ETFA2020

Deterministic ethernet use cases in injection moulding

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Introduction

Matthias Konnerth

- **Teamlead software @ Engel**
- **Representing Engel within Euromap79 standardization**

About ENGEL

Our world is injection moulding

We are one of the leading plastics machinery manufacturers and offer injection moulding machines for any kind of application, innovative technologies, robotics and customized system solutions from a single source. We are world market leader in generating added values and are 100% customer orientated.

About ENGEL

Facts & figures

Founded 1945 in Austria by Ludwig Engel

1,3 billion Euro turnover worldwide (FY 19/20)

100% family-owned in the 4th generation

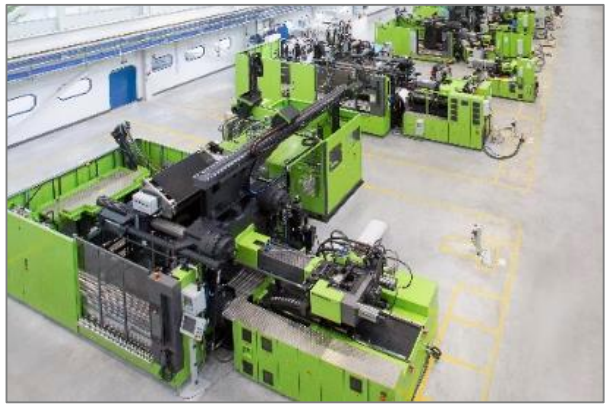
over 500 Mio. Euro Investment volume (FY 2018 – 2022)

6,500 employees worldwide (FY 19/20)

70 Mio. Euro R&D investment per year

Scope of products & services

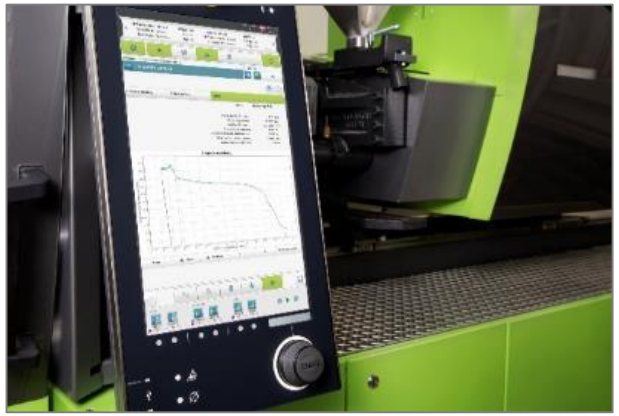
Innovative machines, technologies and solutions from a single source



