EtherCAT® in Test Systems
An Experience Report

EtherCAT in Mobile Applications
Frankfurt, 2013-02-06

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Agenda

> Vector – A Very Short Introduction

VT System

Why EtherCAT?

Experience

Vector – A Very Short Introduction

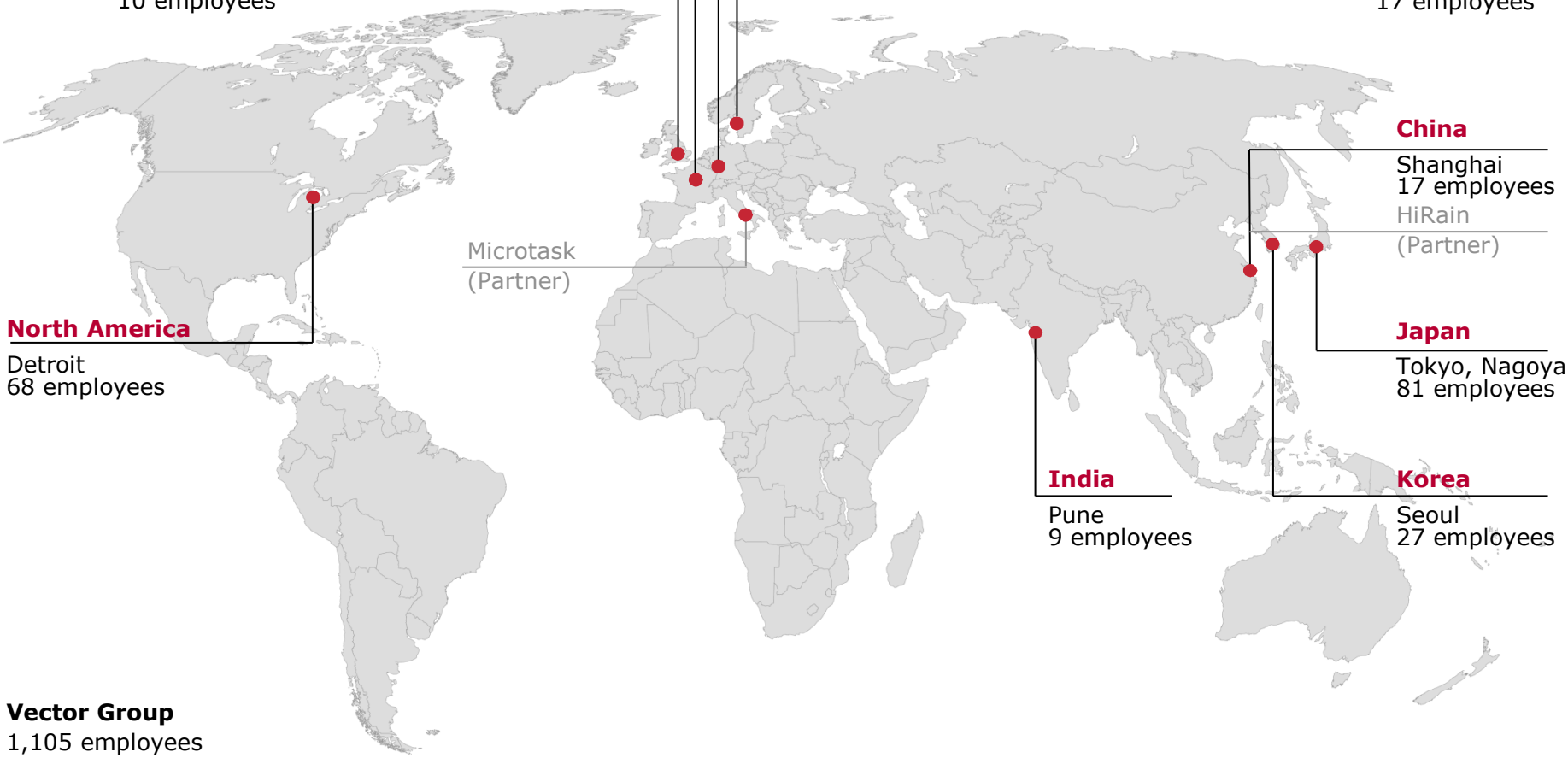
Our Mission

Vector provides OEMs and suppliers
of automotive and related industries

a professional and open development platform of
tools, software components and services

for creating embedded systems.

