

Lab Course (Preliminary Session)

# Deterministic Networking Lab

ETHERNET   
**POWERLINK**

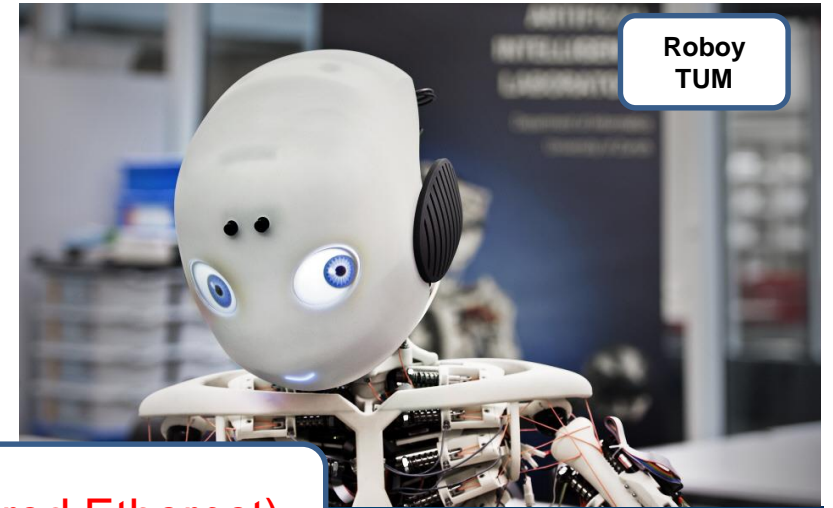
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Prof. Dr.-Ing. Habil. Alois Knoll

Winter Semester 2017/2018

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# What They Have in Common ...

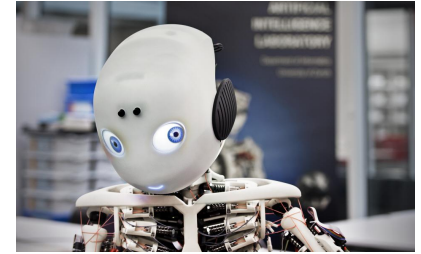


**Reliable Network Infrastructure (Time-Triggered Ethernet)**



# Requirements on Communication Infrastructure

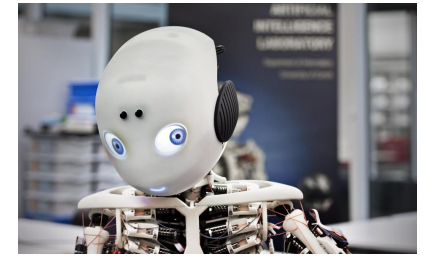
1. Real-time Communication
2. Fault Tolerance Approaches
3. Low Cost (Limited Budget)
4. Low Power (Limited Resources)
5. Low Size (Limited Space)



# Failure in Communication Infrastructure

1. Loss of Life
2. Loss of Economic Assets
3. Loss of Research Achievements

**“DISASTER”**



# Open Vs. Closed Communication Infrastructure

## Open Communication

- **No Performance Guarantees:**  
Best Effort
- **Standards:**  
Ethernet, TCP/IP, UDP, FTP, SSH,...
- **Applications:**  
Multimedia, audio & video, Internet, Web,...
- **Validation and Verification:**  
No Certification, test, simulation,...
- **Low Cost**

## Closed Communication

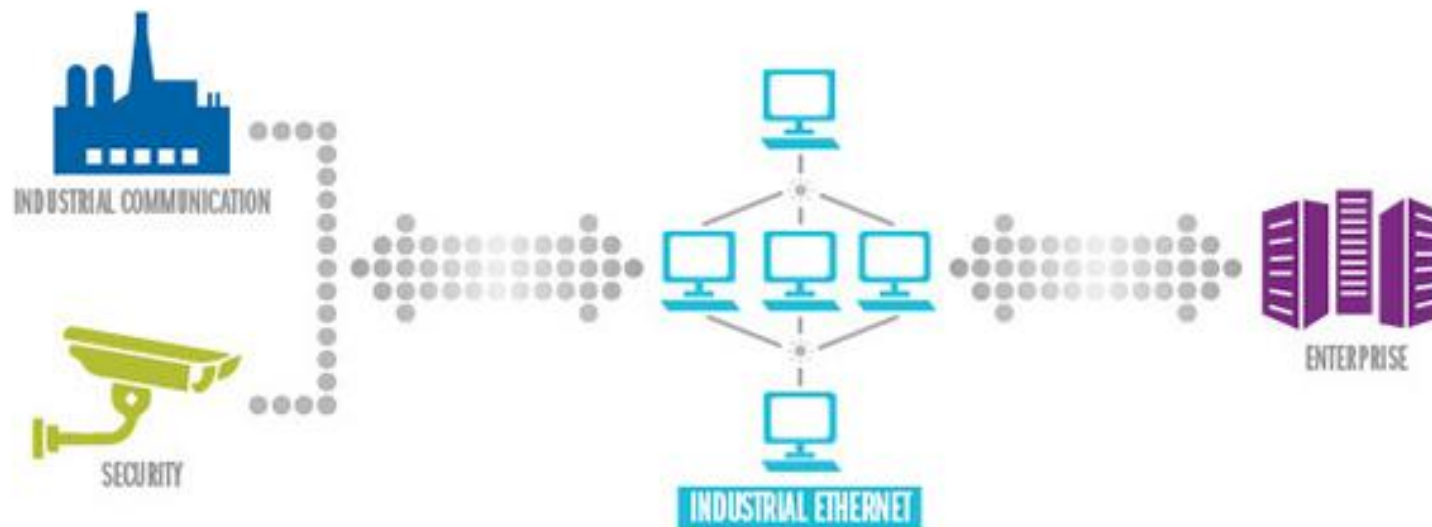
- **Performance Guarantees:**  
Real-time, dependability, safety,...
- **Standards:**  
ARINC 664, TTP, MOST, FlexRay, CAN, LIN,...
- **Applications:**  
Flight Control, Powertrain, Automotive,...
- **Validation and Verification:**  
Certification, formal analysis
- **High Cost**



