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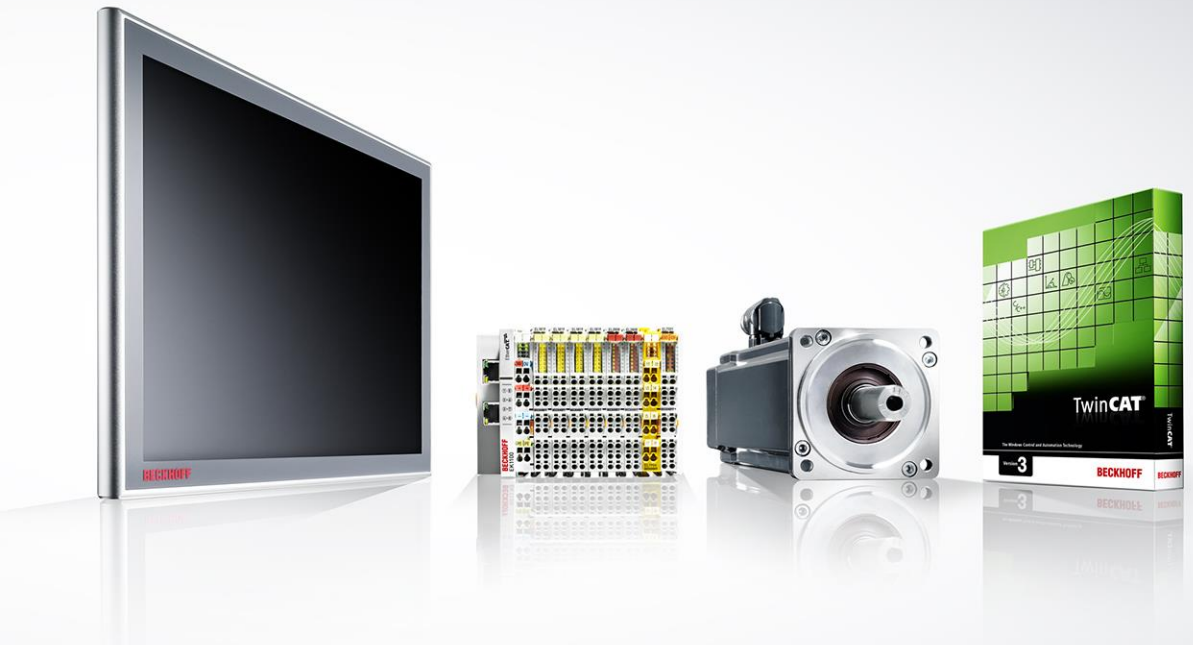
Forming new ecosystems for the Digital Transformation

Challenges and opportunities for a medium-sized company to shape the international automation landscape

Dr. Guido Beckmann
Senior Management
Control System Architecture



Storyline

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1. Beckhoff Automation

2. Digital Transformation

3. Opportunities for a medium-sized automation supplier
   - Shaping own standards
   - Integration in complementary technologies
   - Staying ahead through innovations
   - Supporting international acting customers

4. Summary

Beckhoff | Facts and figures

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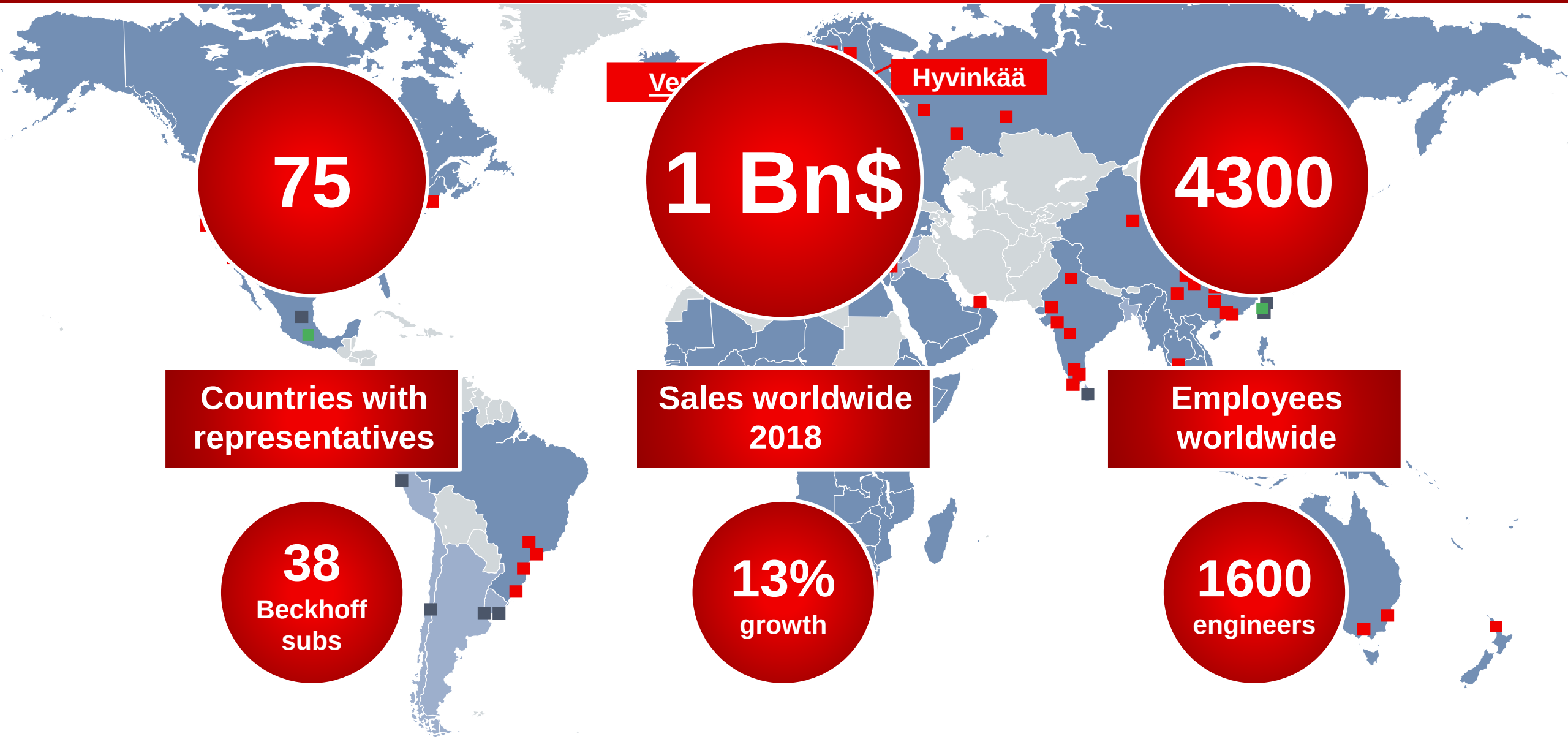

