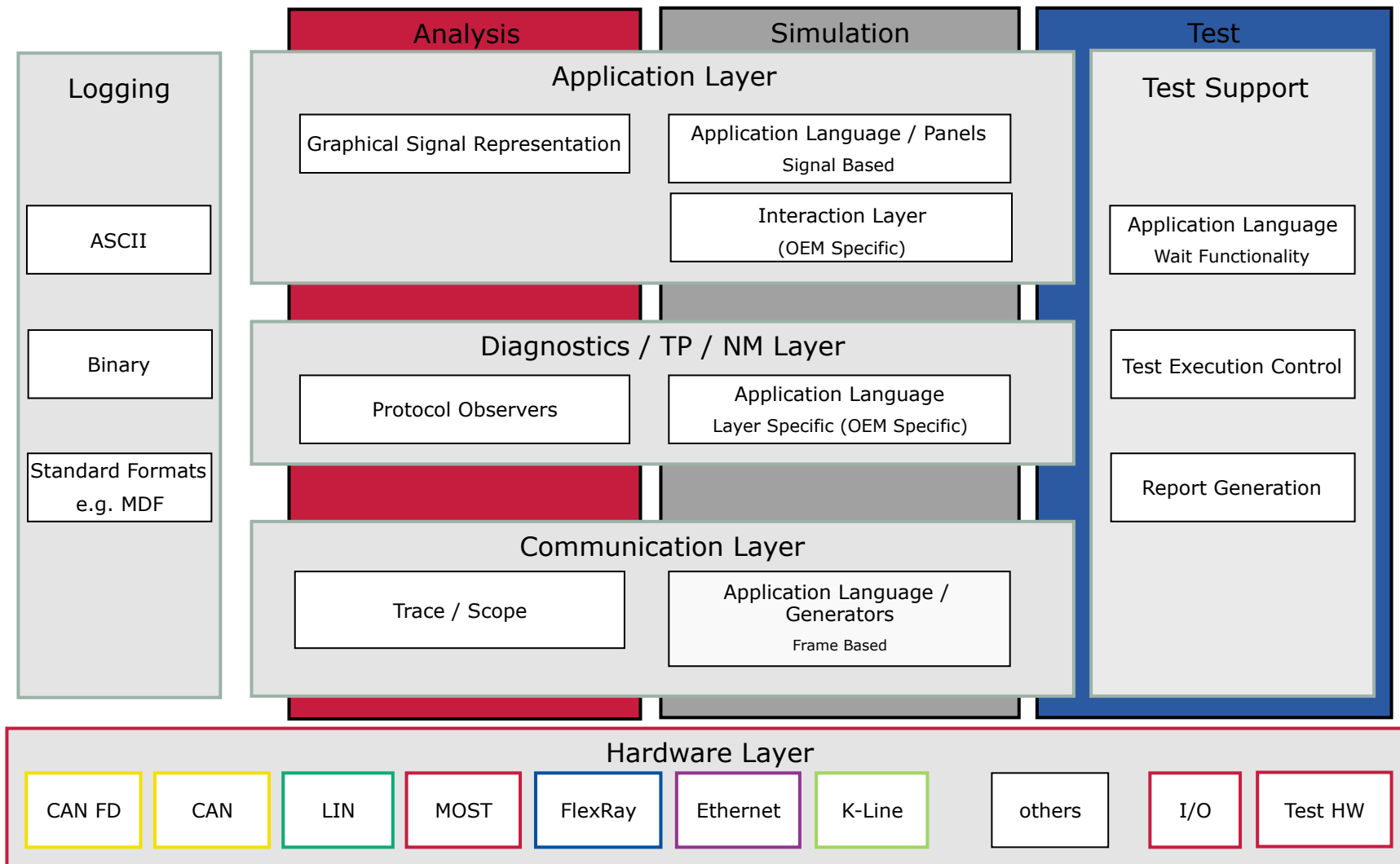
- ▶ How can the modifications be kept simple?
  - ▶ Simply extend existing CAN event for CAN FD bits and higher payload
  - ▶ Easy support of test and logging features for CAN FD
  - ▶ Only analysis windows (e.g. Trace) need to distinguish between CAN and CAN FD frames



The screenshot shows a software interface titled "Trace PowerTrain" with a table of communication events. The table has columns for Time, Chn, ID, Name, Event Type, BRS, ESI, Dir, DLC, and Data. The data rows show a mix of standard CAN frames (SF) and CAN FD frames.