INJECTION MOULDING MACHINES

SYSTEM SOLUTIONS & ROBOTICS

PLASTICISING TECHNOLOGY



DIGITAL SOLUTIONS / SMART FACTORY

PROCESS TECHNOLOGIES

GLOBAL SERVICE & SUPPORT

Injection moulding production cell
Overview

Cartesian robot

Injection moulding machine

6-axis robot

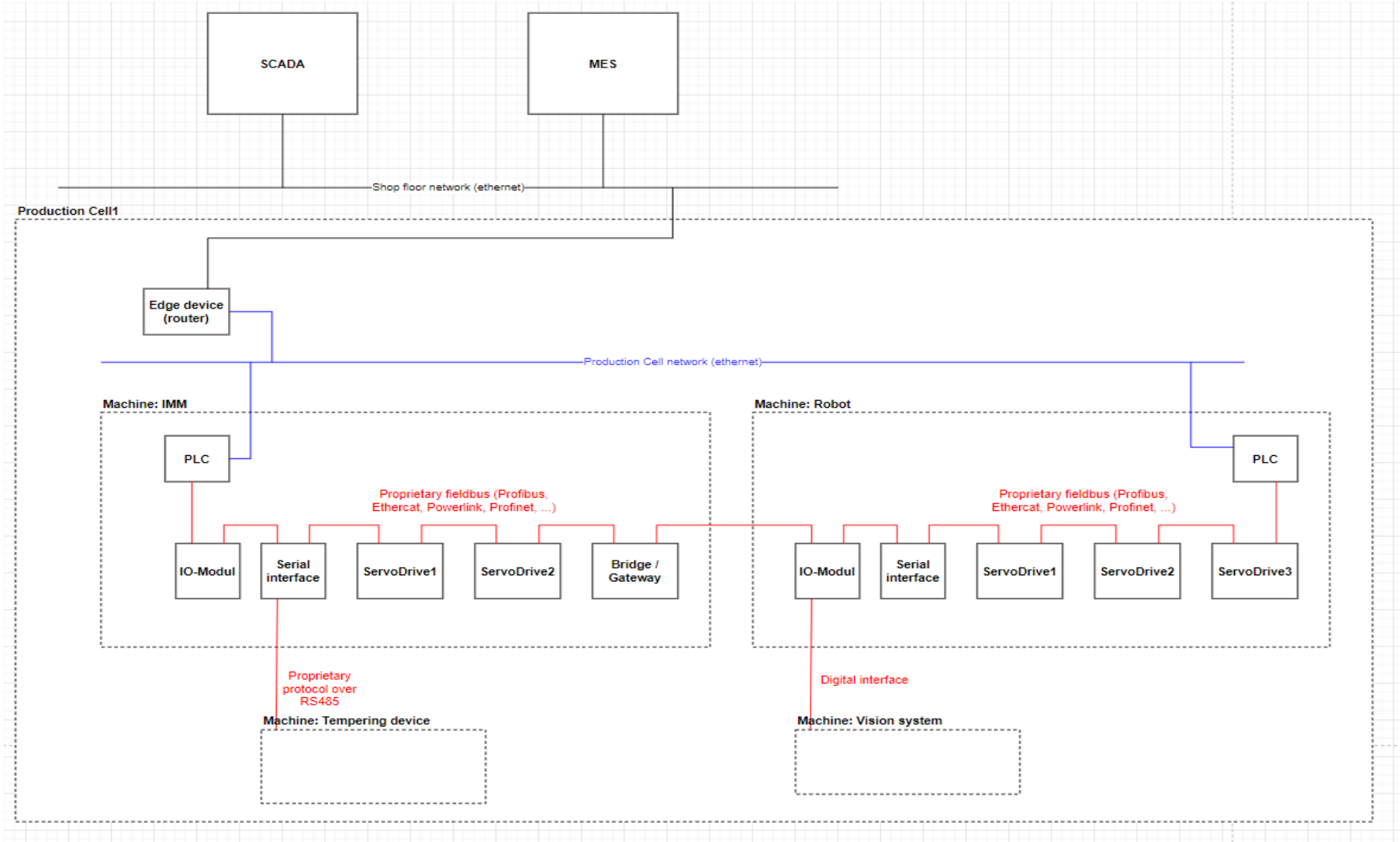
Tempering devices, dosing systems, vision systems, safety gates

Injection moulding production cell
Characteristics

- **Machines from different vendors (heterogenous networks)**
  - IMM from vendor A
  - Robot inserting parts from vendor B
  - Robot removing parts from vendor C
  - Tempering devices from vendor D
- Lot size is decreasing
  - More frequent reconfiguration of the production cell
  - Customers demand more flexible scheduling of jobs
- Production cells getting complexer

Production cell network

Current situation



Drawbacks

- **Use case 1: Interface between machine and robot**
  - Supporting many fieldbusses would be necessary, to make the interface between machine and robot interoperable
  - Euromap 67 was defined, but this is just a digital interface
    - Lack of functionality: position of mould and ejector is missing
    - Many proprietary extensions (customers asks for extra signal for movement)
- **Use case 2: Machine network**

Standardized interfaces
advantages

- Internal (at machine builder)
  - Reduced development costs
  - Reduce maintenance costs (at the moment >25 different interfaces available)
  - Higher overall test coverage
  - Reduced setup of production cell

- External (at customers site)
  - Reduced integration costs of peripheral devices
  - More flexibility in setting up a production cell
  - Higher investment safety

Interoperability
Look on OSI model

Layer	What we are aiming for
Application **Presentation** **Session**	Standardized OPC UA information models, standardized OPC UA services (read, write, call)
Transport	TCP, UDP
Network	IP
Data link	Ethernet
Physical layer	100BaseTX, 1000Base Tx

To achieve interoperability we have to consider all layers of the OSI model!