75

Countries with representatives

1 Bn$

Sales worldwide 2018

4300

Employees worldwide

38
Beckhoff subs

13%
growth

1600
engineers

Beckhoff | New Automation Technology

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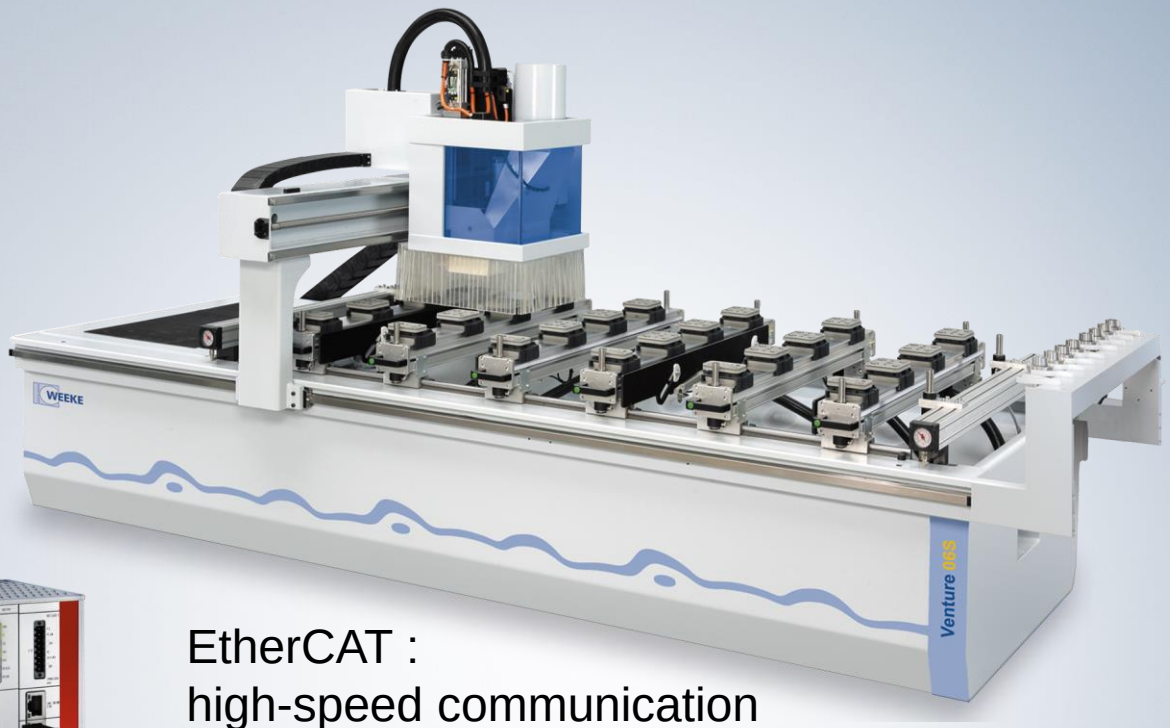
Expertise & Support

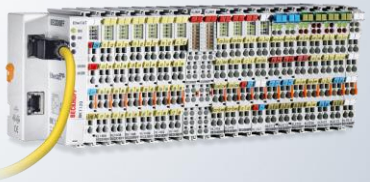


Control Panel

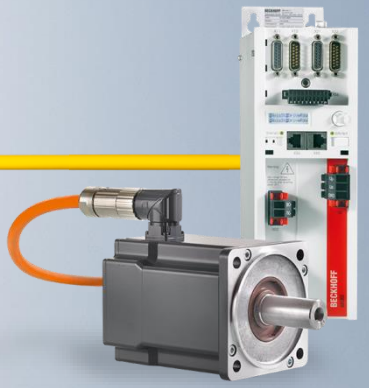
Industrial PC (PLC, Motion Control)

EtherCAT : high-speed communication

TwinCAT: control & real-time software



Bus Terminals



Drive Technology

Digital Transformation | Industrie 4.0 et al.

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Digital Transformation | Life cycle and Hierarchy Levels

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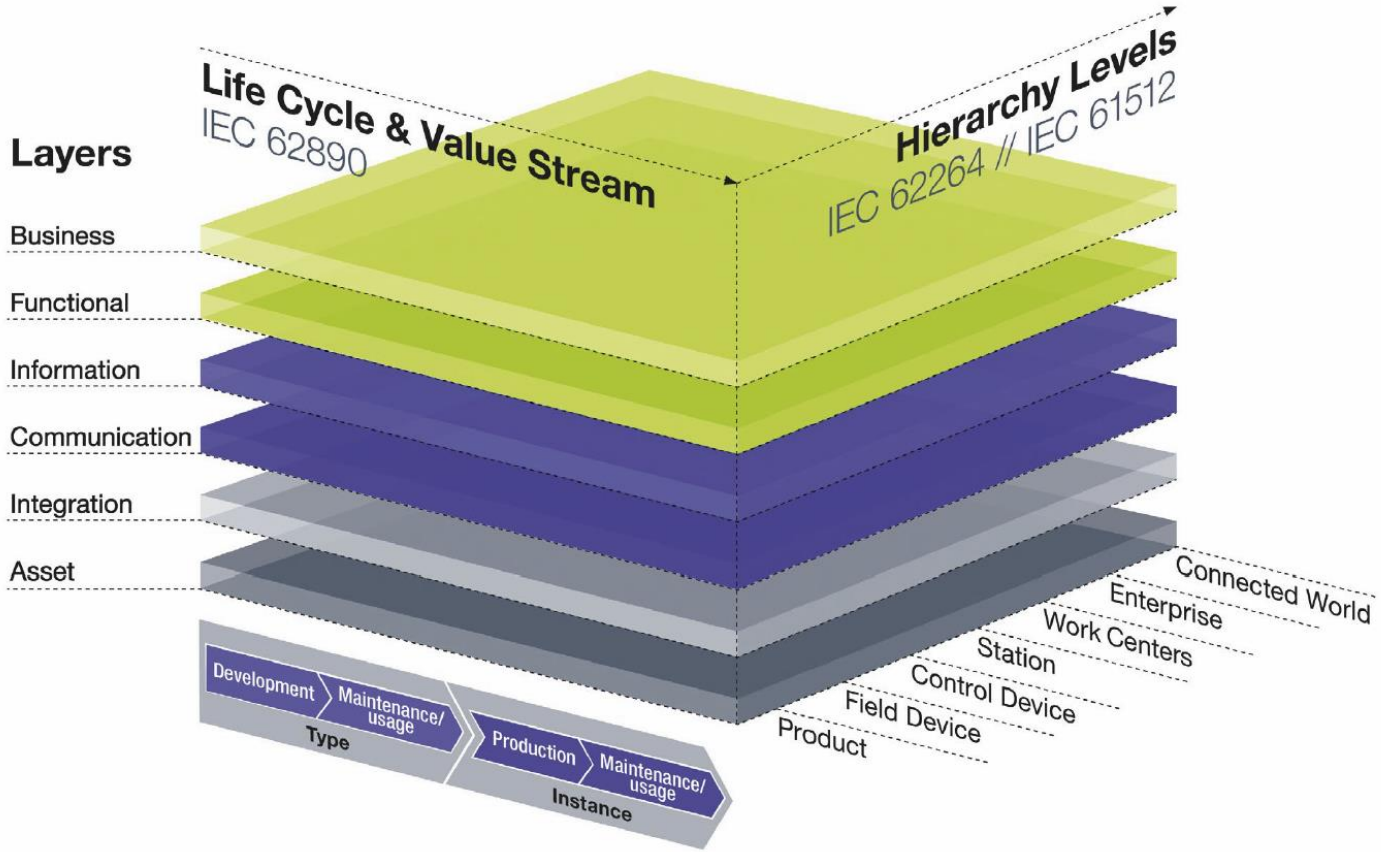
Marketing | Engineering | Simulation | Production | Logistic | Application | Service



