

# Welcome to the “Incorporating Industrial Ethernet into Your Measurement Chain” Webinar

**THE PRESENTATION WILL BEGIN AT 10AM EASTERN TIME**

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## Organizational Information

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- ▲ Today's presentation will be E-mailed to all attendees. The webinar will also be posted on our website: <http://www.hbm.com/en/3157/webinars/>
- ▲ If you have additional technical questions, feel free to contact our technical support team at [support@usa.hbm.com](mailto:support@usa.hbm.com)

# Nehemiah McIntyre

- ▲ BS Biomedical Engineering from Michigan Technological University
- ▲ MS Kinesiology from Michigan Technological University
- ▲ Application Engineer with HBK since 2020
- ▲ Enjoy photography, music, and dogs



Michigan  
Technological  
University



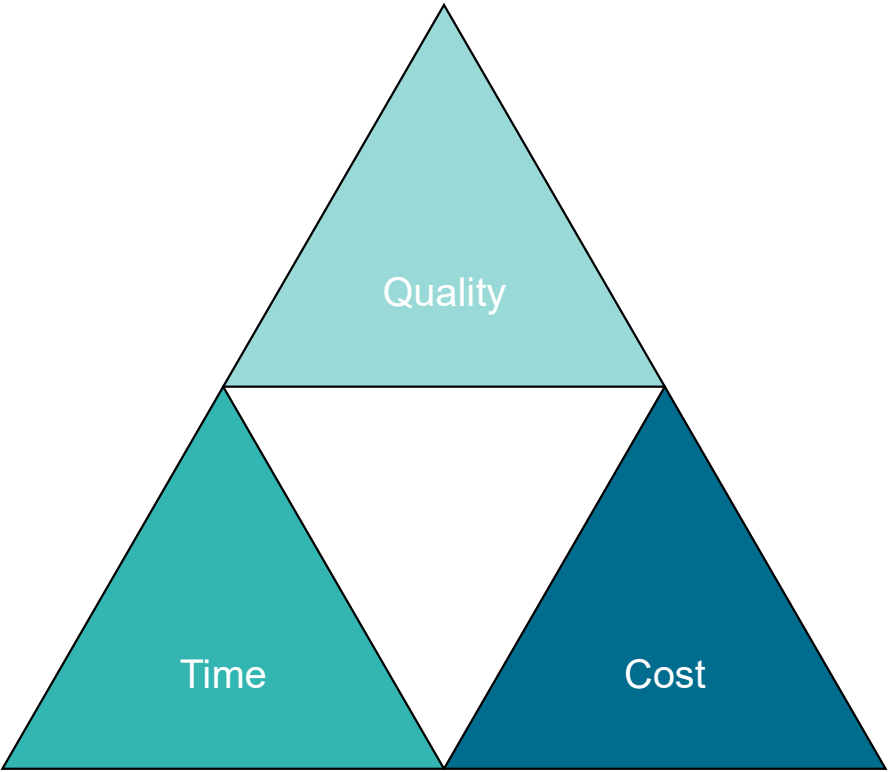
# Agenda

1. History of Automation
2. Network Basics
3. Industrial Ethernet Introduction
4. Industrial Ethernet Operating Principles
5. HBK Equipment
6. Demonstration

# Memberships



# History of Automation



# History of Automation

- ▲ Pneumatics and steam
  - Large, bulky
  - Dangerous
  - Explicitly designed
  - Routine maintenance required

# History of Automation

- ▲ 1950s: 4-20 mA
  - Lower cost
  - Scalable
  - Not prone to noise or loss
  - Implemented with relay





# History of Automation

- ▲ 1960s: PLC
  - Simplified logic to digital systems
  - Centralized structures

VS

- Decentralized structures
  - Fieldbus communication
  - No determinism



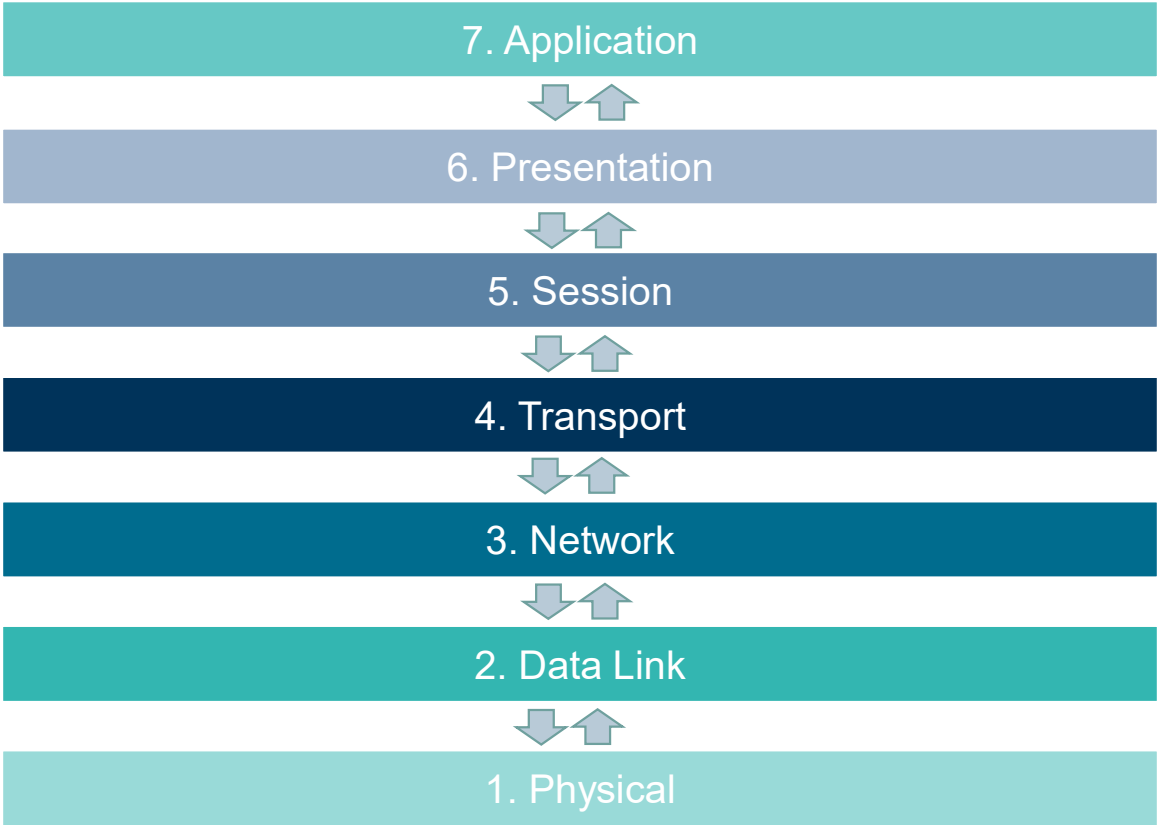
# Industrial Ethernet



# Industrial Ethernet

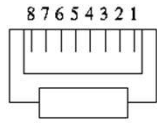


# Network Basics: OSI Model

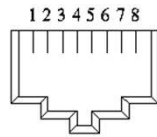


# Network Basics: OSI Model

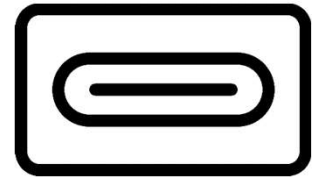
- ▲ Layer 1: Physical
  - Receives and transmits signal