Vector Worldwide



Vector Group
1,105 employees
Date: December 2012

Vector Application Areas

Development of Distributed Systems
PREEvision, Network Designer, …

ECU Software
MICROSAR, Customer Services, …

ECU Testing
CANoe, VT System, Logger, …

Diagnostics
CANdela, ODXStudio, …

ECU Calibration
CANape, VX1000, vCDM, …

Process Management and Development
Consulting Services

Supported Markets (Non Passenger Cars)

Truck/Trailer Application

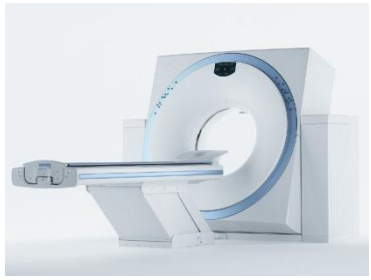
Special Vehicles

Buses

Agriculture Electronics

Railway Electronics

Aerospace



Medical Systems

Wind Turbines

Other Industries

- Manufacturer of sensors/ actuators for bus systems
- Building automation
- Networking in ship building
- Networking in construction machines

Agenda

Vector – A Very Short Introduction

> VT System

Why EtherCAT?

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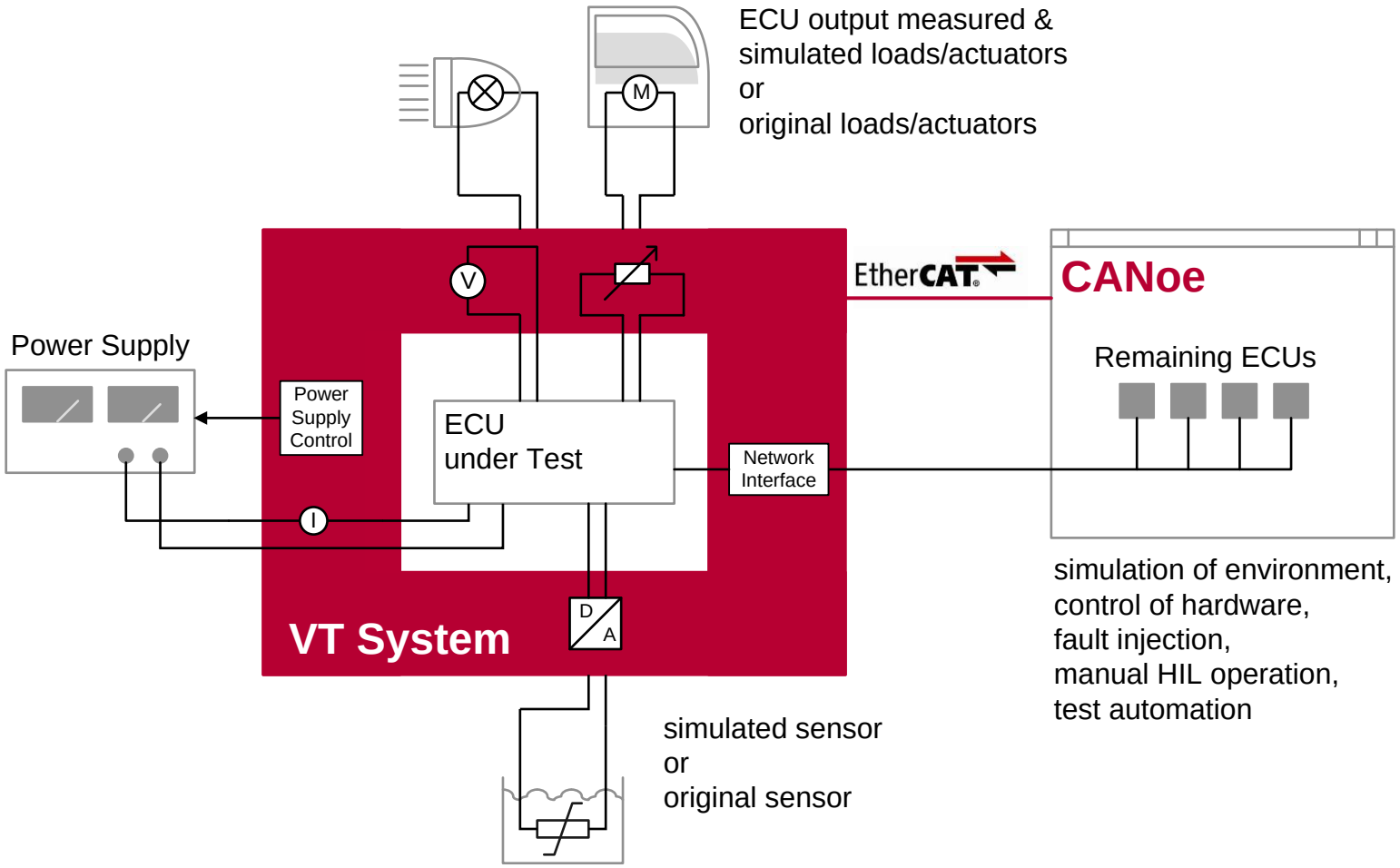
VT System

