ACADEMIC SALON ON TIME-SENSITIVE NETWORKING AND DETERMINISTIC APPLICATIONS

DYNAMIC CONFIGURATION OF TSN FOR INDUSTRIAL APPLICATIONS IN THE KITOS PROJECT

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14 October 2021

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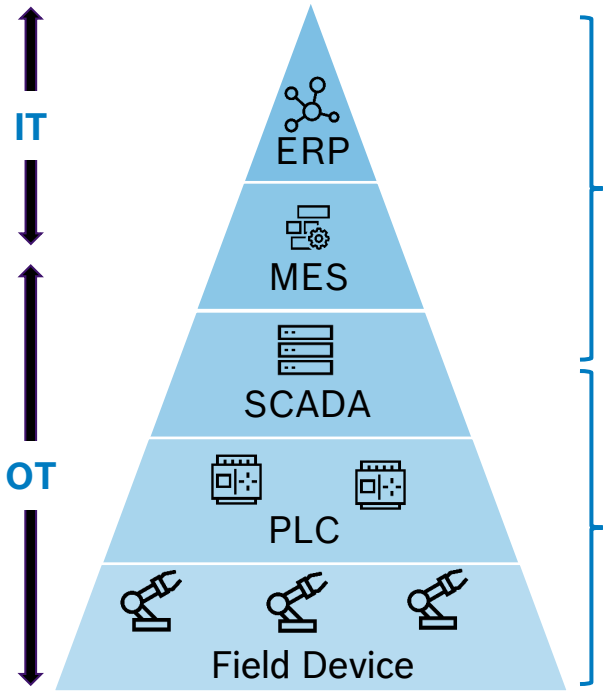
Dynamic Configuration of TSN for Industrial Applications

Motivation

Status Quo



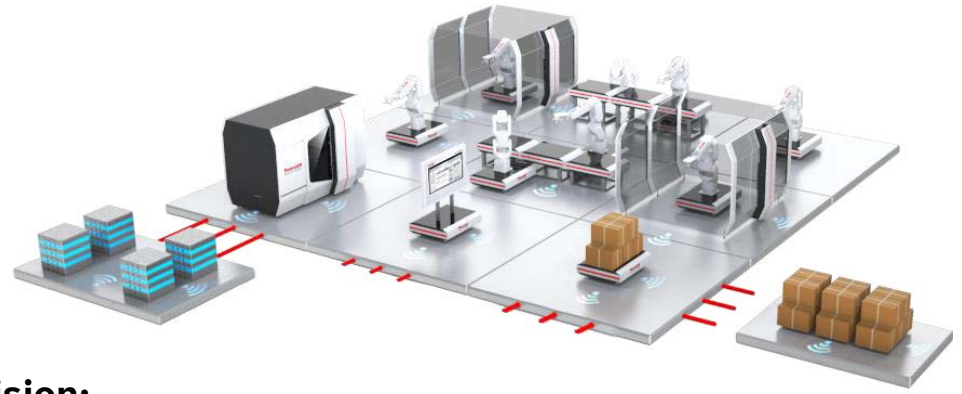
Ethernet

Industrial Ethernet

sercos the automation bus
ETHERNET POWERLINK
EtherNet/IP
CC-Link IE
PROFINET
EtherCAT Technology Group

➔ **Diverse non-interoperable standards w/o convergence**

Factory of the Future



Source: Rexroth

Vision:

- ❑ Machine functions migrating towards Edge/Cloud
- ❑ Modular / flexible production lines
- ❑ No vendor lock in through open standards
- ❑ Network convergence, i.e. IT/OT applications sharing a common substrate network

➔ **Need for new standards addressing future requirements**

ERP: Enterprise Resource Planning **MES:** Manufacturing Execution System **SCADA:** Supervisory Control and Data Acquisition **PLC:** Programmable Logic Controller
IT: Information Technology **OT:** Operation Technology