*End view of RJ45 Plug*



*Looking into an RJ45 Jack*



## Network Basics: OSI Model

- ▲ Layer 2: Data link
  - How data moves from node to node in a network



## Network Basics: OSI Model

- ▲ Layer 3: Network
  - Communication among dissimilar networks

192.168.0.x

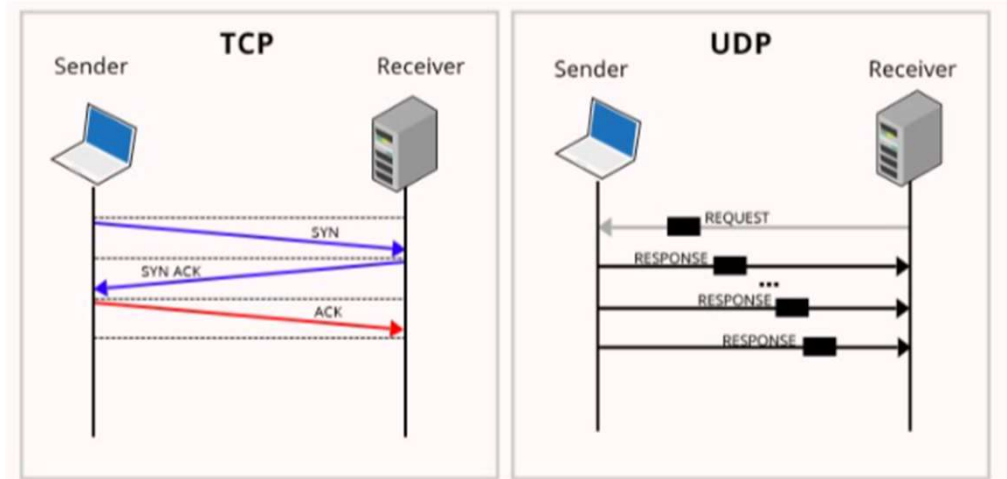
VS

192.168.1.x

# Network Basics: OSI Model

## Layer 4: Transport

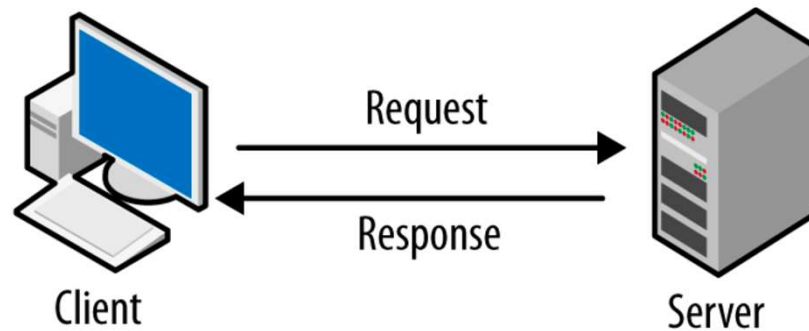
- How data is transmitted
- Transmission Control Protocol (TCP)
  - Data integrity is guaranteed
  - More time consuming
- User Datagram Protocol (UDP)
  - “Fire and forget”



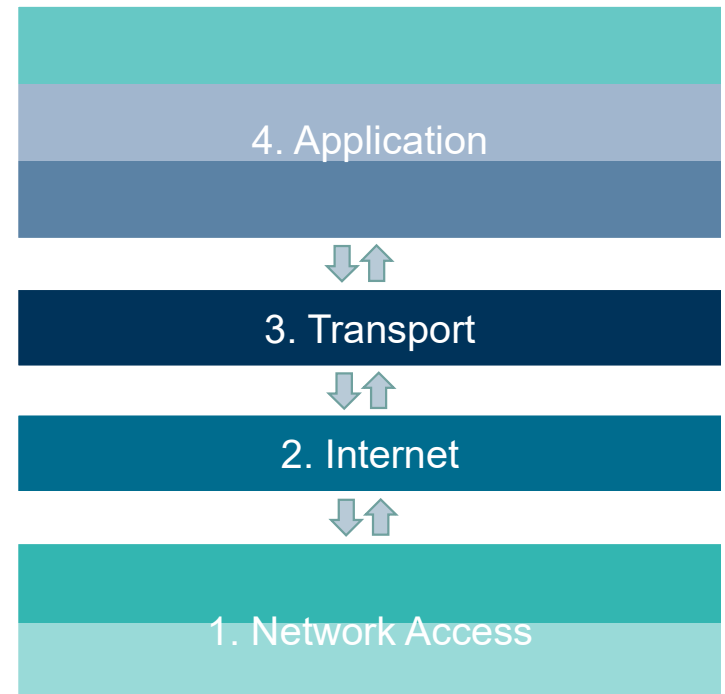
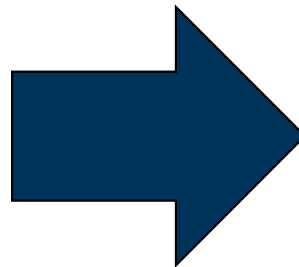
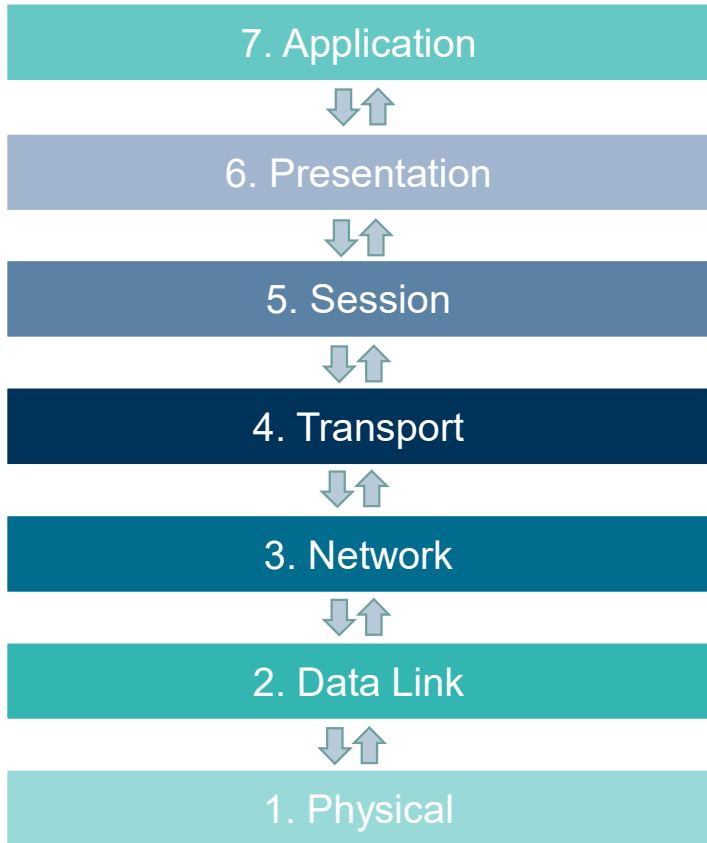