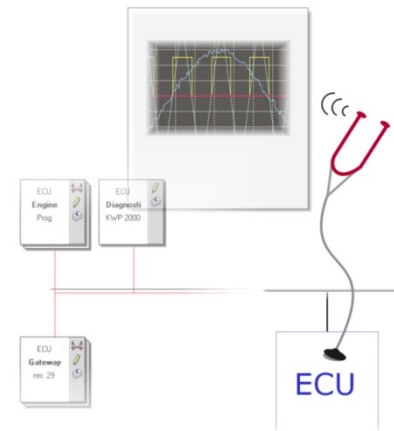
| Time      | Chn   | ID  | Name           | Event Type   | BRS | ESI | Dir | DLC | Data                        |
|-----------|-------|-----|----------------|--------------|-----|-----|-----|-----|-----------------------------|
| 5.023198  | 2     | 200 | Diag_Request   | SF           | 1   | 0   | Tx  | 1   | [01] 20 [00 00 00 00 00 00] |
| 23.080757 | CAN 2 | 67  | Ignition_Info  | CAN FD Frame | 1   | 0   | Tx  | 2   | 01 00                       |
| 23.051206 | CAN 2 | 66  | EngineDataIEEE | CAN FD Frame | 1   | 0   | Tx  | 8   | 4F EC F5 44 00 80 F7 44     |
| 23.050974 | CAN 2 | 3FC | GearBoxInfo    | CAN FD Frame | 1   | 0   | Tx  | 1   | 05                          |
| 23.051410 | CAN 2 | C9  | ABSdata        | CAN FD Frame | 1   | 0   | Tx  | 6   | 54 00 00 00 B1 2C           |
| 23.051646 | CAN 2 | 64  | EngineData     | CAN FD Frame | 1   | 0   | Tx  | 8   | AF 07 2D 2D BC 07 C8 19     |
| 5.024568  | 2     | 400 | Diag_Response  | SF           | 1   | 0   | Tx  | 1   | [01] 60 [00 00 00 00 00 00] |

# Simulation of CAN FD – Higher Layers



# Simulation of CAN FD – Higher Layers

- ▶ How does CAN FD influence higher layers?
  - ▶ CAN FD's extended payload affects both the interaction and transport layers
  - ▶ New implementations of these layers are needed
  - ▶ Interchangeable layers allow OEM-specific implementations





# Simulation of CAN FD – Higher Layers

- ▶ Which layers are unaffected by CAN FD?
  - ▶ The application layer is unaffected if modeled using a protocol-independent signal layer
  - ▶ A signal layer allows the easy reuse of simulation models, test scripts and graphical input interfaces