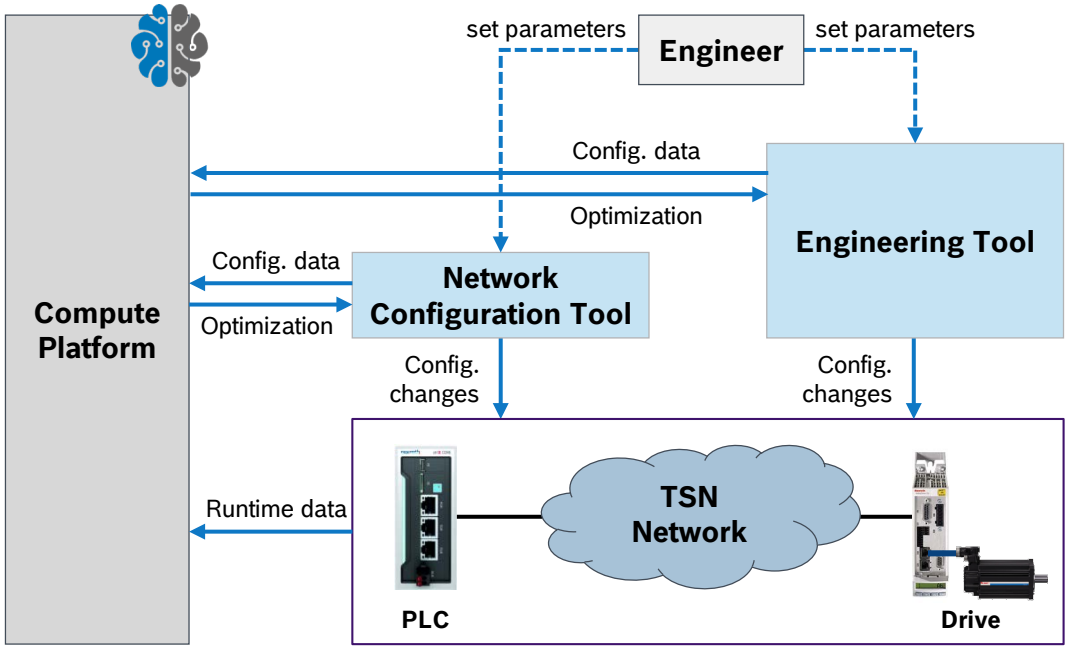
Dynamic Configuration of TSN for Industrial Applications
BMBF Project KITOS

KITOS

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Goal

Equip industrial networks with mechanisms to support self-healing & -optimization facilitating the required agility & reliability for future production processes.



Approach

- **Methods for dynamic configuration of TSN**
- **Adaptation and integration of configuration tools**
- **Development of a platform for assisted configuration**
- **Analysis and evaluation of relevant algorithms**

Consortium

BOSCH Technik fürs Leben
CODESYS
DFKI
rexroth A Bosch Company
hilscher COMPETENCE IN COMMUNICATION
TECHNISCHE UNIVERSITÄT DRESDEN
EBERHARD KARLS UNIVERSITÄT TÜBINGEN

-- associated ----------

HIRSCHMANN A BELDEN BRAND
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www.dfki.de/web/forschung/projekte-publikationen/projekte-uebersicht/projekt/kitos

TSN: Time Sensitive Networking **PLC:** Programmable Logic Controller **AI:** Artificial Intelligence