# In Reality: Mixed-Criticality Systems

Main goal is to share system resources and partition critical and non-critical distributed functions over the network

## Same Physical Network for Data Flows from Both Side of Infrastructure



## Time Triggered Ethernet

# Motivation for Ethernet

- Lower Price of Ethernet Hardware
- Well-Established Open-World Standard and Scalable
- Possibility of Building a Well-Structured Classification of Concepts on Top of Ethernet (OSI Model)
- Cost-Efficient diagnosis Tool



**Ethernet Compatibility Enables the Usage of Technology that is Established, Tested and Verified**

# Deterministic Networking Lab

## Course Structure



# Course Structure

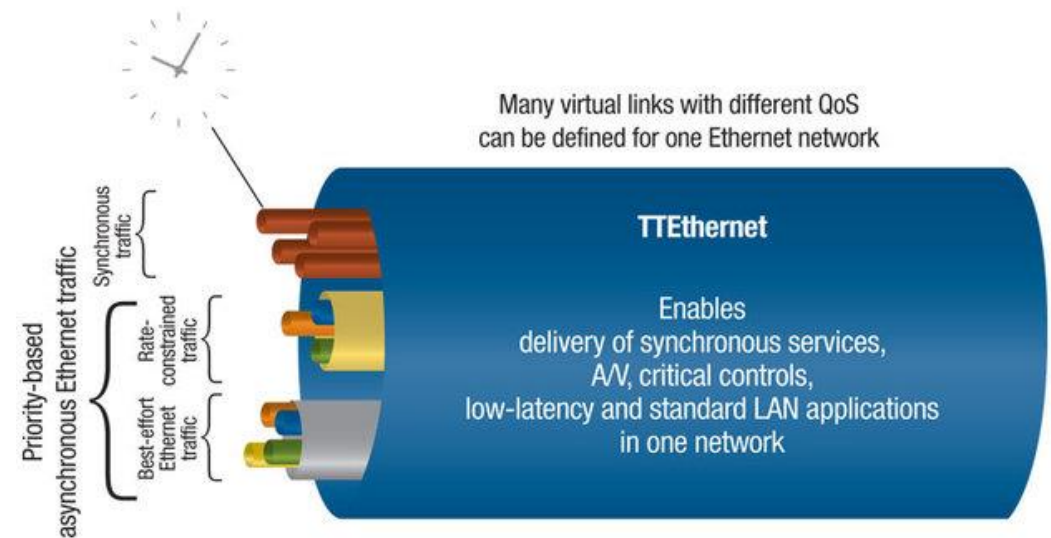
1. Introduction and Basics
2. Theoretical (A&B)
3. Practical
4. Grading

# Course Structure

- 1. Introduction and Basics**
2. Theoretical (A&B)
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# 1- Introduction and Basics

- Deterministic Networking / Basics and Requirements
- Hard Real Time Requirements
- Introduction to the Working Lab and Hardware



# Course Structure

1. Introduction and Basics
- 2. Theoretical (A&B)**
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## 2- Theoretical – Phase A

- Study Materials Will be Distributed
- A Comparison Will be Performed Between POWERLINK and:
  - ✓ PROFINET
  - ✓ TSN
  - ✓ CANopen
  - ✓ EtherCAT
  - ✓ Ethernet/IP
  - ✓ SAEJ1939
  - ✓ DeviceNet
- Presentation and Open Discussion on the Comparisons
- Technical Report on the Evaluations and the Discussions