## Network Basics: OSI Model

- ▲ Layer 5: Session
  - Controls connection between server and client
- ▲ Layer 6: Presentation
  - Manages syntax between different protocols
- ▲ Layer 7: Application
  - The layer that the user directly interacts with

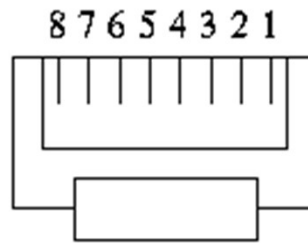


# Network Basic: TCP/IP Model

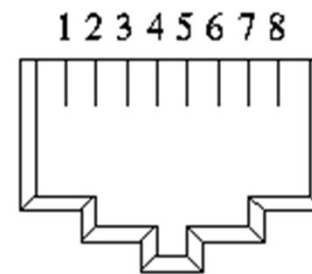


# Network Basic: Ethernet

- ▲ IEEE 802.3
- ▲ OSI Layers 1 and 2

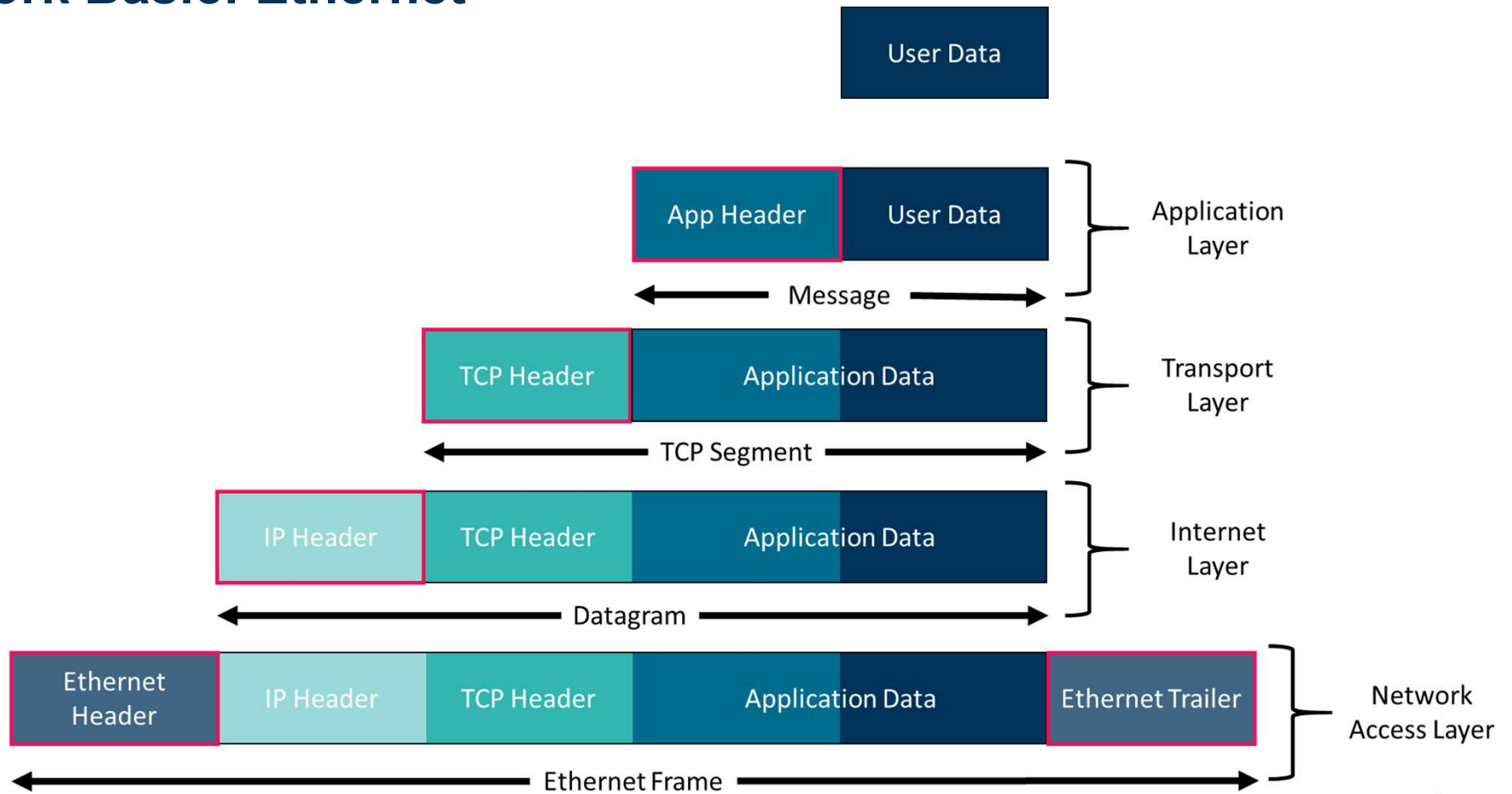


*End view of RJ45 Plug*



*Looking into an RJ45 Jack*

# Network Basic: Ethernet

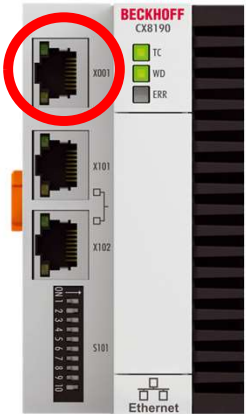


## Why Industrial Ethernet?

- ▲ Ethernet already is:
  - Flexible and expandable
  - Capable of moving large amounts of data to multiple nodes
- ▲ BUT
  - Encapsulation
  - “Store and forward”
  - Collision detection mechanisms