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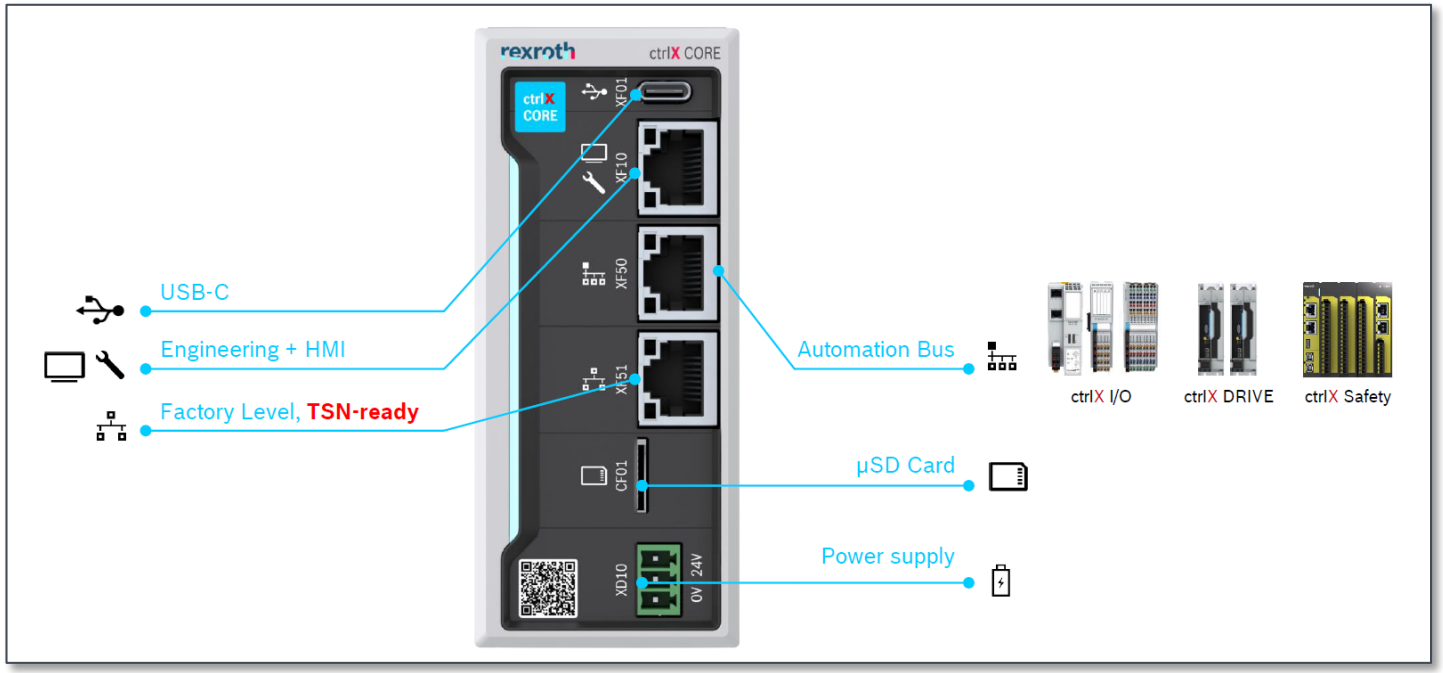
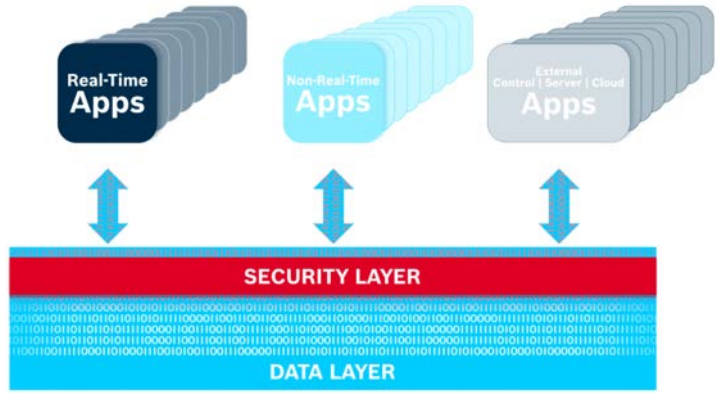
Dynamic Configuration of TSN for Industrial Applications
ctrlX Core – The Embedded Control Platform



Source: Rexroth

ctrlX Data Layer

Source: Rexroth



- Provides access to any **real-time and non-real-time** system and app data
- Supports the most important software protocols (e.g. REST HTTPS, OPC UA)

➔ Major Goals:

- **Enable & evaluate TSN capabilities of ctrlX Core**
- **Achieve integration into multi-vendor industrial network**
- **Identify novel network configuration & management concepts**

https://apps.boschrexroth.com/microsites/ctrlx-automation/en/portfolio/ctrlx-core/

TSN: Time Sensitive Networking

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Dynamic Configuration of TSN for Industrial Applications
Use Cases – Methodology

Valuable sources for use cases & requirements in context of time-sensitive communication, e.g.:

- Use Cases IEC/IEEE 60802
- 3GPP TR 22.804
- 5G-ACIA Whitepapers

Lots of relevant use cases, yet not focusing on management of volatile TSN networks.

Our approach:

		Use Cases			
		UC 1	**UC 2**	**UC 3**	**...**
Problem Statements	**PS 1**	Scenario 1.1	Scenario 2.1-1 Scenario 2.1-2	-	-
	PS 2	Scenario 1.2	-	Scenario 3.2-1 Scenario 3.2-2	-
	PS 3	Scenario 1.3-1 Scenario 1.3-2	Scenario 2.3	-	-
	...	...	...	...	...

Problem Statements	Challenge
Initial configuration	To find appropriate TSN configuration parameters.
Reconfiguration & optimization	To find optimal TSN configuration options.
Extending networks	To adapt the configuration to new requirements & constraints.
Heterogeneous networks	To address fragmentation in network topologies & infrastructure features.
Condition monitoring	To detect performance degradation & predict failures.
...	...