Overview

VT System is a modular test system for functional tests of automotive ECUs with CANoe.

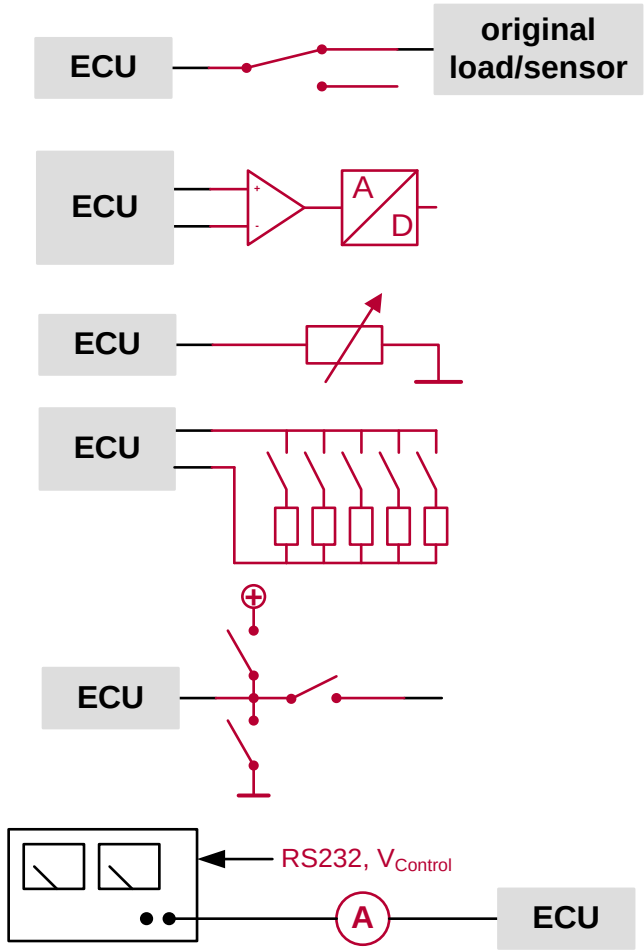
VT System

Integrated ECU Test Hardware



Functionality

- Switching the signal path, e.g. to the original load or sensor
- Measurement of ECU output signals, including differential signals, average values, RMS, PWM parameters
- Simulation of loads
- Stimulation of sensor inputs (sensor simulation), including arbitrary signal generation and PWM output
- Fault injection, e.g. short circuits to ground or V_{bat}, short-circuits between ECU lines, broken wires
- Control of supply power, definition of input voltage and measurement of power consumption



VT System

Modular Test Systems

- Independent I/O modules for 19” racks
  - Each module handles several ECU inputs or outputs (e.g. a temperature sensor input or a lamp output)
  - Type and number of modules may be configured individually
  - Individual assemblies from small boxes to complete test racks

- VT modules and PC connected over Ethernet
  - Industrial Ethernet protocol EtherCAT used
  - Racks can be cascaded
  - Modules are interconnected using a small backplane with EtherCAT on LVDS (E-Bus)

Agenda

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VT System

> **Why EtherCAT?**

Experience

Why EtherCAT?