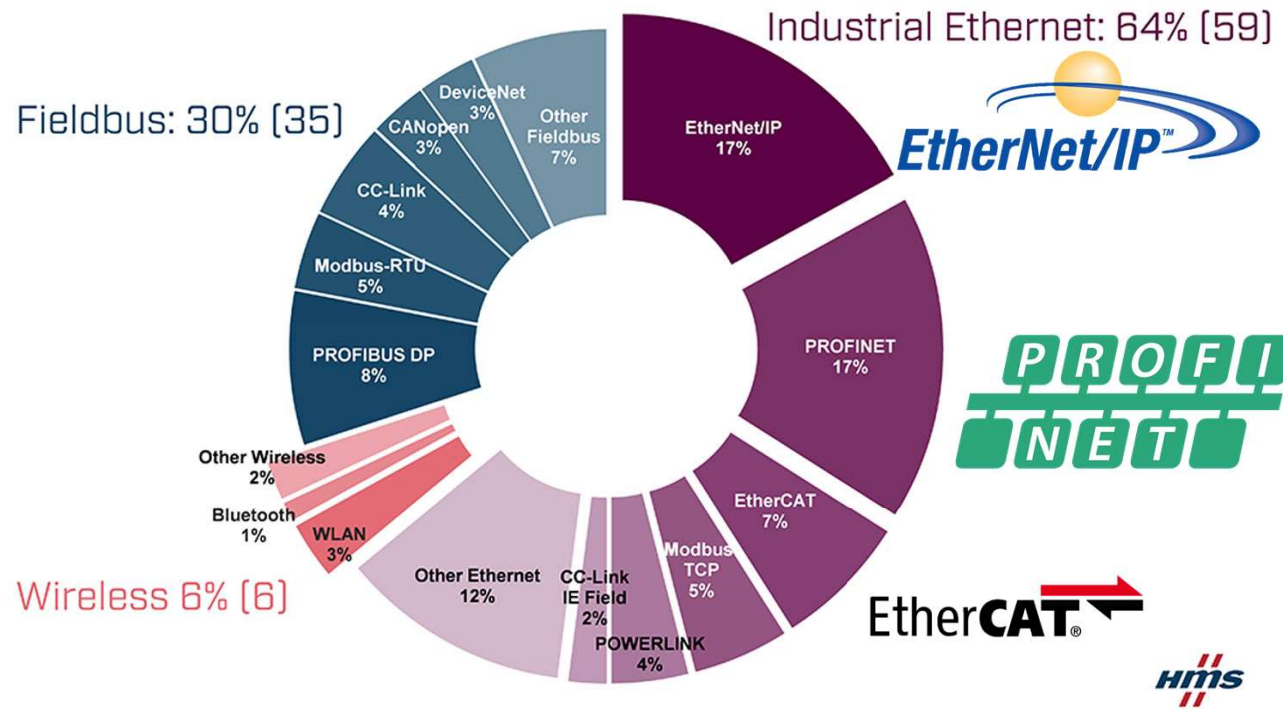
# Industrial Ethernet

Any fieldbus that incorporates IEEE 802.3



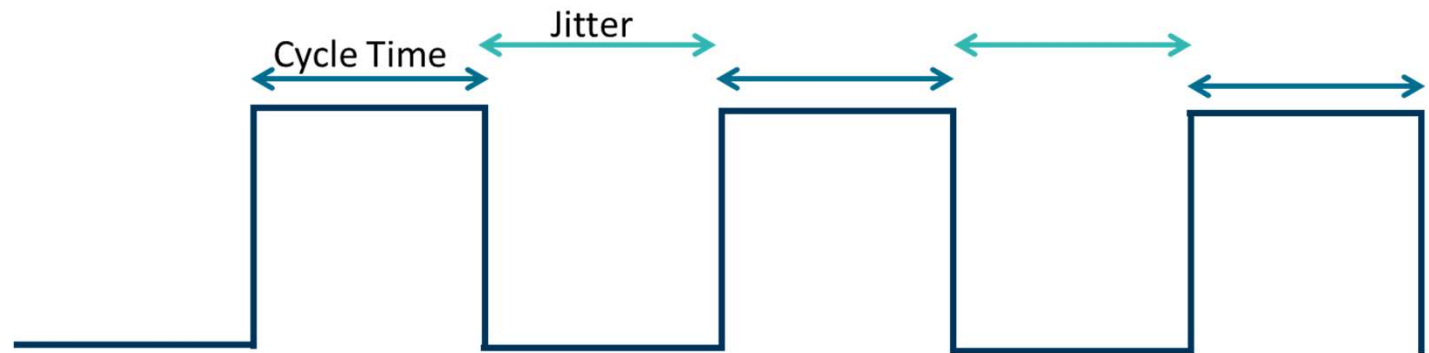
# Industrial Ethernet

Any fieldbus that incorporates IEEE 802.3



## EtherCAT

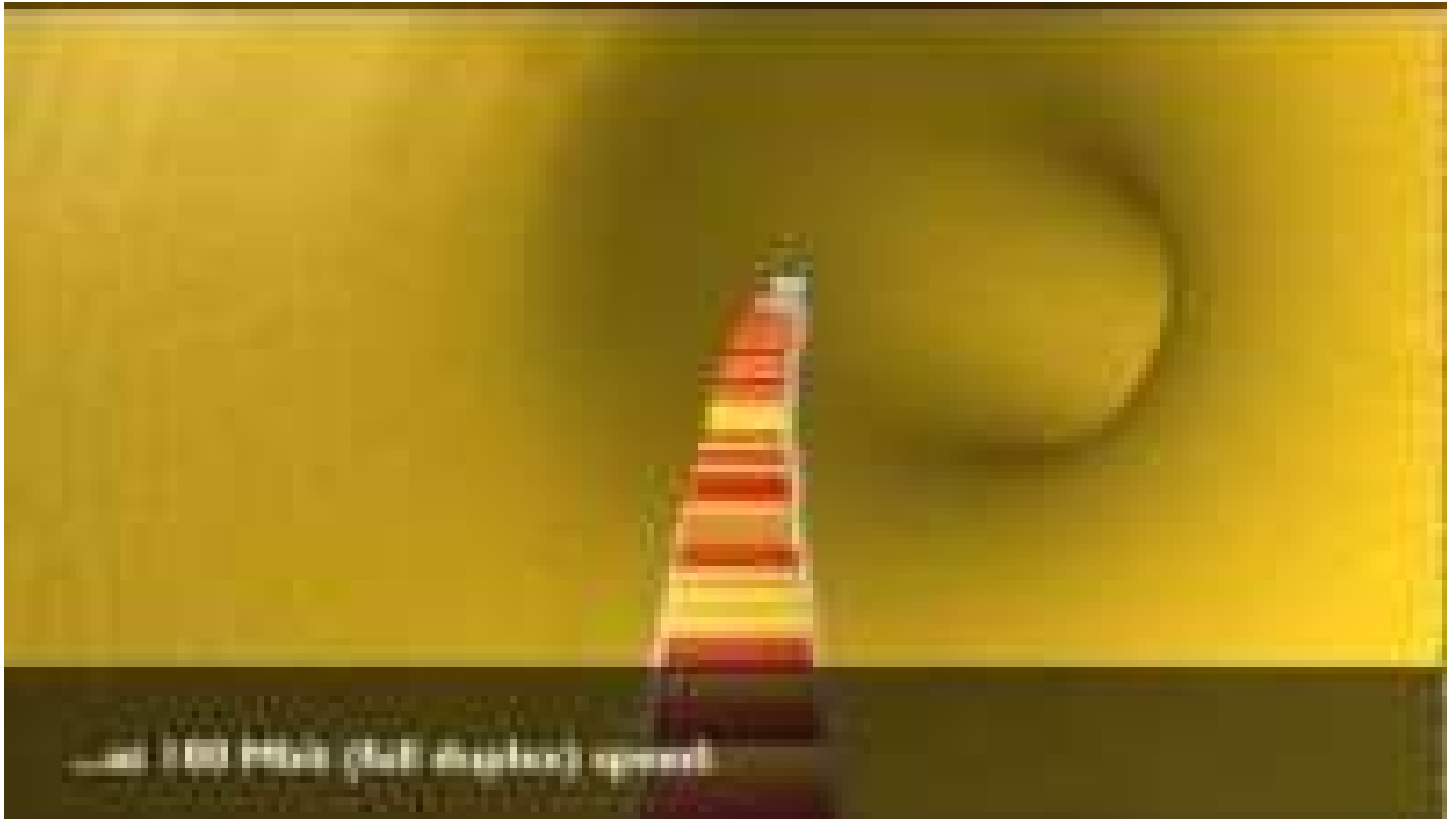