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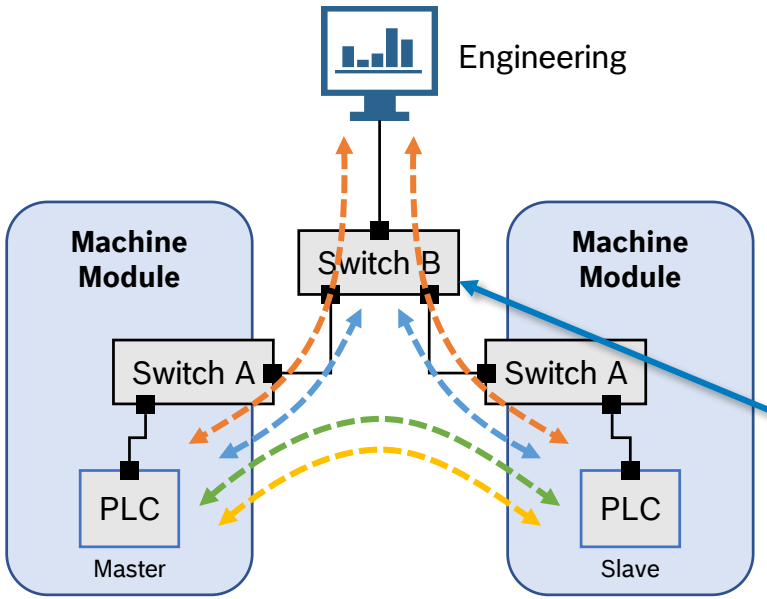
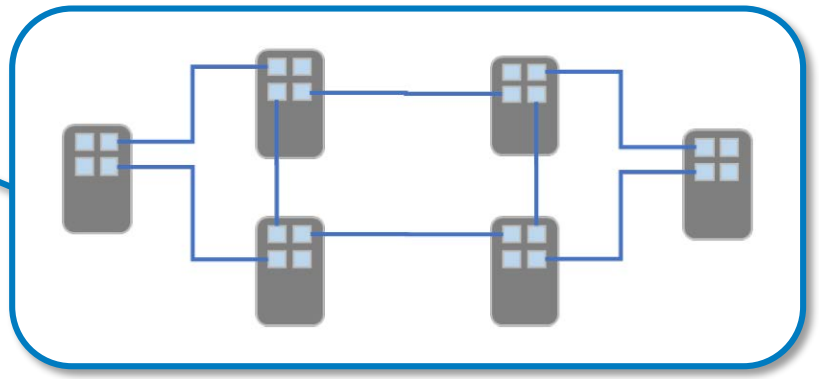
Use Cases – Control-to-Control



Source	Target	Type
PLC (Master)	PLC (Slave)	Isochronous
PLC (Slave)	PLC (Master)	Isochronous
PLC (Master)	PLC (Slave)	Acyclic
PLC (Slave)	PLC (Master)	Response
Engineering tool	Ctrl. / Dev	Acyclic
Ctrl. / Dev	Engineering Tool	Response
Sync master	Sync slave	Cyclic