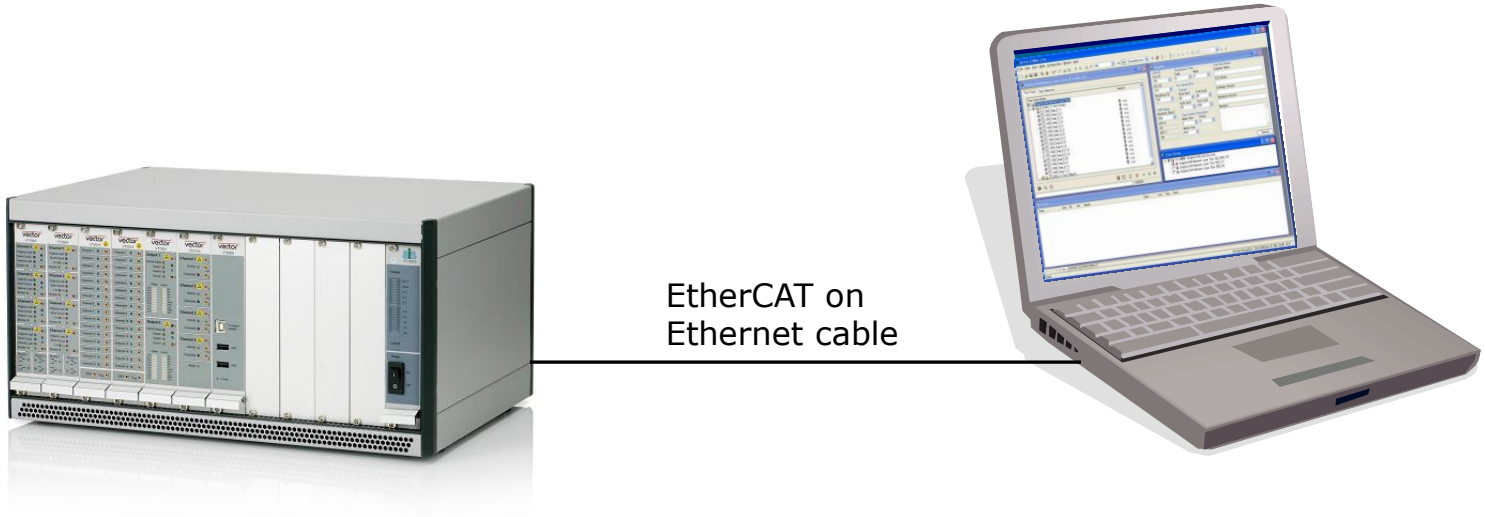
Real-time Features

- The connection between **I/O hardware** (VT System) and **test control software** (CANoe on the PC) has to be
  - Real-time = defined round-trip time
  - Fast
  - Low Latency
  - Reliable = system is switched off when connection is broken

Why EtherCAT?

PC Interface

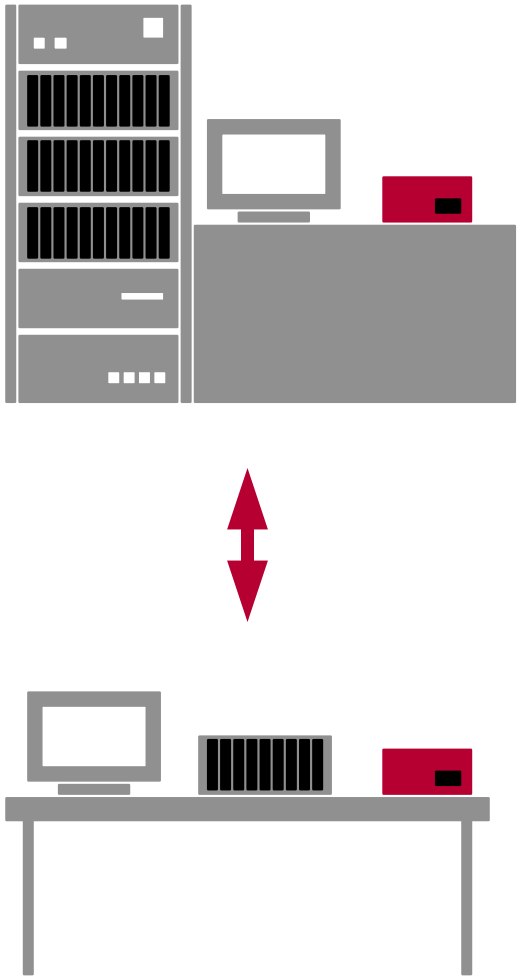
- Using the standard Ethernet port on host PC
  - No specific host interface needed
  - No specific low-level drivers needed
  - Ethernet port available on all kinds of computing platforms (rack PC, desktops, notebooks, embedded PCs, COM boards, …)
  - VT System may be used temporarily (e.g. by notebooks)