- ▲ Real-time and deterministic
  - 50  $\mu\text{s}$  (as low as 12.5  $\mu\text{s}$  demonstrated)
- ▲ Supports ring and line topologies
  - Eliminates need for network switches



EtherCAT®

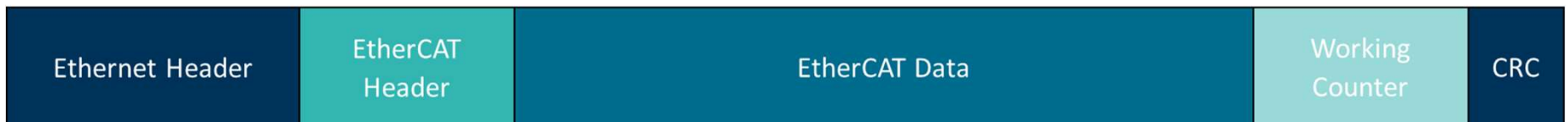
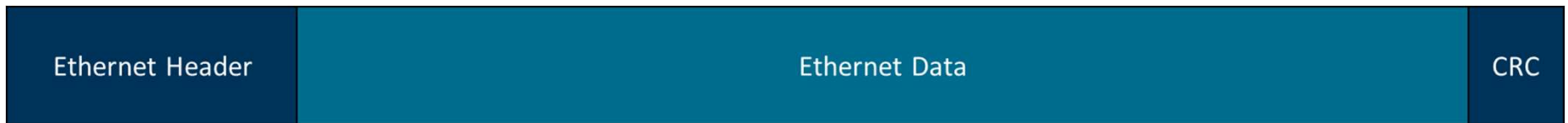