Switch B represents a network infrastructure

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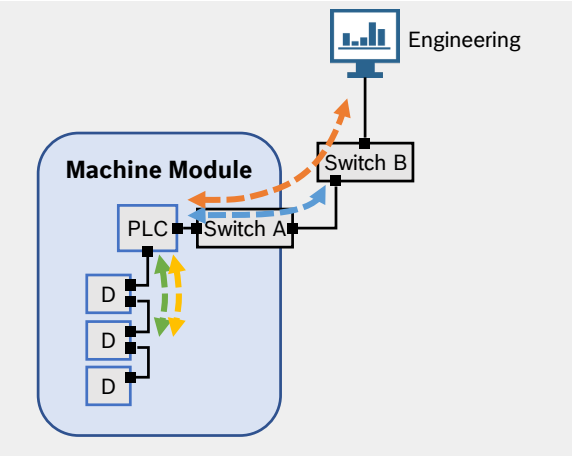
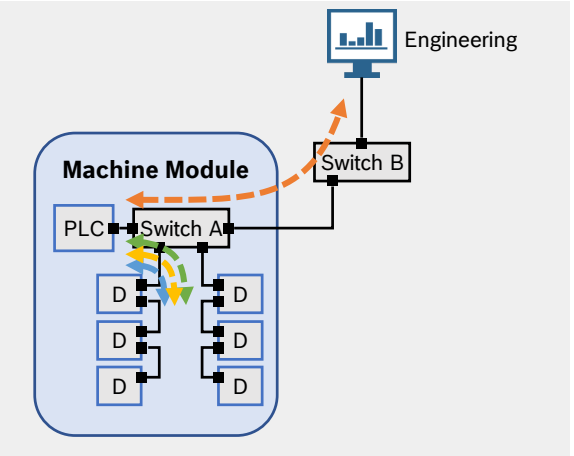
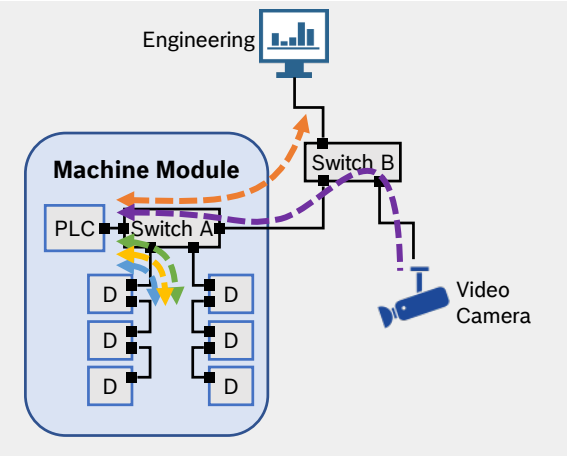
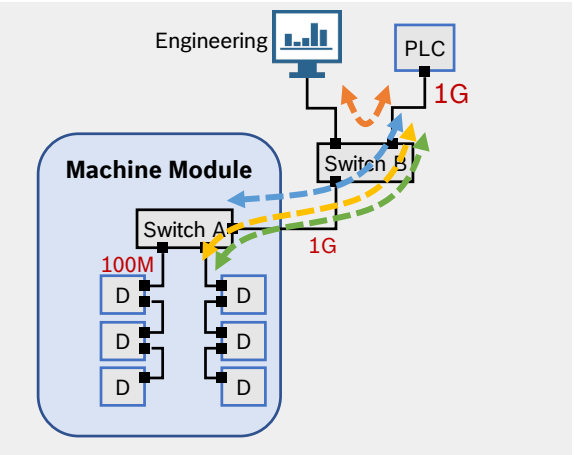
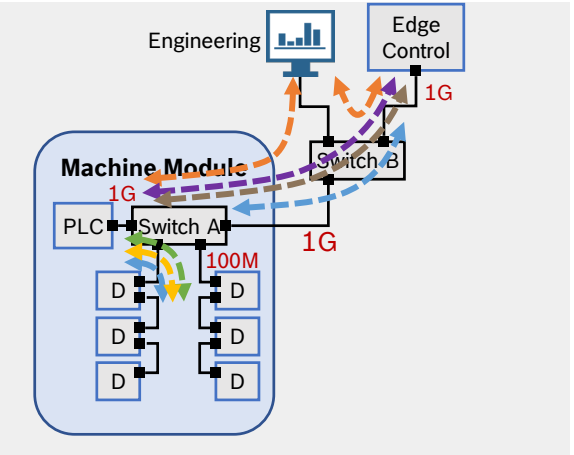
Use Cases – Other Examples