Why EtherCAT?

Scalability

- Several kinds of test systems possible:
  - Small test boxes on developer's desk
  - Universal I/O hardware
  - Comprehensive ECU tester
  - HIL systems
- Racks can be cascaded
- Even test systems can be cascaded

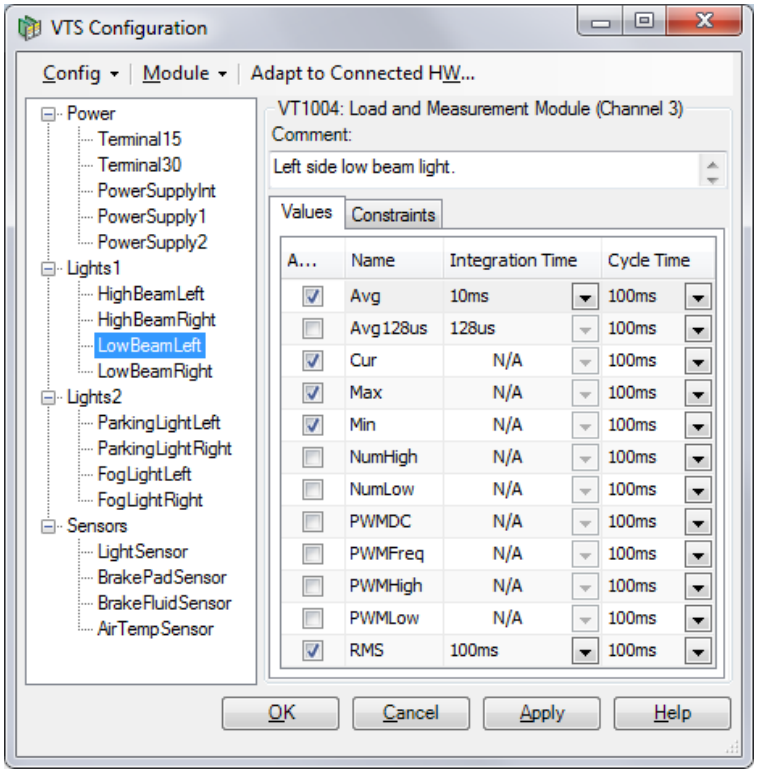


Why EtherCAT?

Automatic Configuration

- Automatic system detection
  - Only Ethernet interface has to be selected by the user
- Automatic module detection
- Easy configuration in CANoe
  - Selecting measurement values
  - Defining names of channels