Reference Architecture Model Industrie 4.0 (RAMI 4.0) *)

*) Implementation Strategy Industrie 4.0

Digital Transformation | All about data and communication…

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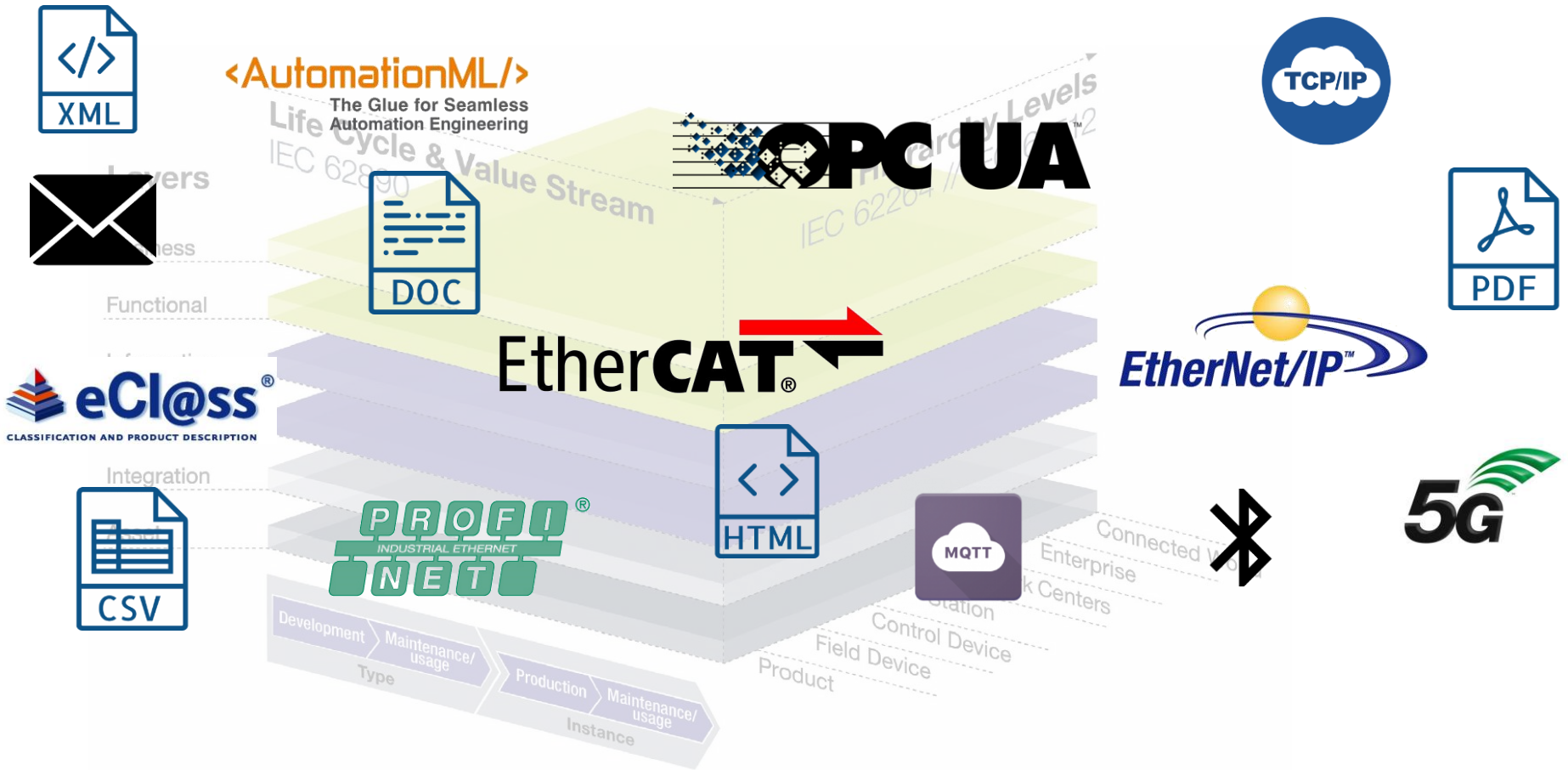
Marketing | Engineering | Simulation | Production | Logistic | Application | Service

Automation Supplier

Machine Builder

End User



Digital Transformation | All about data and communication…

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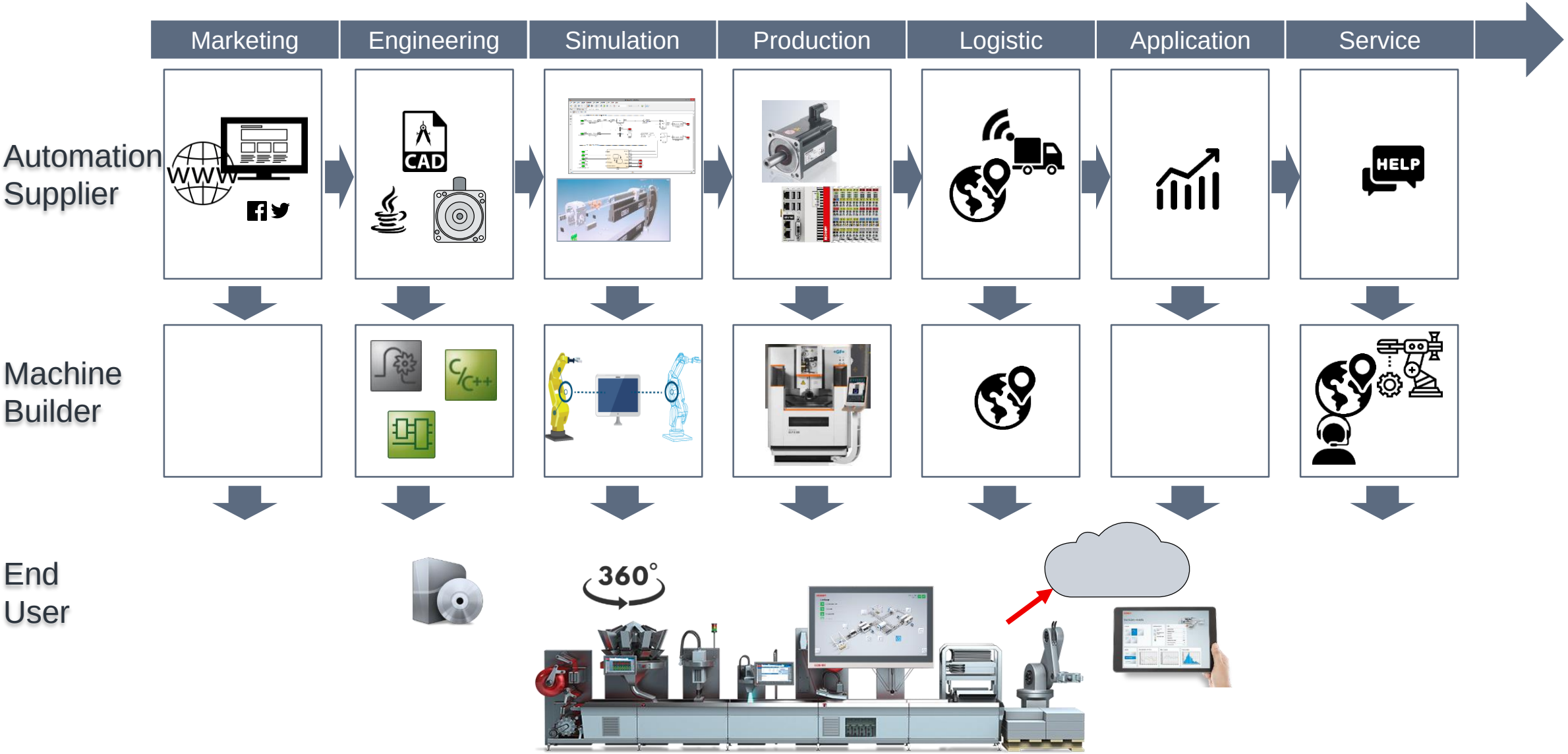