# 2- Theoretical – Phase B

## ➤ “openPOWERLINK” in Deep:

- ✓ POWERLINK Data Link Layer (DLL)
- ✓ Supported Platforms by POWERLINK
- ✓ Developing openPOWERLINK

## ➤ Objectives:

- ✓ Identifying Responsible Modules for Different Parts of the Protocol
- ✓ Identifying the Portable and Platform Dependent Parts of the Stack

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# 3- Practical

- **Goal:** Implementing openPOWERLINK Stacks on a Table Demonstrator with Real Data Streams

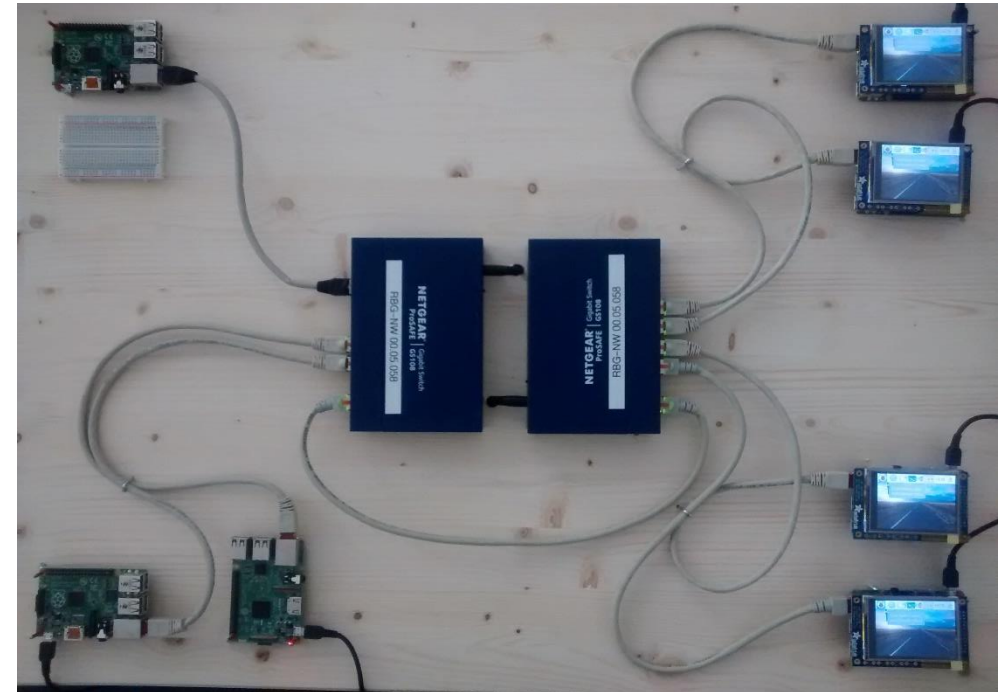
- **Objectives:**

- ✓ Customizing the openPOWERLINK Stack
- ✓ Controlling the I/O of an Industrial Module Using POWERLINK
- ✓ Wireshark Tracing
- ✓ Getting Familiar with:
  - Cyclic POWERLINK Operation
  - openPOWERLINK Development Toolchain (XDD files/openCONFIGURATOR/CDC/etc.)



# 3- Practical Cont.

- **Goal:** You Will Get a Basic Understanding on How POWERLINK Works
- **Main Tasks:**
  - ✓ Cyclic POWERLINK Operation
  - ✓ openPOWERLINK Development Toolchain
  - ✓ Porting openPOWERLINK to New Platforms
  - ✓ Tracing POWERLINK with Wireshark



# Course Structure

1. Introduction and Basics
2. Theoretical
3. Practical
- 4. Grading**

# Grading

- ✓ 40% of Final Grade → Theoretical Sessions
- ✓ 40% of Final Grade → Practical Sessions
- ✓ 20% of Final Grade → Final Representation of Work

# Note

- Number of Participants: 10
- Master and Bachelor Students Are Welcomed
  
- Background (Nice to Have):
  - ✓ Basic Knowledge of Embedded Systems/Devices
  - ✓ Basic Knowledge in TCP/IP Networking
  - ✓ Background in Network Monitoring (Wireshark)
  - ✓ Background in Working with Linux (Debian)
  - ✓ Knowledge in Python / C
  - ✓ Background in Sensor Data Acquisition

# If You Plan to Register

- Registration Via Matching System
- Send an Email to [Shafaei@in.tum.de](mailto:Shafaei@in.tum.de) with Title “**DetNet1718**” by 30<sup>th</sup> of July
- Mention:
  1. Name and the Current Semester (Master Or Bachelor)
  2. One of Your Reasons to Participate in this Lab Course
  3. Your Background According to slide 21