# EtherCAT

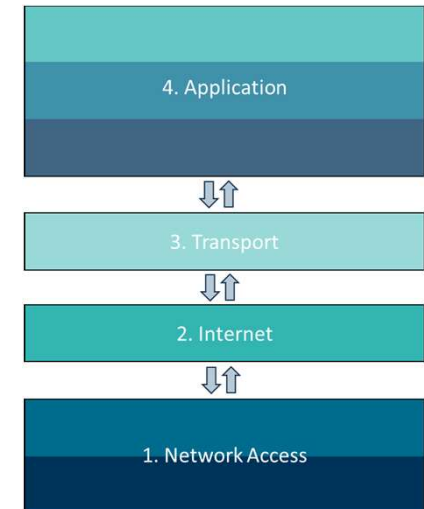
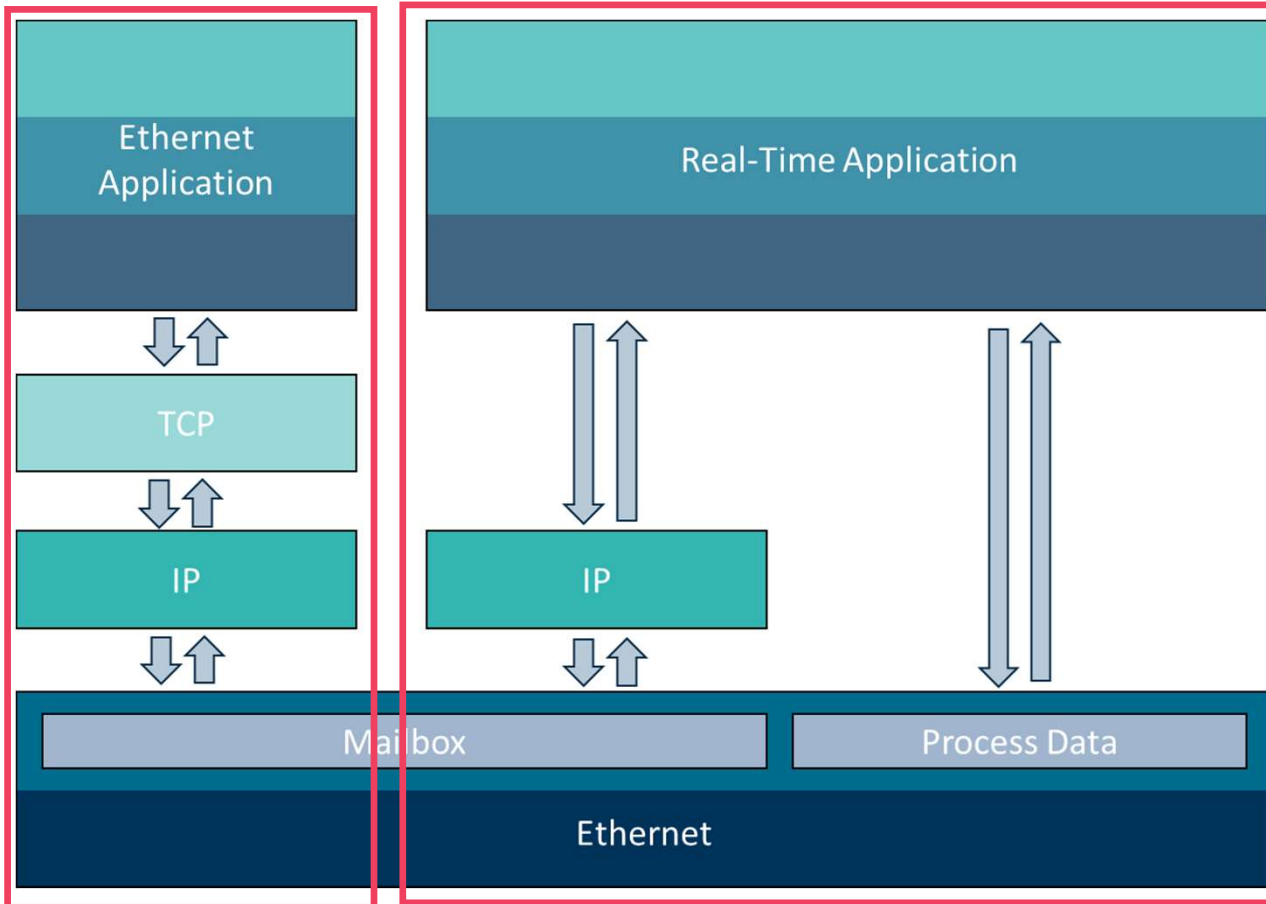


# EtherCAT

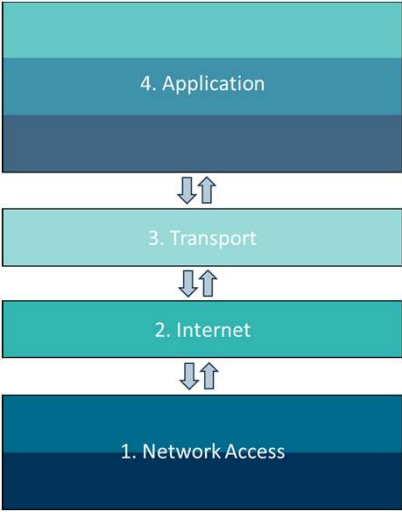
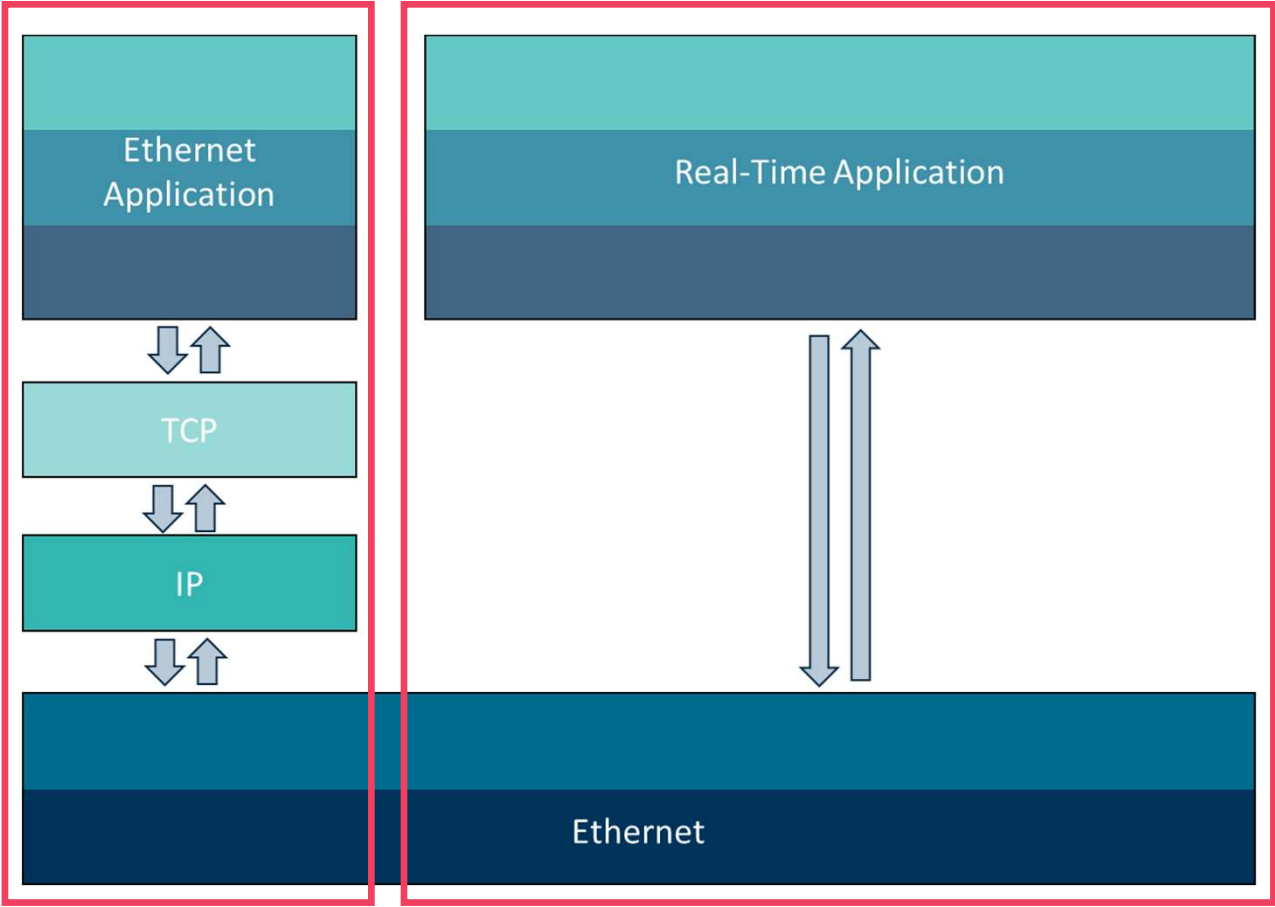
- ▲ “On-the-fly”
- ▲ One frame per cycle
- ▲ Packaged into a standard ethernet frame