PC Control | Unified Universal Automation Platform

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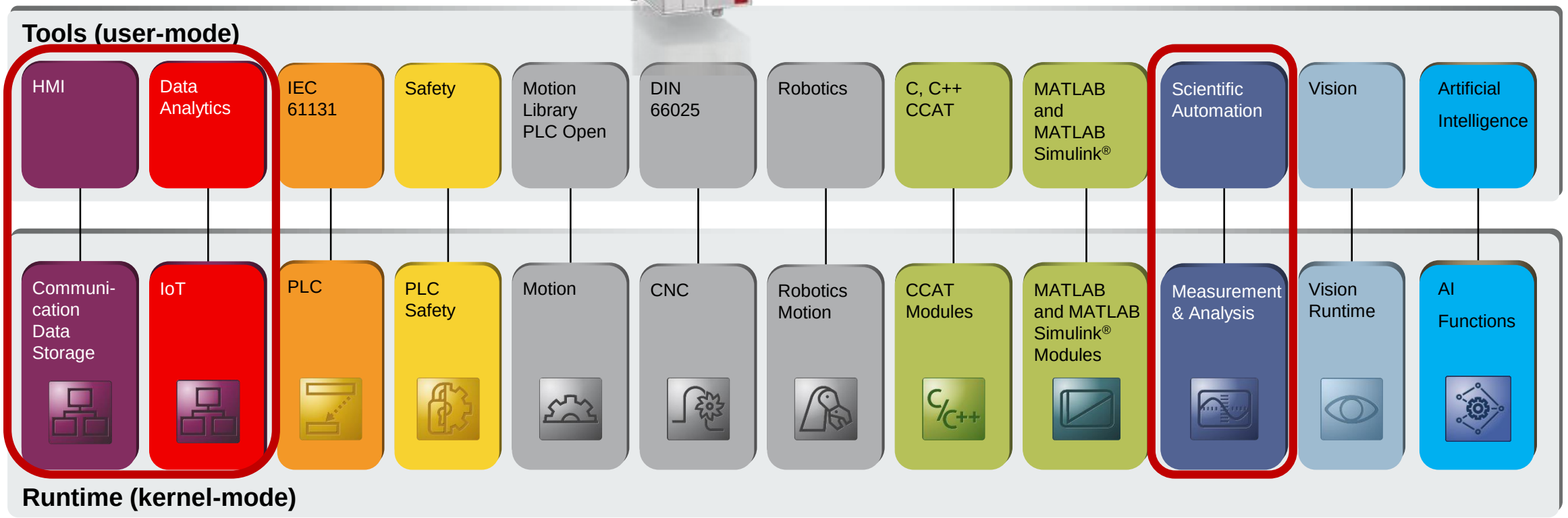
- PC-based Control
- Real-time Software solutions



Cloud scenarios

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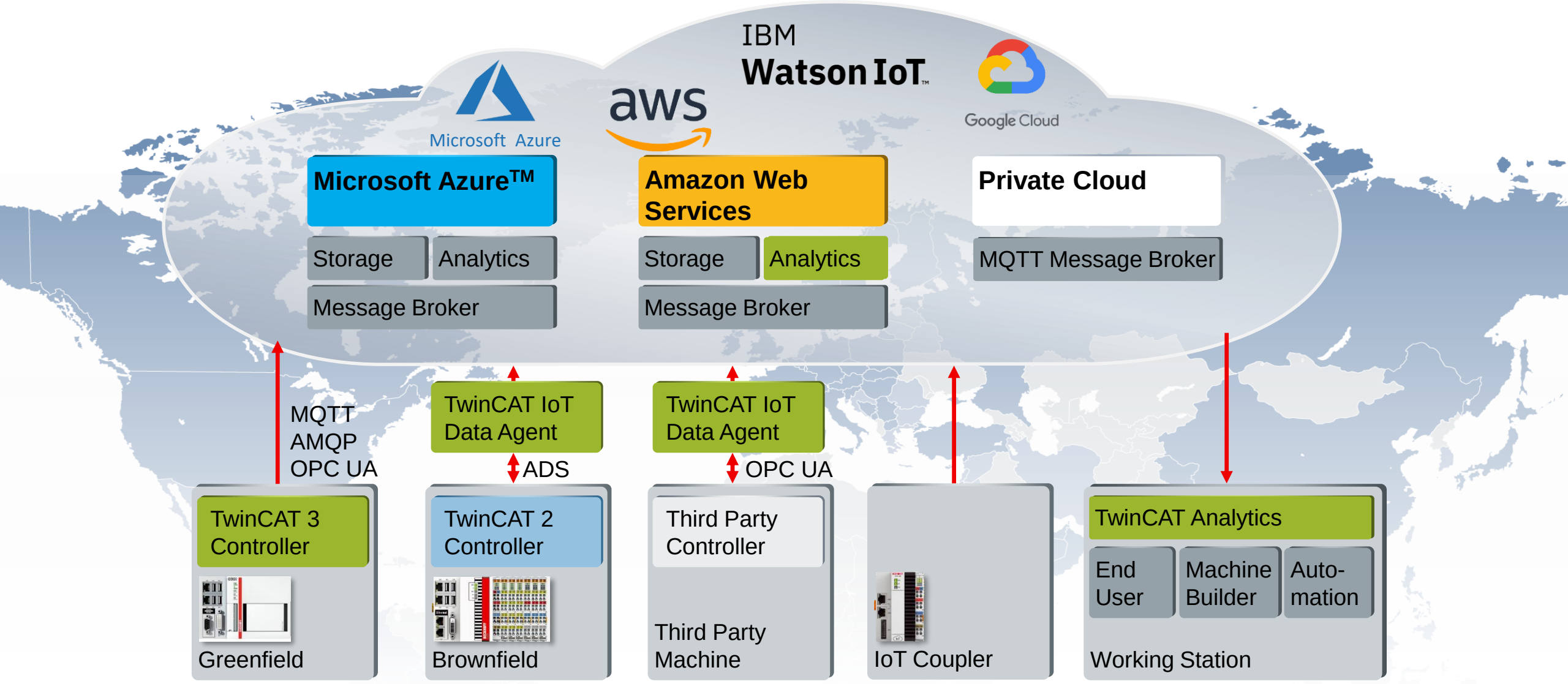