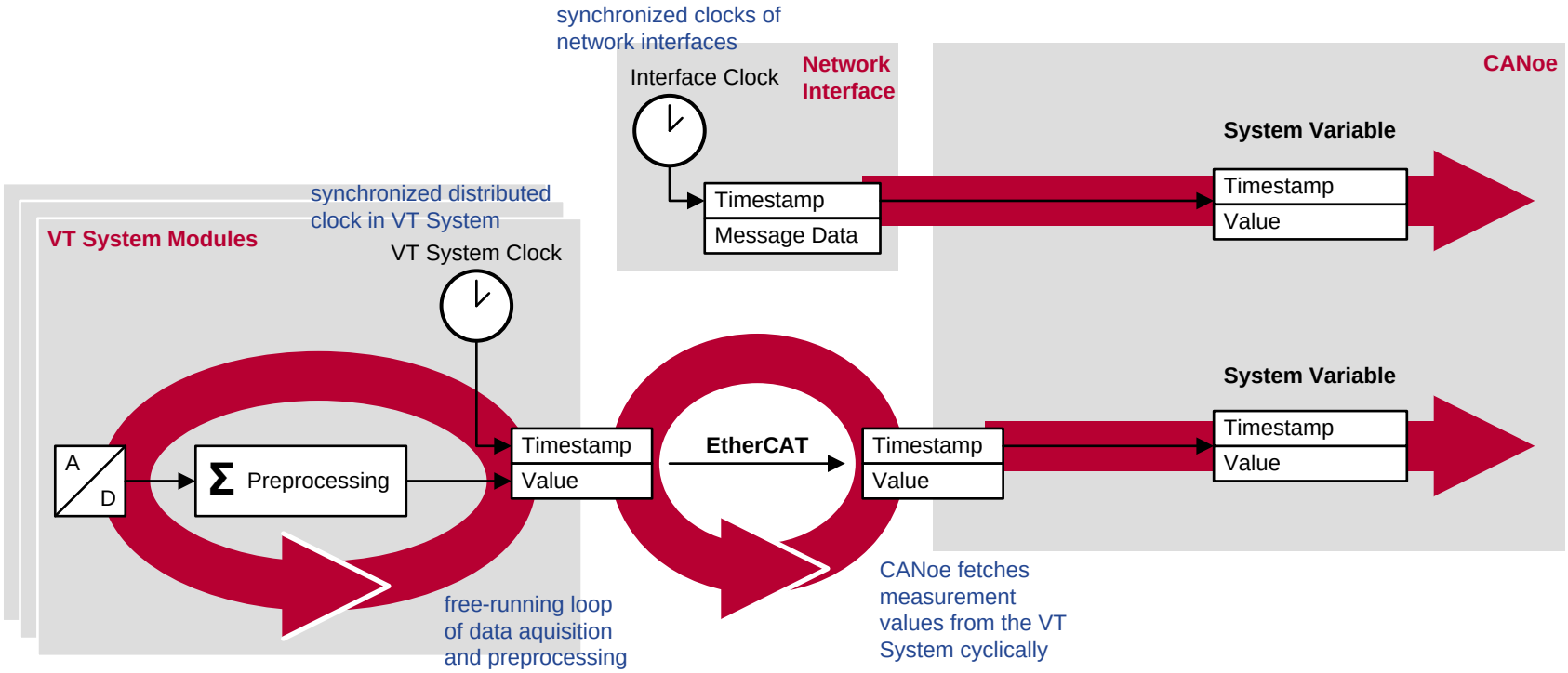
→ Comfort for usage, not really necessary for operation



Why EtherCAT?

Decoupling of Module and Host Operation

- Free-running operation of I/O modules
- Synchronized clocks on VT System
- Time-sync within VT System and with host system (incl. other network interfaces)



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Why EtherCAT?

> Experience

EtherCAT on the Host PC

+ No problem with all kinds of Ethernet hardware
  - Even USB/EtherCAT adapters will work – but not very well (bad latency)
+ Almost no network configuration needed
+ No security issues (virus …)
  - EtherCAT ≠ IP
– Sometimes trouble with firewall software on customer PCs
– Sometimes problems are hard to find
  - E.g. if the company network is used
    (of course, it's the fault of the user, but it works perfectly unless a second …)