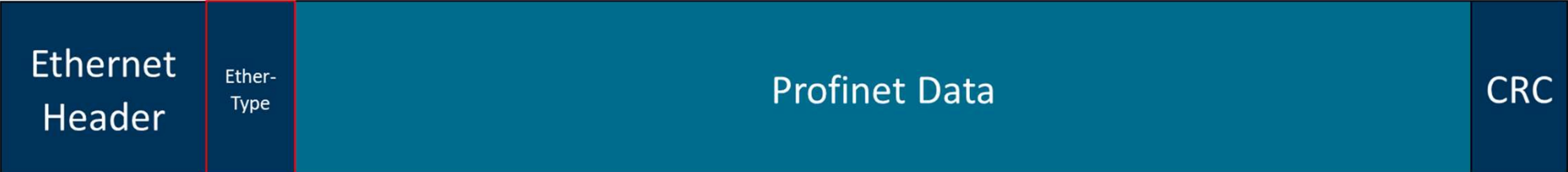
# EtherCAT



# Profinet



# Profinet



# Profinet

## ▲ RT (Real-Time)

- Cycle times as low as 250  $\mu$ s (1-10 ms typical)

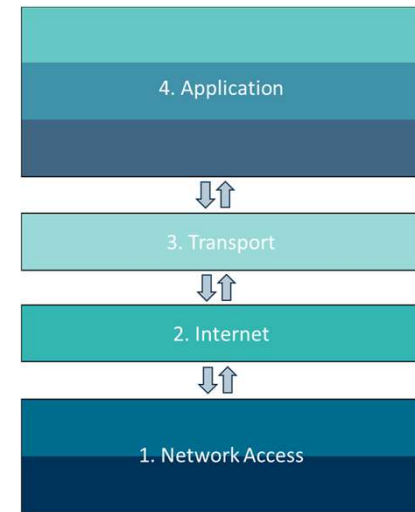
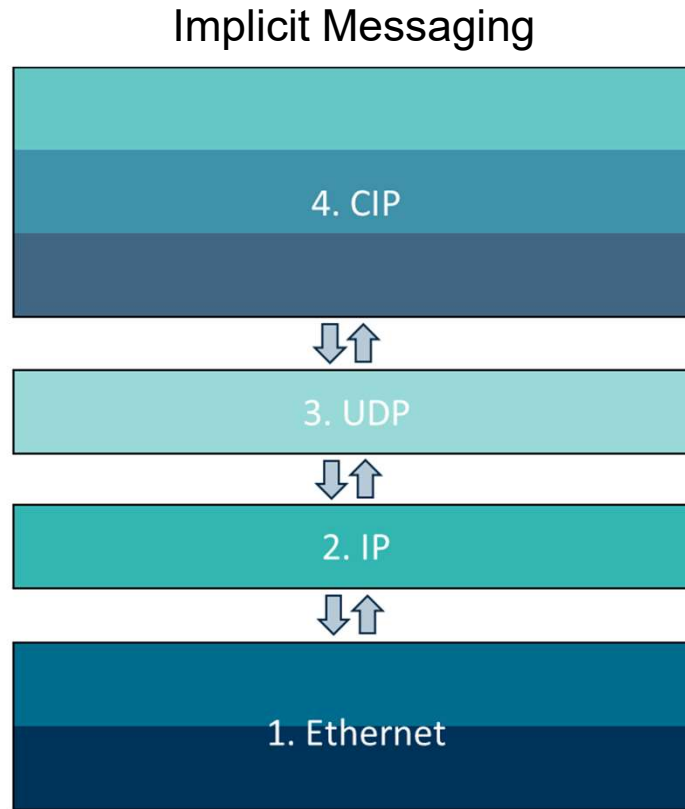
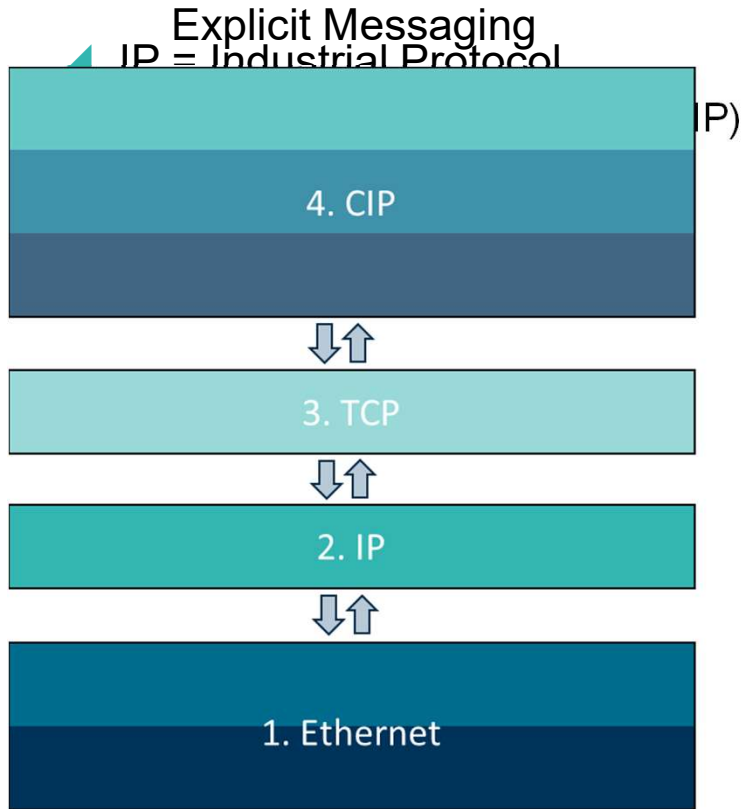
## ▲ IRT (Isochronous Real-Time)

- Bandwidth allocated explicitly for these tasks
- Cycle times as low as 31  $\mu$ s

1. Fast forwarding: Data processed as node identifies it
2. Dynamic frame packing: Reduces frame sizes and numbers in line topologies
3. Segmentation: RT frames sent in between TCP/IP segments