PC Control | Unified Universal Automation Platform

BECKHOFF

- PC-based Control
- Real-time Software solutions

Tools (user-mode)

HMI | Data Analytics | IEC 61131 | Safety | Motion Library PLC Open | DIN 66025 | Robotics | C, C++ CCAT | MATLAB and MATLAB Simulink® | Scientific Automation | Vision | Artificial Intelligence

Communi-cation Data Storage | IoT | PLC | PLC Safety | Motion | CNC | Robotics Motion | CCAT Modules | MATLAB and MATLAB Simulink® Modules | Measurement & Analysis | Vision Runtime | AI Functions

Runtime (kernel-mode)

TwinCAT 3 Machine Learning

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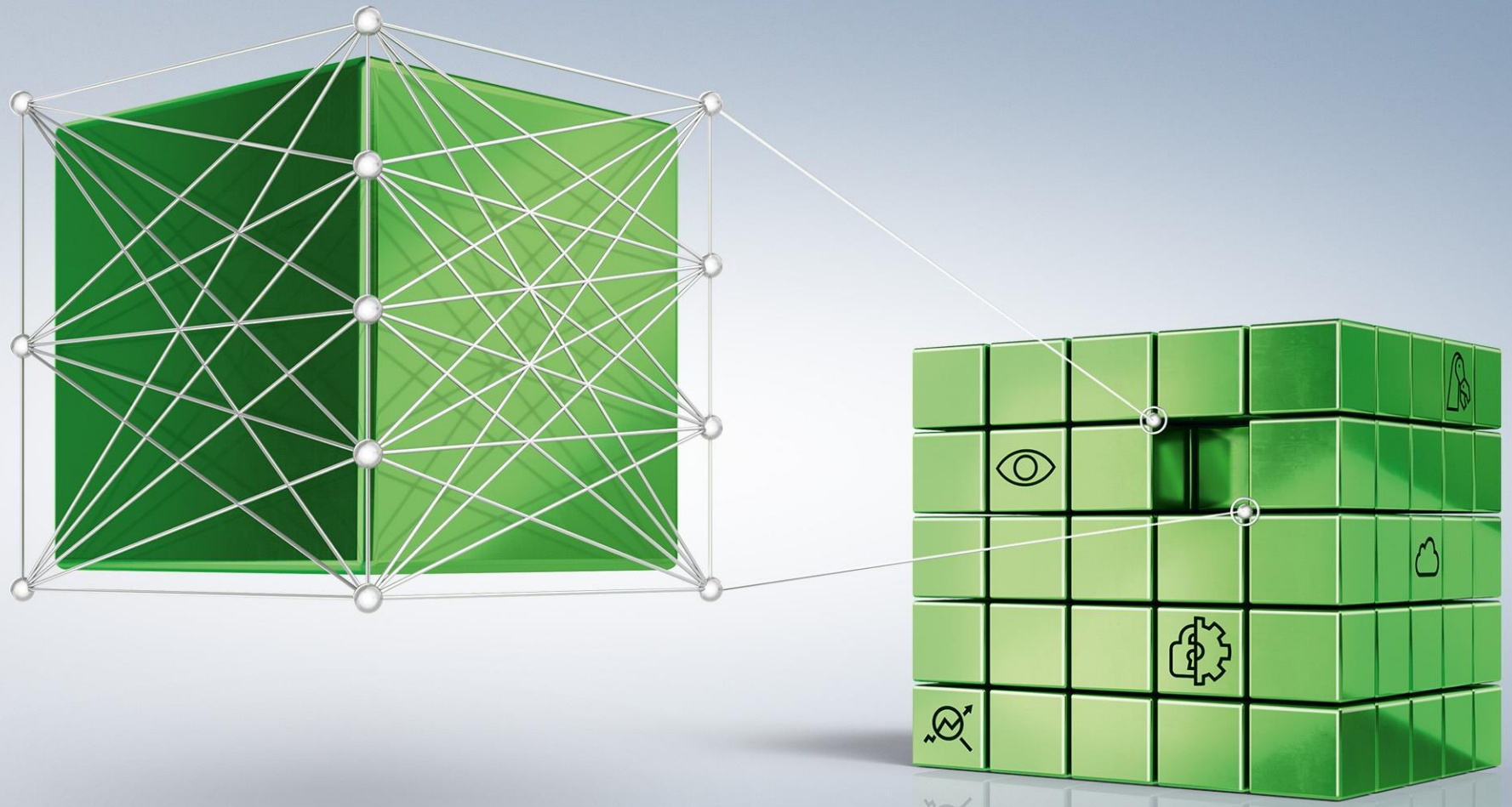