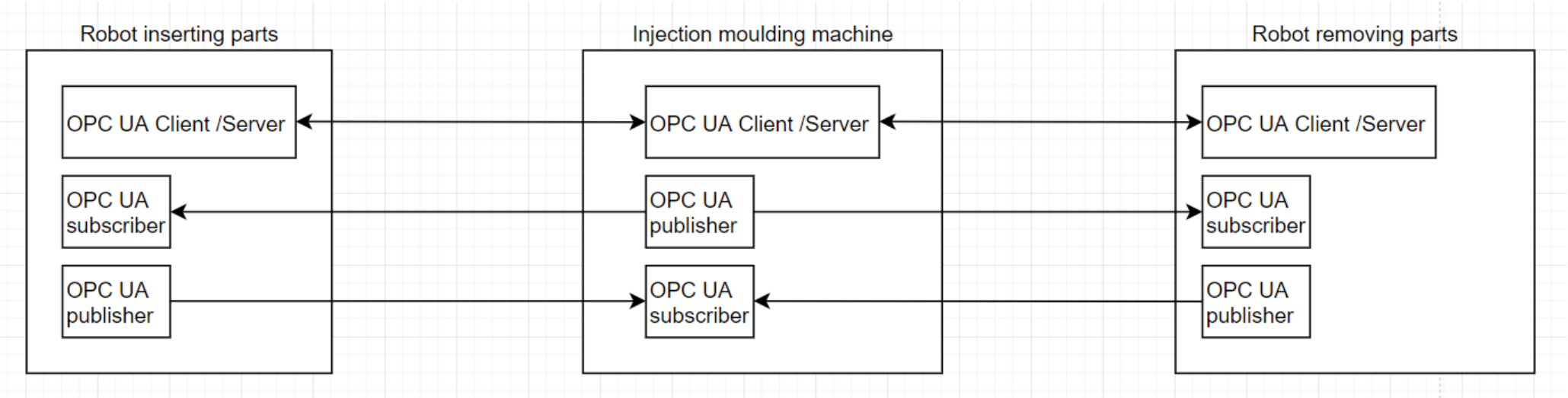
Deterministic Ethernet (TSN) as normed in IEEE802.1, 802.3 and further for industrial Automation in IEC/IEE60802 profile is the way to go for us in layer 1+2

Use case robot integration

- Work in progress in EUROMAP79
- Interface between injection moulding machine and robot
- OPC UA Client/Server on machine and robot side (non-deterministic)
  - For remote actions (e.g. moving an axis)
  - For transfering datasets
- **OPC UA Publish/Subscribe on machine and robot side (determinism required) -> Pub/Sub over TSN**
  - Machine is publishing positions
  - Robot is locking/releasing machine movements (via variables or methods)

Euromap 79

Communication patterns – multiple robot scenario



Use case robot integration

Traffic characteristics

Traffic	class	Cycle time (ms)	Payload (byte)
Cyclic data from injection moulding machine to robot (positions signals)	Cyclic with fixed priority	1-10	100-500
Cyclic data from robot to injection moulding machine (locking and releasing movements of the injection moulding machine)	Cyclic with fixed priority	1-10	100-500
Acyclic Traffic for configuration	Best effort	/	Not bounded

Production cell network
Topology and configuration

- Configuration of the production cell network is done at our customers site
- Customers doesn‘t have any know-how in
  - Setting up a TSN network
- Integration of a robot must be seamless for them
  - No need for calculating a schedule
- Production cell is in manual / standstill when reconfiguration is happening
- Network topology production cell:
  - in most cases a **star topology**