Experience

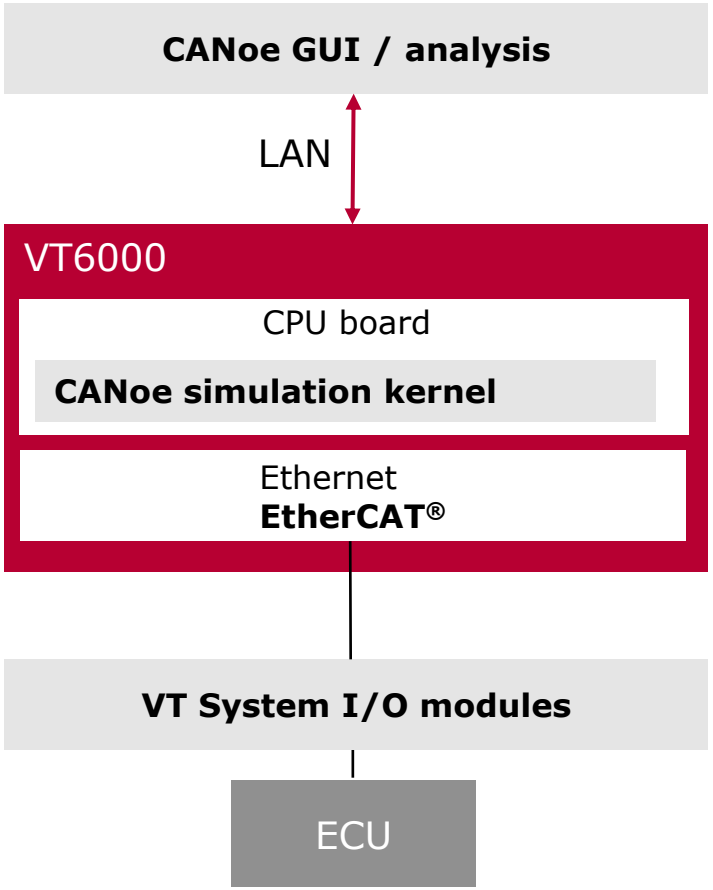
Real-time

- EtherCAT is proven to be fast, real-time, and reliable
- Timing of PC application (EtherCAT driver) is critical
  - Accuracy of EtherCAT send timers determines the overall accuracy
  - Therefore we introduced timestamps for measurement purposes
- Streaming of large data blobs is not the strength of EtherCAT, but sometimes necessary …
  - Download of configuration data to modules
  - Upload of recorded data from module to PC
- For streaming of event based data (e.g. CAN messages) we use a parallel data path (PCI Express on cable)

- What will we do if more reliable operation is needed?

- Real-time module within VT System
  - Embedded PC based on COM module
  - GUI PC connected by LAN
  - Dedicated EtherCAT interface for controlling the I/O modules

→ EtherCAT can also be used successfully in this high-performance system



EtherCAT on the Modules

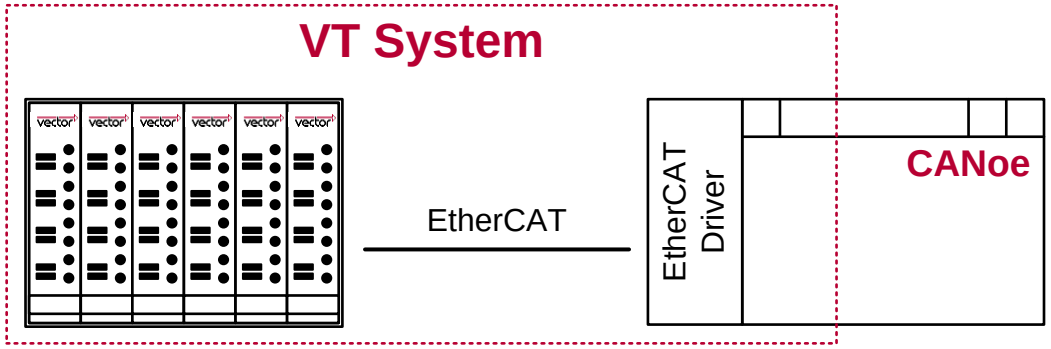
+ Straightforward HW design based on EtherCAT ASIC

+ Needed firmware is not very complex
  - EtherCAT state machine mainly handled by ASIC

– Throughput of µC interface is limited
  - Measurement value update rate limited in some applications (using a FPGA and a very high number of measurement values)

EtherCAT in a Specific Application

- VT System consists of
  - VT Hardware with FPGA/firmware
  - Software functions on the host PC



- EtherCAT is used for real-time communication

EtherCAT can successfully be used for a specific application like the VT System!

Thank you for your attention.

For detailed information about Vector
and our products please visit

www.vector.com

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Vector Informatik GmbH