Wording | AI – ML - DL

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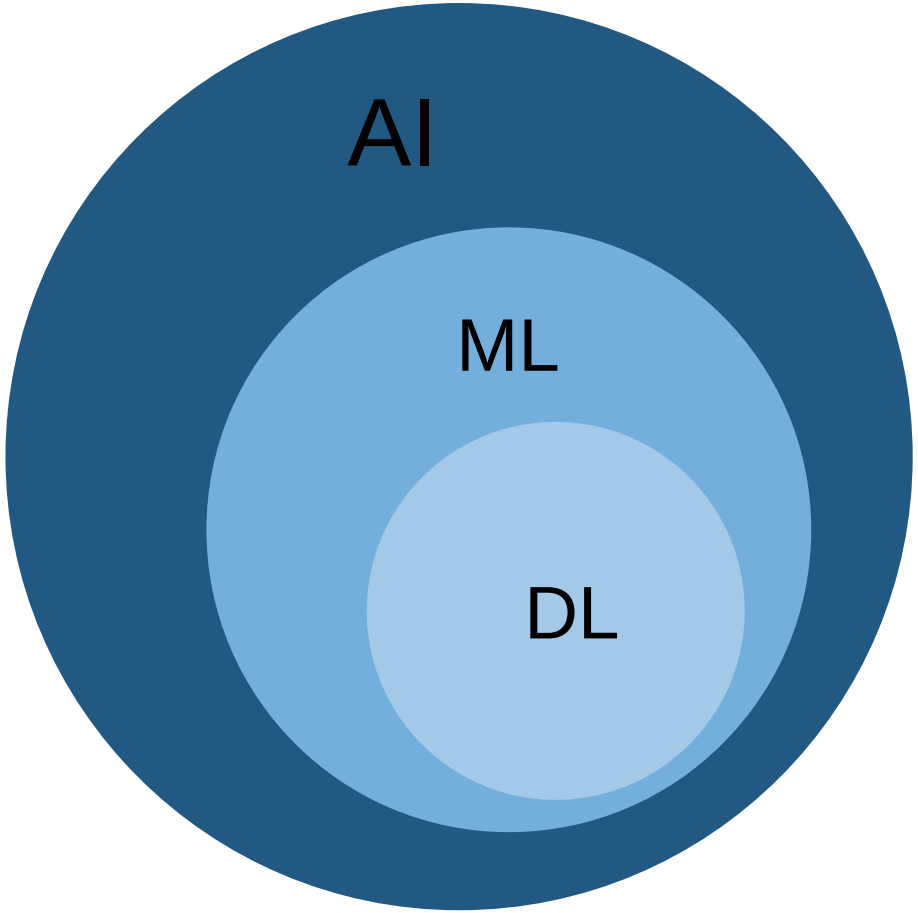
- Artificial Intelligence (AI)
  - Artificial agent that can mimic human like intelligence
  - Distinguish between week and strong AI
- Machine Learning (ML)
  - Concept to reach (weak) AI
  - Based on mathematical models that can learn a certain task by training data
  - Mainly based on optimization of models
- Deep Learning (DL)
  - Focus on Deep Neural Networks (DNN) as models
  - Complex models that need huge data sets for training
  - Powerful in Vision applications



Machine Learning
High Level

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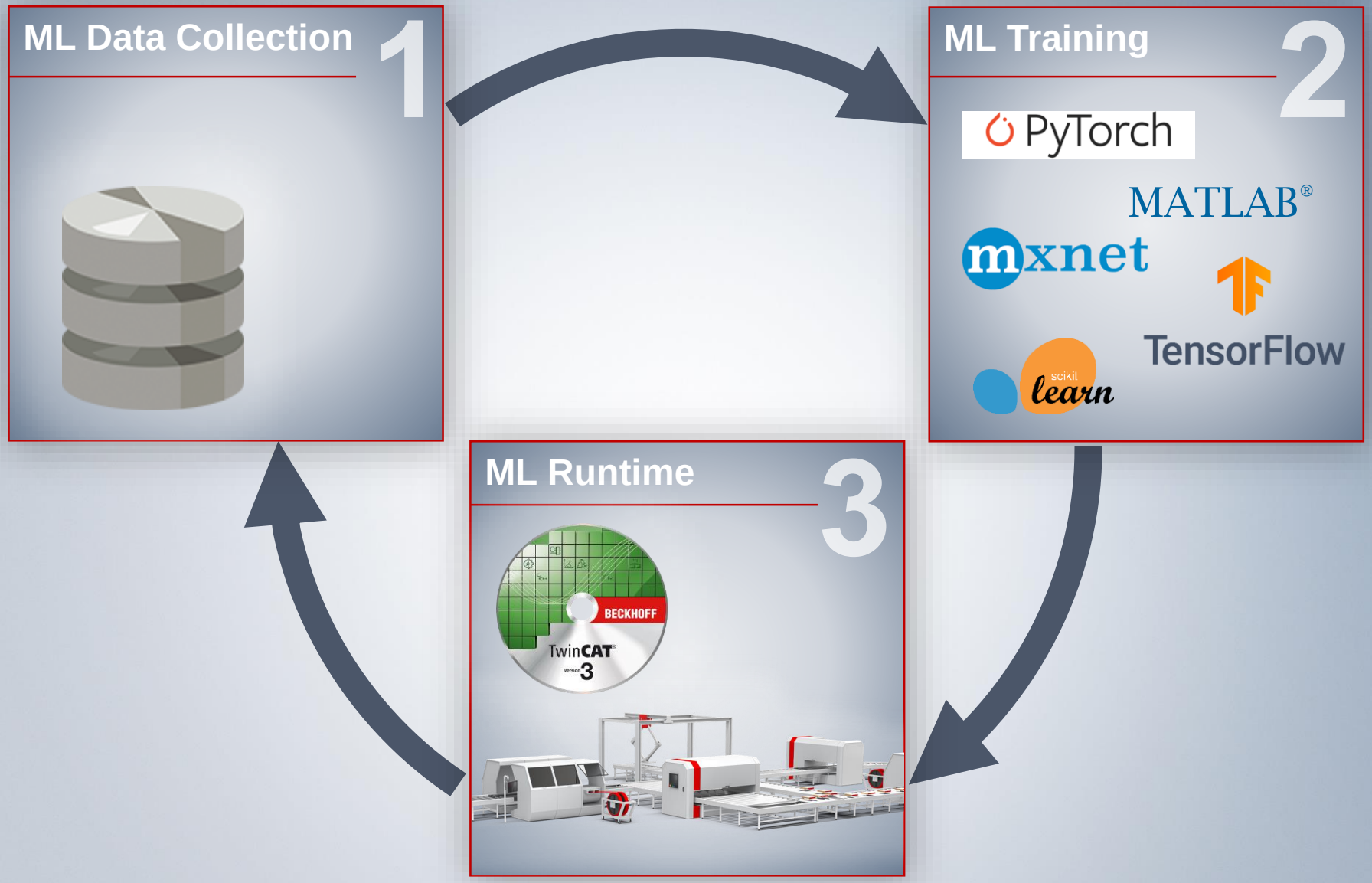