Use case machine network

Traffic characteristics

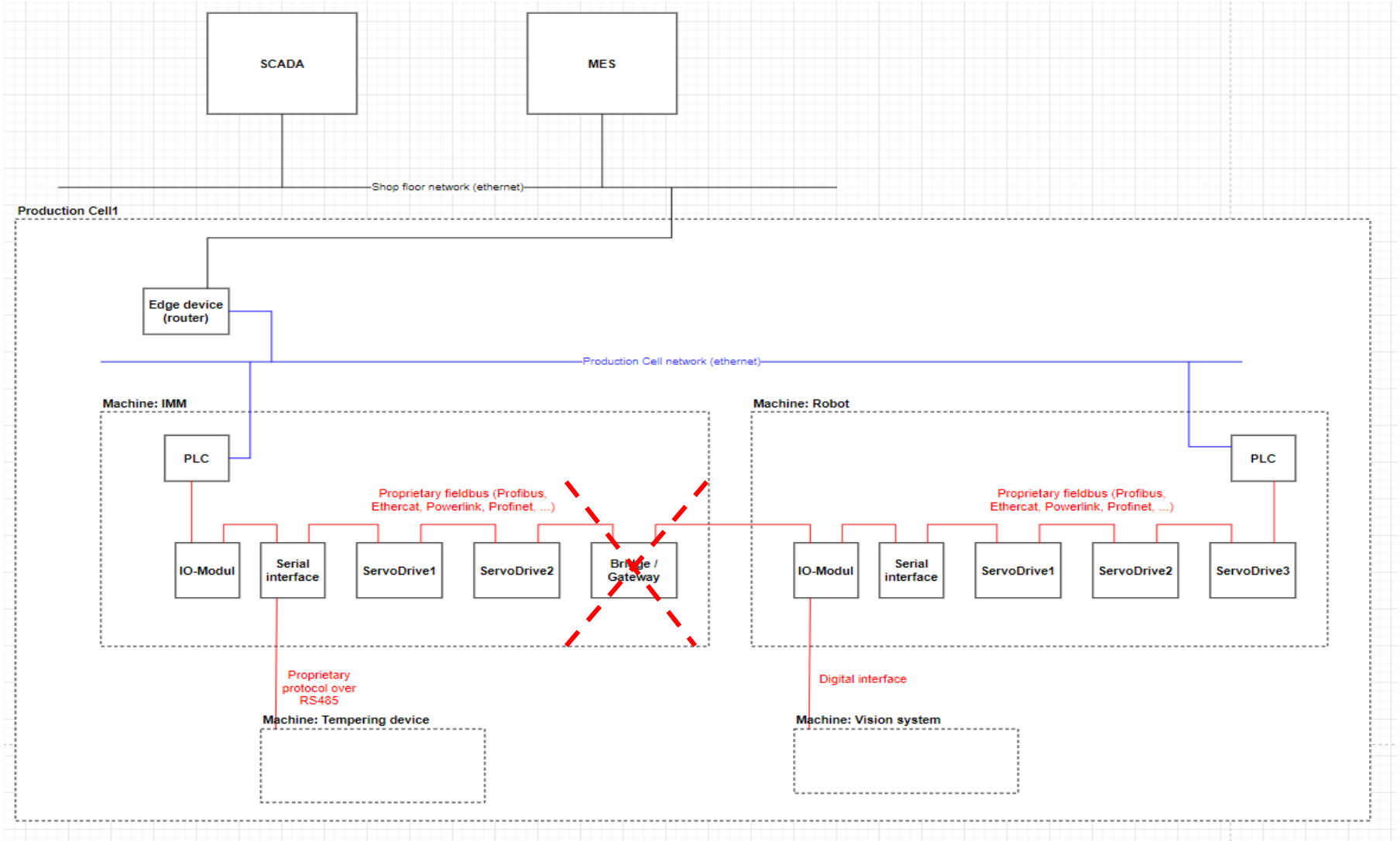
Traffic	class	Cycle time (ms)	Payload (byte)
From sensors to PLC	Cyclic with fixed priority	<=1ms	<100 per Endpoint
From PLC to actors	Cyclic with fixed priority	<=1ms	<100 per Endpoint
Acyclic Traffic for configuration	Best effort	/	Not bounded

Machine network
Topology and configuration

- Network configuration is known at design time
- Integration of a robot must be seamless for them
  - No need for calculating a schedule
- Machine in manual / standstill when reconfiguration is happening
- Network topology production cell:
  - Mostly line topology (so called „daisy-chaining“)
  - About 10-20 endpoints

Conclusio

Next steps



Thank you

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Q&A

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