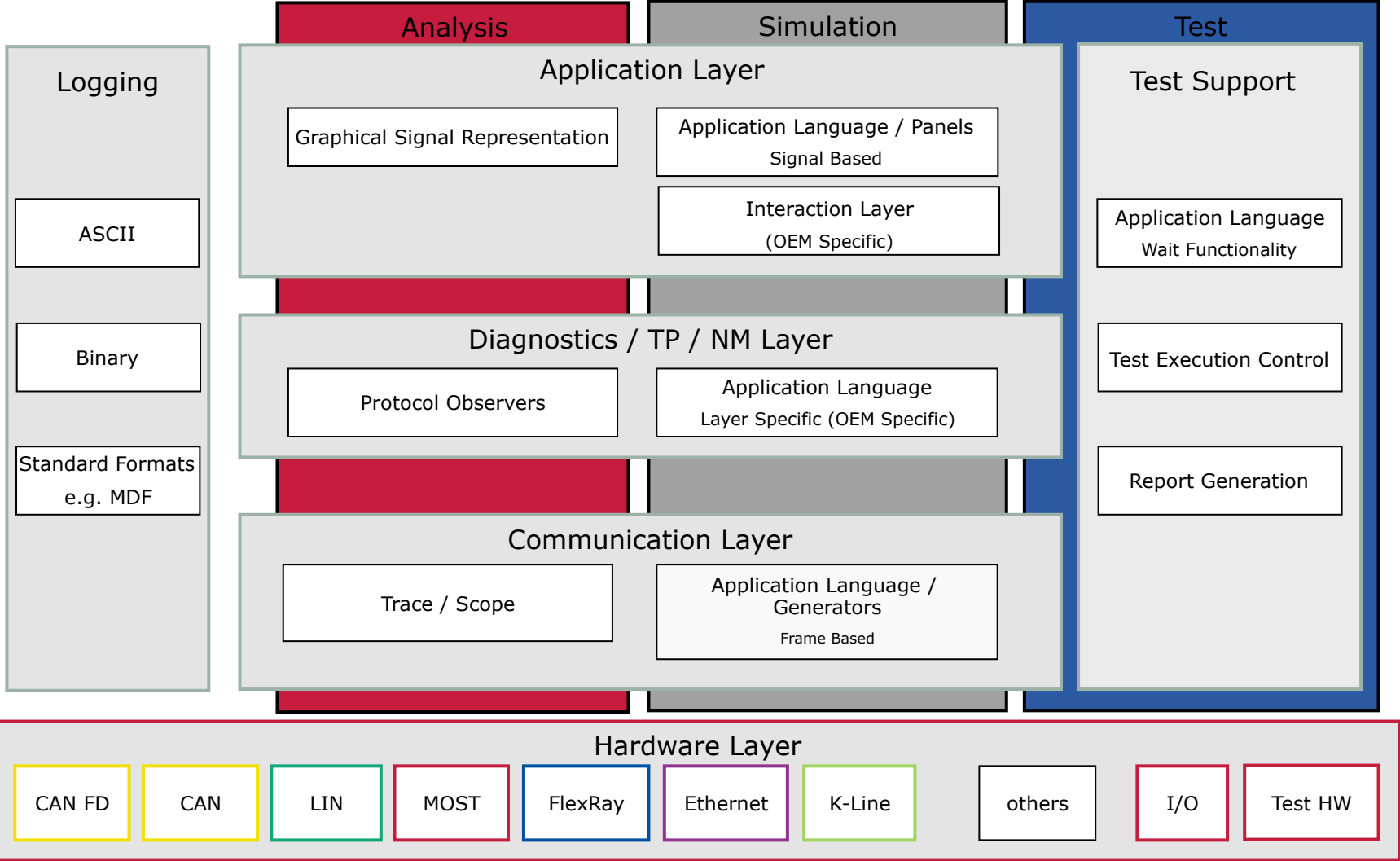


```
variables
{
    const long kErrorActive = 1;
    const long kErrorPassive = 0;
-}

// Application Layer
on signal EngineSpeed
{
    if (@this > 78 && @this < 112)
    {
        write("Engine runs within correct parameters.");
    }
}

// Communication Layer
on message EngineState
{
    if (@this.ESI == kErrorPassive)
    {
        write("CAN FD Node is error passive.");
    }
}
-}
```

# Layer Model for a Test- and Simulation Tool



# Impact of CAN FD on other Bus Systems

- ▶ Do we expect CAN FD to have any impact on LIN?
  - ▶ CAN FD has no big advantages for body applications and is not expected to replace any typical LIN applications
  - ▶ Only raw TP routing is not possible for CAN FD frames with payload > 8 bytes



# Impact of CAN FD on other Bus Systems

- ▶ **Do we expect CAN FD to have any impact on FlexRay?**
  - ▶ CAN FD is a cheaper alternative to FlexRay and designed to close the gap between CAN and FlexRay
  - ▶ CAN FD is expecting to be used for event-triggered applications requiring a higher data rate
  - ▶ FlexRay is better suited for time-triggered applications
  - ▶ Since many applications are still event-triggered, CAN-FD is may be used instead of FlexRay
  - ▶ More likely, CAN FD and FlexRay will coexist in future vehicle networks

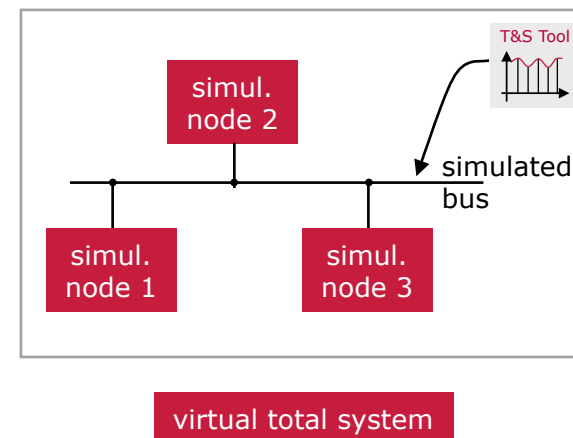


# Impact of CAN FD on other Bus Systems

- ▶ **Do we expect CAN FD to replace existing CAN systems?**
  - ▶ CAN systems with high bus loads (>50%) are good candidates for CAN FD
  - ▶ The higher data rate and payload of CAN FD may help to avoid splitting CAN systems with high bus loads
  - ▶ Splitted CAN networks can be combined to a single CAN FD network in order to avoid gateway latencies
  - ▶ For migration purposes it can make sense to mix CAN with CAN FD in a single network
  - ▶ Legacy CAN ECUs will require an adapted controller that ignores CAN FD frames
  - ▶ It is not yet clear if mixed CAN - CAN FD networks will be common in future cars

