Welcome to the webinar: “Real-Time Automation and Data Analysis in Test Stands”
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Agenda

- Real-time, time sync'd, live, online – all the same?
- Centralized versus decentralized automation and control aspects
- Some aspects and advantageous of a field bus
- Ethernet and real-time?
- QuantumX Industrial Ethernet integration
- Examples: tire testing, durability testing, dyno testing
- Summary
Real-time, time sync‘d, live, online – all the same?

- **Real-time** means reactive / inter active / control / loop oriented / to automate and as such hardware and software system

- **Turnaround time** can be seen as the time from an event or input to a real system response

- Real-time must guarantee response within specified time constraints, often referred to as „**deadline**“ or „**determinism**“.

- Examples for real-time control applications:
  - fly-by-wire aircraft
  - ABS/ESP braking system of a vehicle
  - System component bench testing

Let’s have a look at an EggSample
EggSample for a machine where real-time is MUST

Robot: real-time task
Function

Operation distance

speed

Turnaround time = distance / speed

Not reached: -> disaster
EggSample – real-time control equipment

Actuator(s)

Sensors

Algo
Real-time, time sync’d, live, online – all the same?

- A real-time application runs on a **real-time operating systems** (RTOS). Some examples: RTAI for Linux or QNX

- **Time stamping** has nothing to do with real-time processing. This means that all analog sensor information or even digital signals get a time stamp as additional on top. **Time sync’d** means that all devices acquiring data are working based on the time stamp – based on mechanisms like PTPv2, distributed clock, IRIG-B or GPS or a combination of them.

- All non-real time tasks can be named **Live or online**, which is good for data visualization, analysis and data mining. Some events like non time critical alarms with a tolerance in latency are also OK to be named online.

Example: HBM software catman can work in a 50 ms time frame and process and visualize all data online
Centralized versus decentralized automation and control aspects

Centralized

Pros / Cons

Perfect for small scale systems
In short range

Still the lowest latency and thus perfect for hardest real-time requirements

Actuators driven mainly analog

Wide range of solutions
Centralized versus **decentralized** automation and control aspects

**Decentralized** (fully digital)

- **Algo**
- **Sim**
- **Act**
- **DAQ**

**Pros / Cons**

- **Pros**
  - Perfect for larger systems (distance and size)
  - Actuators are driven digital
  - Allows specialists in the market to be pulled together
  - Standardization necessary
  - Higher complexity

- **Cons**
  - Needed: real-time capable field bus

HBM: public
Some aspects and advantageous of a field bus

What is a Fieldbus?

- A so called fieldbus is the family name of industrial computer network protocols used for **real-time control** (prioritized, scheduled, fix time latency)

- Hereby a master controller is linked via a Fieldbus to **decentralized units** (sensors & actuators)

- The idea of a fieldbus started to **reduce wiring** and so it actually started with el. Standardized current in a range from 0/4 to 20 mA wired through a number of devices!

Nowadays, over 20 Ethernet based fieldbusses are available in the market!
Why Ethernet?
- Standardized (addressing, transport, applications and services, etc)
- Established and thus highly reliable (IT, IoT / IIoT)
- Pure amount of data is pushing the limit: 100 Mbit…. 10 GBit
- Distance between participants up to 100 m
- Affordable cost

What is the difference to Standard Ethernet?
- Real-Time Requirements: deterministic, synchronized with small jitter
- Fieldbus needs higher reliable components: connectors, CAT6 / CAT7 cables

But
- Cycle times below 1 ms can only achieved by special slave controllers (ASIC or FPGA which is at the moment not IEEE standardized)
- There is no world wide standard of a bus – all open but big players behind.
Main Ethernet based Fieldbus Players

Main players at the moment:

• Siemens / PNO:

• Beckhoff / ETG:

• Rockwell / ODVA:

• B & R / EPSG

• Bosch-Rexroth / ITG:

At the horizon: TSN
Benefits of Industrial Ethernet

**Functional benefits**
- Digitalized field data
- One single cable transferring many signals in real-time
- Highly reliable data transmission
- High resolution of measured value with mainly 24 bit
- Quickly extendible in different topologies (star, line, tree, mix)
- Low extension or integration cost (single cable, software)
- Less faults (wrong wiring)