Machine Learning
Data collection

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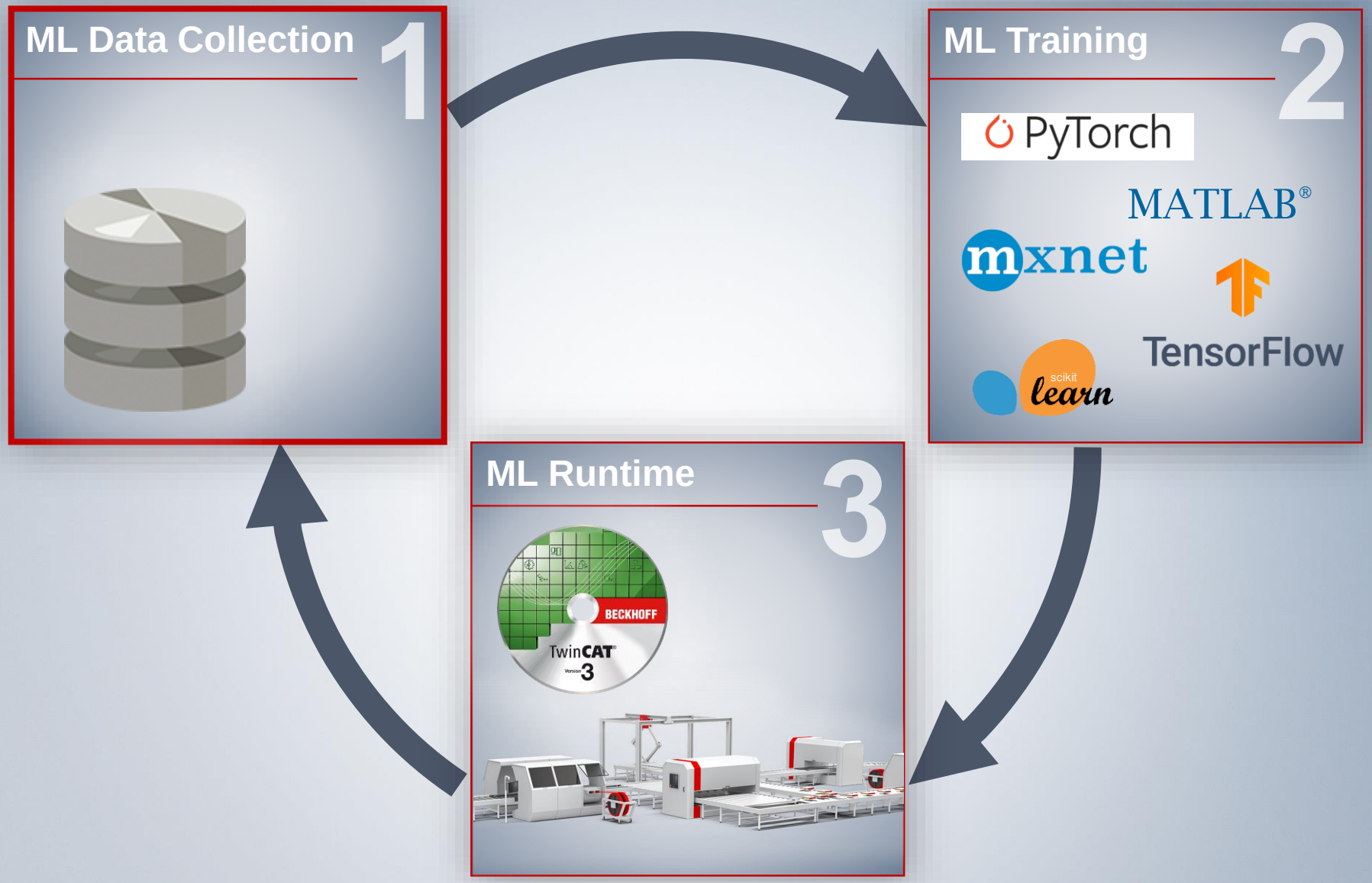

Machine Learning
Data collection

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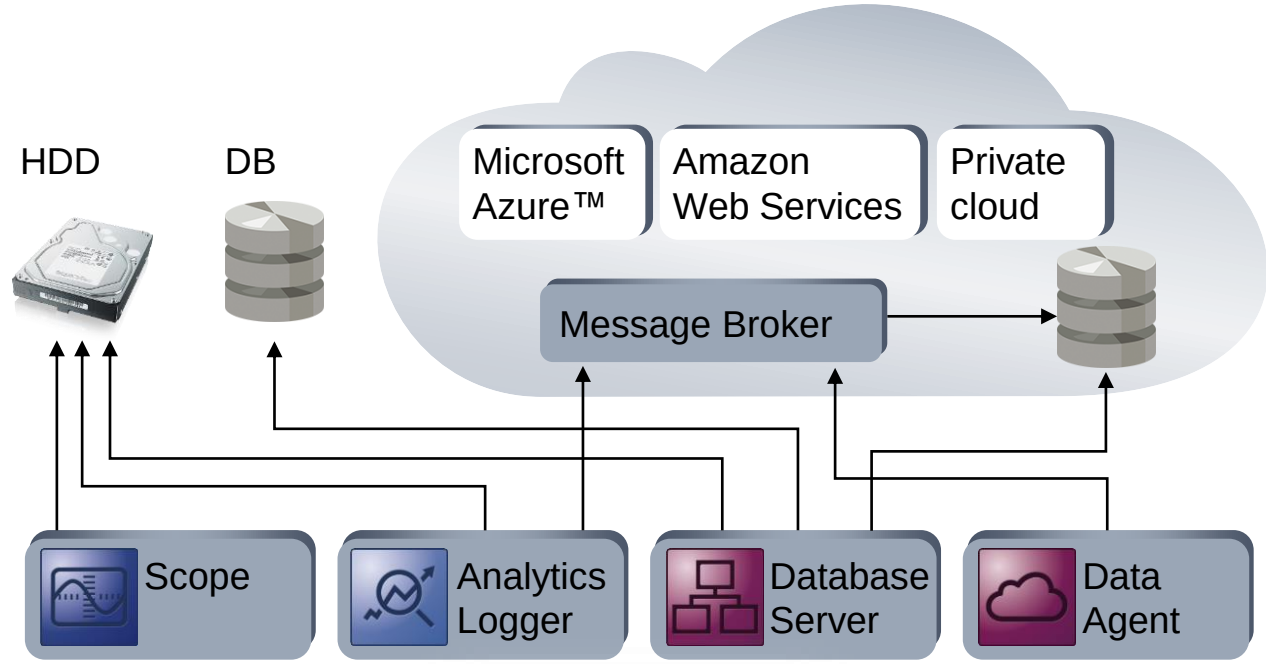
- Machine Learning relies on data.
- use of common Beckhoff products
  - TC3 Scope
  - TC3 Database Server
  - TC3 Data Agent
  - TC3 Analytics Logger
  - …
- Product selection depends on application:
  - long-term data collection?
  - access to source code of machine?
  - sample rate and amount of data?
  - …