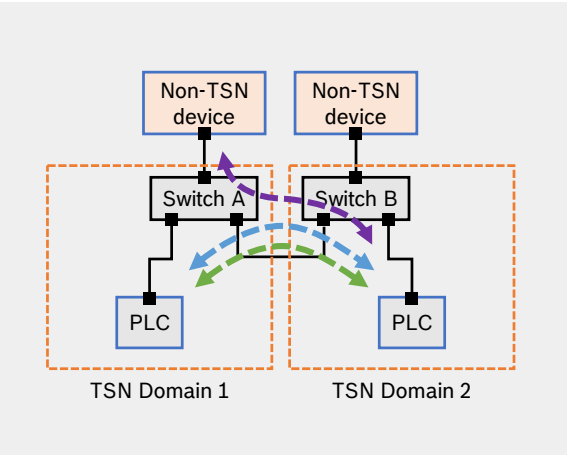












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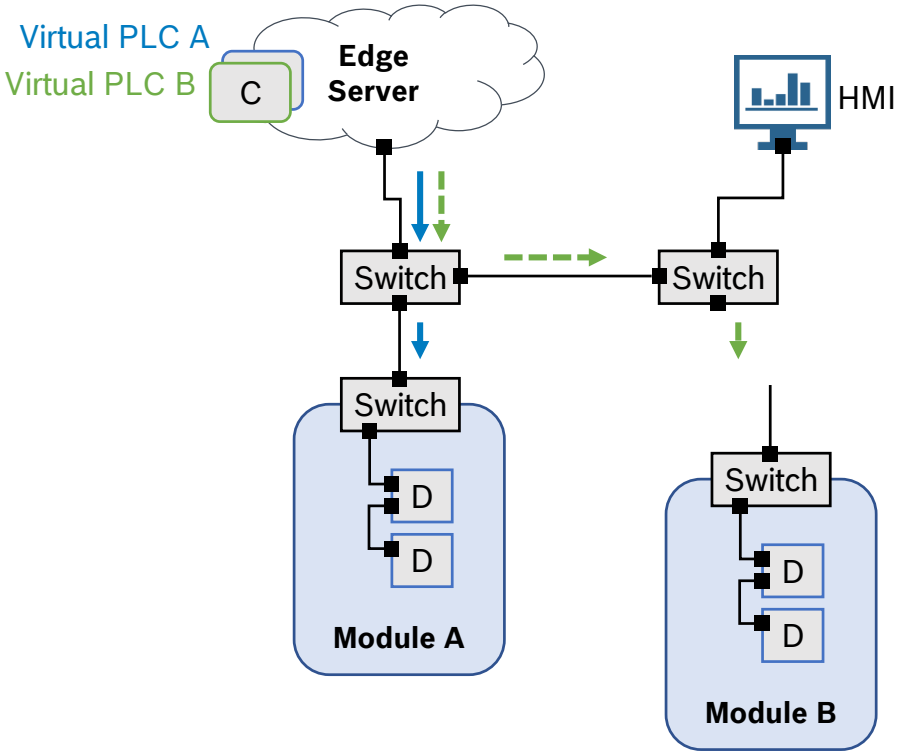
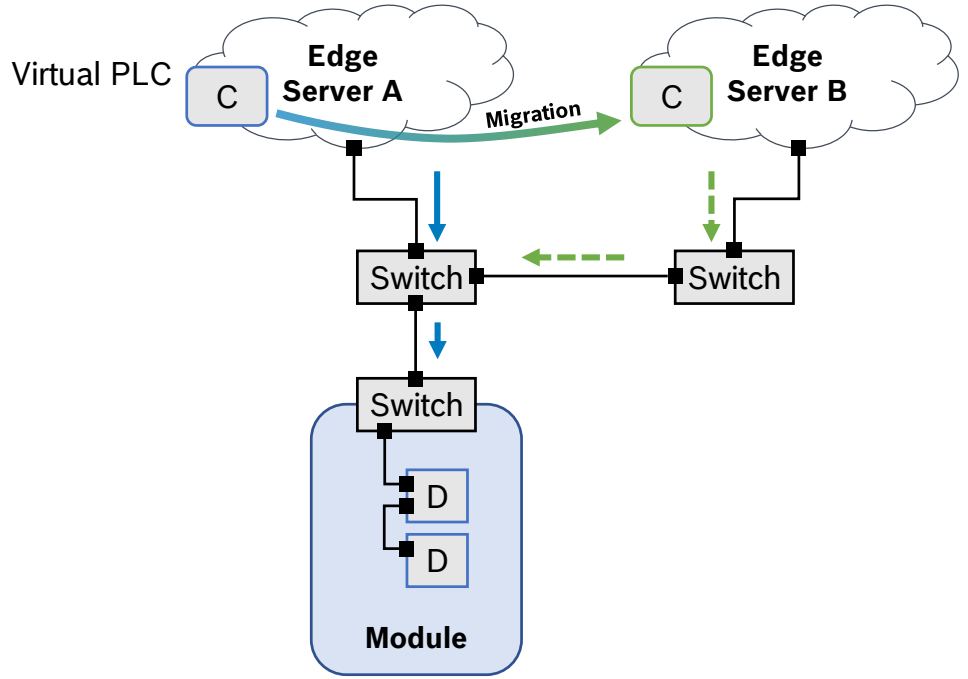
Examples for Dynamic Configuration

Adding / Removing Machine Modules



Migrating Edge Applications



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Dynamic Configuration of TSN for Industrial Applications
Conclusion

There is a strong need for new standards like, e.g., OPC UA FX & IEC/IEEE 60802 addressing future requirements.

Interoperability enabling multi-vendor industrial networks is an end customer requirement.

TSN comes with lots of opportunities for future use cases, but complexity needs to be addressed.

Research projects like KITOS are targeting at flexibility in configuring industrial networks.

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Thank You!

Still Curious?

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