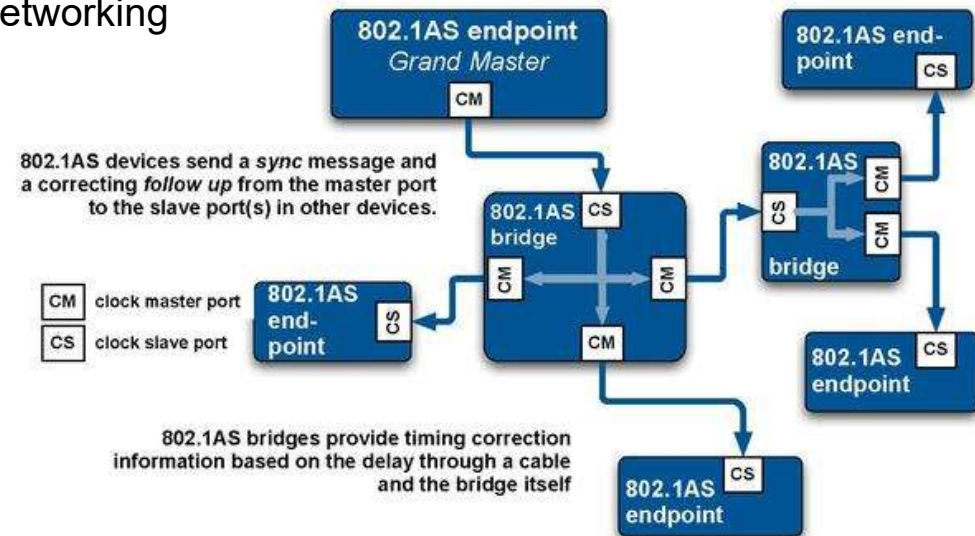


# EtherNet/IP



## Looking forwards

- ▲ New network standards
  - Time Sensitive Networking (TSN)
  - Improved determinism
- ▲ Higher bandwidth
  - 2.5 Gb / 10 Gb networking





## HBK Offerings

- ▲ QuantumX and SomatXR
  - CX27C
  - 4.8 kHz update rate
  - ISO 17025 accredited calibration



# HBK Offerings

- ▲ Industrial solutions
  - PMX via gateway cards
  - ClipX
  - EtherNet/IP, EtherCAT, Profinet
  - Up to 9.6 kHz update rate



## HBK Offerings

- ▲ Torque measurement
  - TIM-EC, TIM-PN
  - Direct integration of T40B via TMC
  - Frequency connection

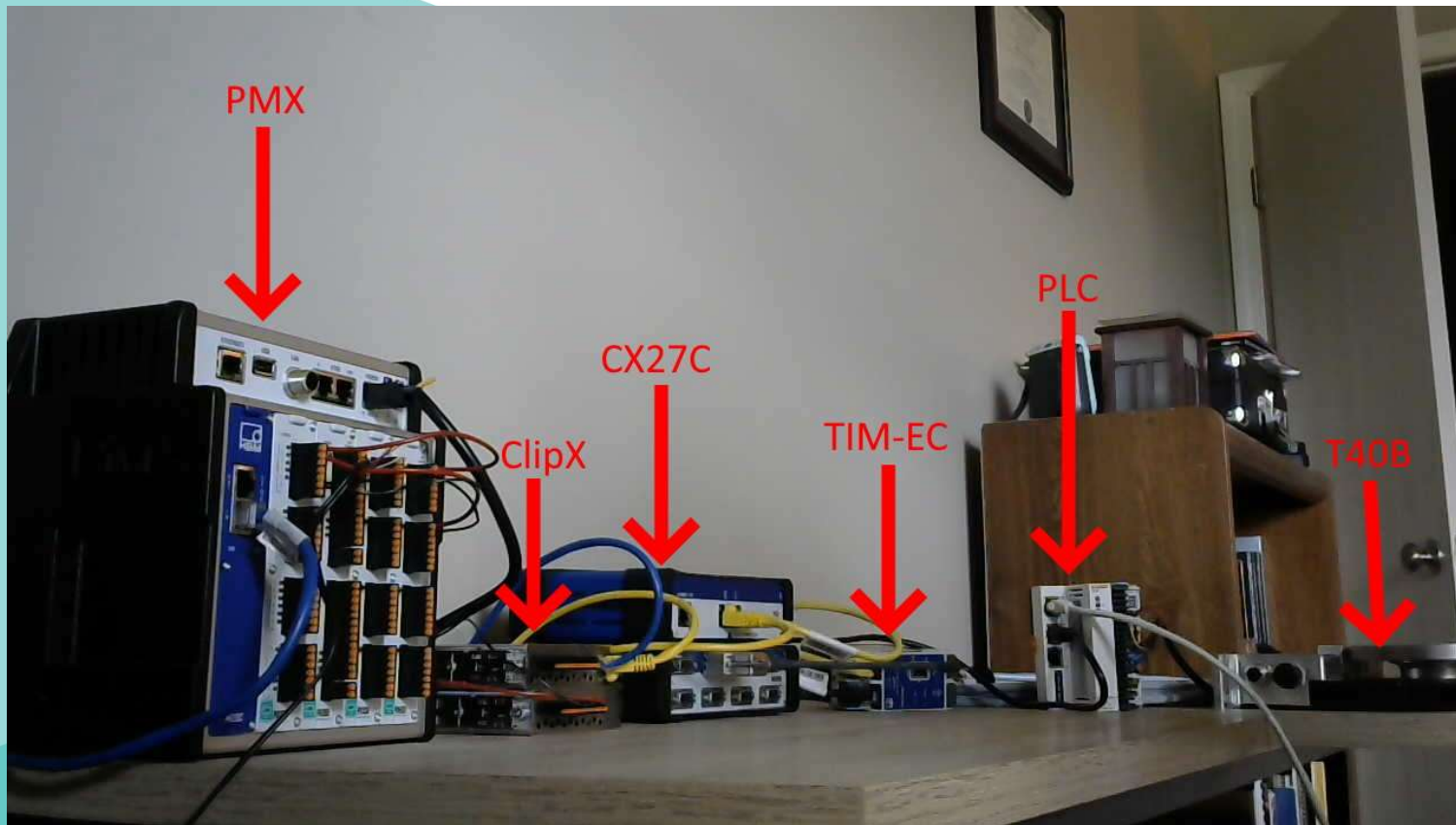


## HBK Offerings

- ▲ Genesis HighSpeed
  - Optional EtherCAT interface
  - Available on B modules (tethered only)
  - 1 kHz update rate



# Demonstration



## Questions?

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# Thank You