**Reduction in capital costs**
- Installation costs in larger applications can be reduced significantly
- Maintenance Savings: diagnostic & troubleshooting capabilities
QuantumX – One DAQ Family – Many Possibilities

- **Universal Inputs**
  - > 16 transducers types
  - MX340B, MX440B

- **High Speed Mechanical**
  - Universal, Torque, Speed
  - MX410B, MX460B

- **High Accuracy Full Bridge**
  - Force, Torque, Weighing
  - MX430B, MX239B

- **High Channel Count Specialists**
  - Strain, +/-10V, 4..20 mA, Thermocouple
  - MX1615B, MX1601B,
  - MX1609KB, MX1609TB

- **Electrically Isolated Inputs**
  - Voltage, current, temperature
  - MX403B, MX093B

Every module is a system...
... scale and distribute modules...
... integrate in real-time...
... or use it stand alone!
QuantumX – New Module CX27C available :: PROFINET IRT

Powerful Data Recorder
Mobile DAQ, monitoring, bench
CX22B-W

CAN bus
Mobile recording (CAN, xCP), Bench integration (DBC generation)
MX471B

Industrial Ethernet integration in parallel to Ethernet
CX27B – EtherCAT
NEW: CX27C – PROFINET IRT

Small Scale Real-Time Automation
Analog voltage output, Multi IO
MX878B, MX879B

HBM: public
Example: **Tire Testing** based on PROFINET IRT

- HBM MCS Multi Component Transducer
- MX840B
- MX1609KB
- MX430B
- MX430B
- HBM MCS Multi Component Transducer
- MX840B
- MX1609KB
- MX430B
- MX430B

**Test Automation**

**Data Recording**

**Vehicle part**

**Road**

**QuantumX**

**CX27C**

**ETHERNET**

**HBM: public**
QuantumX PROFINET Integration Workflow

**MX Assistant**
1. Configure all inputs
2. Map to PROFINET IRT
3. Generate GSD file (XML description)
4. Read into PN controller
5. Configure PN controller

**PROFINET Controller**
1. Read GSD into controller sw
2. Configure controller
Durability Testing

HBM takes care of the Test Specimen Analysis

Durability analysis
Performance analysis
Data Server

AUTOMATION SYSTEM

Test drive
Load profile
Automation
Safety

Data Acquisition System

Strain
Force
Acceleration
Displacement
…anything

Test Specimen

Coupling

Durability Actuator

CONTROLLER

HBM: public
Typical Powertrain / Dyno Testing

Combustion Engine / Powertrain Analysis
- Angle based analysis
- Durability analysis
- Performance analysis
- Data Server

Data Acquisition System
- Torque
- Speed
- Temperature
- Pressure
- Strain

AUTOMATION SYSTEM
- Test drive
- Automation

ENGINE

SHAFT

TORQUE / Speed

DYNAMOMETER

POWER CABINET

CONTROLLER

Low time latency
Fast control loop

HBM: public
Challenges in Bench Testing – Experts of the Field in one Setup

- Bench Operation
- Data Acquisition
- HiL Simulation
- ECU

Real-time Fieldbus Backbone
Summary

✓ Small test sequences can be done by QuantumX and catmanAP alone
✓ Large scale real-time automation and data analysis are different tasks best done by different platforms and people focussing on different domains
   - driving the bench and the test setup + safety
   - analysing the test specimen and its reaction
✓ Both domains can be linked together by an Ethernet based real-time bus
✓ QuantumX can serve both domains with data, offering
   ✓ high quality of data
      (noise immune, long term stable, outstanding strain gage technology)
   ✓ supporting common transducers
   ✓ allowing plug & measure (TEDS, automatic channel configuration)
   ✓ high data rates in parallel to real-time (100 kS/s per channel)
   ✓ simple to operate and to operate
   ✓ freely scalable and distributable

... saves time & money in testing
More information can be found on our website:

- [https://www.hbm.com/quantumx](https://www.hbm.com/quantumx)
Any questions?

- If you have any questions, please do not hesitate to contact us: webinar@hbm.com

- Or email the presenter directly: christof.salcher@hbm.com