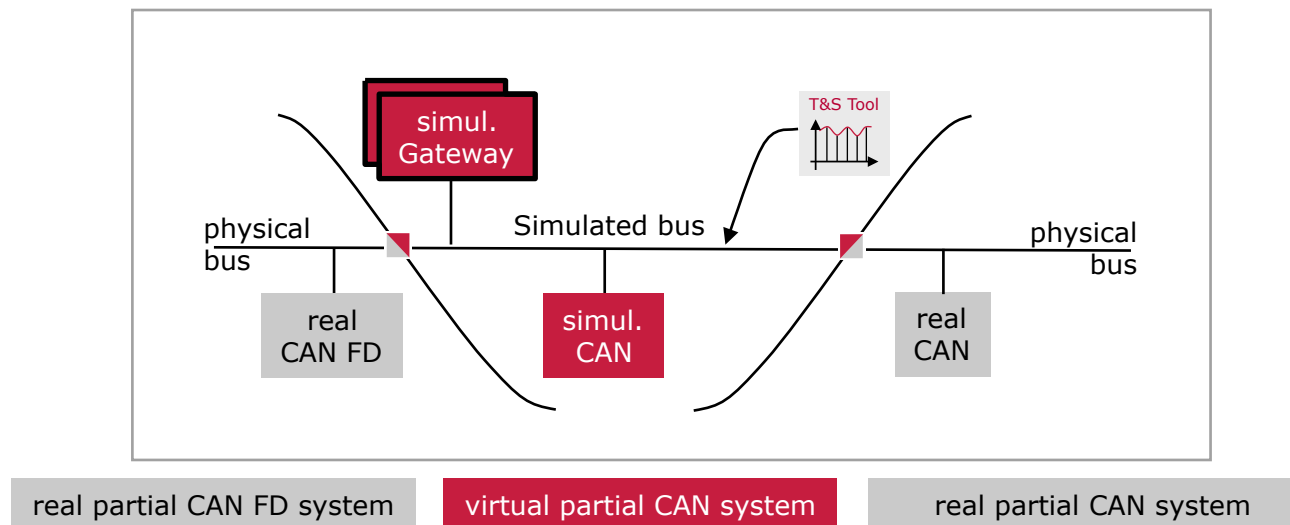
# Migration of CAN to CAN FD

- ▶ How can a tool support migration from CAN to CAN FD?
  - ▶ Determine the bus load using full network simulation
  - ▶ Make decisions concerning baud rate and payload
  - ▶ Improve the sending behavior
  - ▶ Decide whether splitted buses can be combined



# Migration of CAN to CAN FD

- ▶ Remaining network simulation to model a gateway between CAN / CAN FD
- ▶ Allows communication between CAN and CAN FD ECUs
- ▶ No change of CAN ECUs in development phase required



# Conclusion

- ▶ **CAN FD needs a flexible simulation and test tool**
  - ▶ Flexible FPGA-based network interface for early start of development
  - ▶ Support of various database formats (e.g. ASR SD, DBC)
  - ▶ Support of multiple abstraction layers (e.g. signal, PDU)
  - ▶ Open environment for OEM-specific features (e.g. PDU-CRC)
  - ▶ Support of CAN to CAN FD migration (e.g. gateway and mixed mode simulation)



# Vector's Roadmap for CAN FD

- ▶ Tool support of CAN FD available in Q4 2012
  - ▶ To be released with CANoe/CANalyzer 8.0 SP
    - ▶ Initial support is restricted to 8 databytes
    - ▶ Support of 64 bytes will follow in 2013
- ▶ Network Interfaces for CAN FD available in Q4 2012
  - ▶ VN1630 will be the first interface available for CAN FD
  - ▶ VN1610/1611/1640 interfaces will follow shortly





Thank you for your attention.

For detailed information about Vector  
and our products please visit

[www.vector.com](http://www.vector.com)

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