Machine Learning
Training

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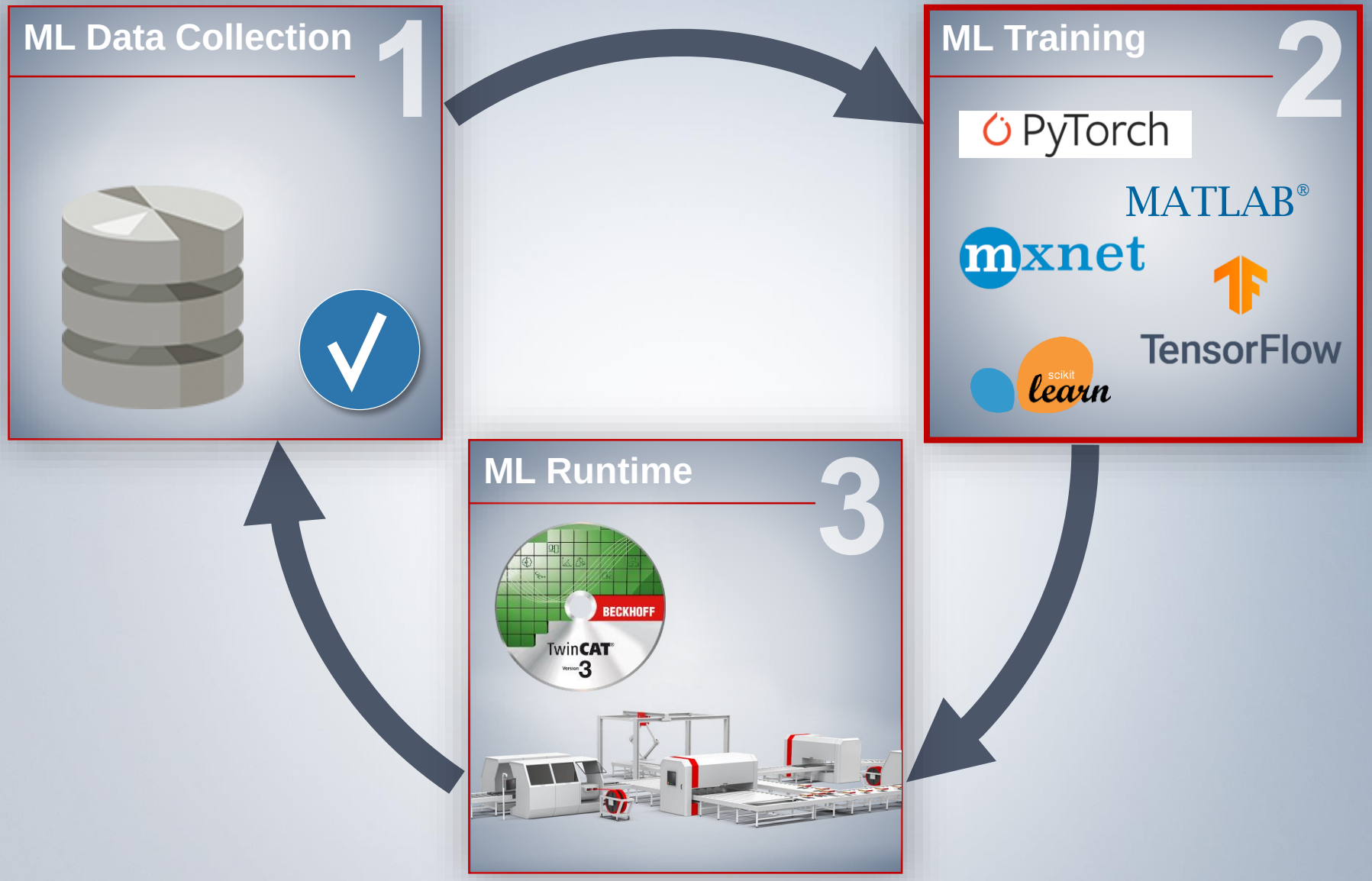

ML Training
What does the data scientist do?

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General process of data crunching within the framework:

Data preparation

- outliers, transformation, …

Modeling

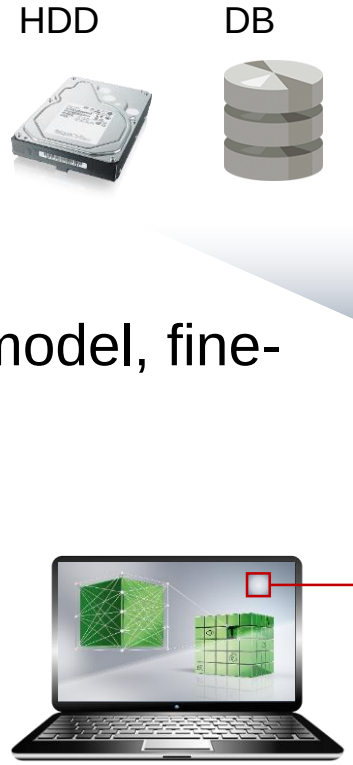
- model selection, fine-tune the model, fine-tune the learning, …

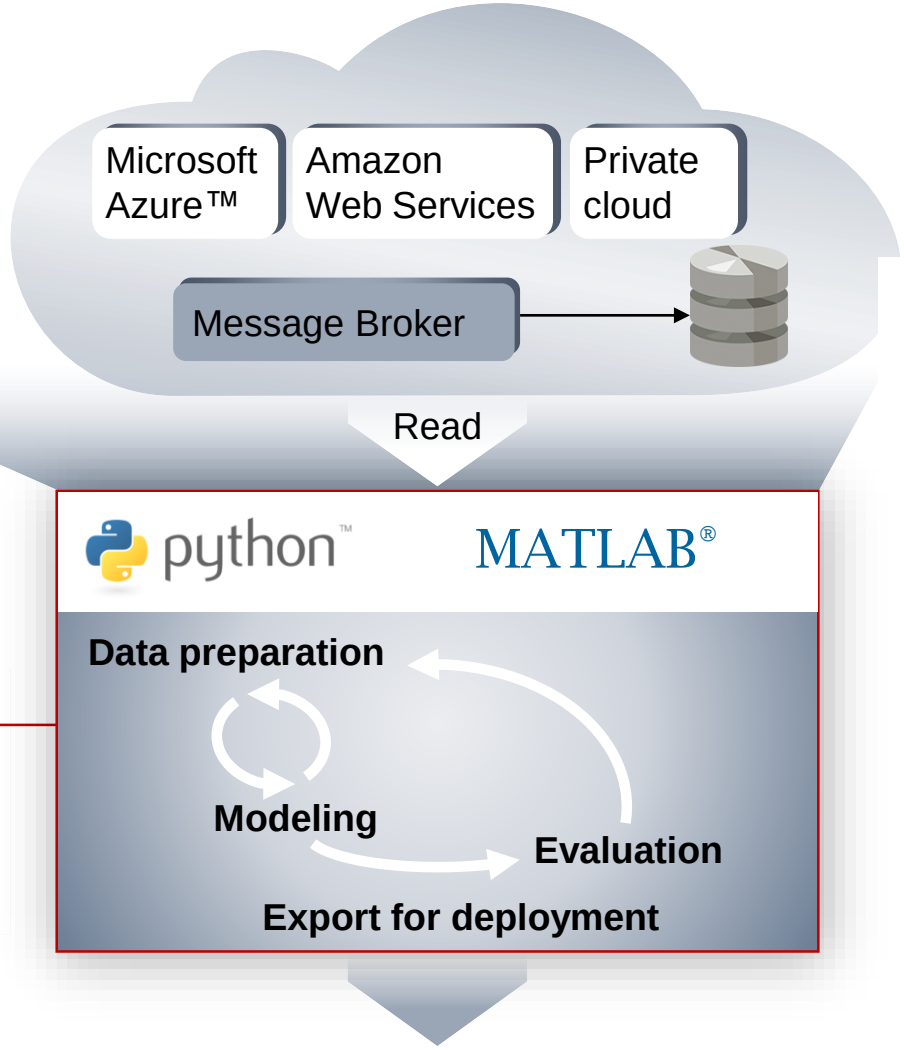
Evaluation

- validation of learned model based on unknown data

Deployment

- creating a description file for TwinCAT 3





python
MATLAB®
Caffe2
TensorFlow
PyTorch
PaddlePaddle
mxnet
scikit learn

Machine Learning | Artificial Intelligence in the runtime

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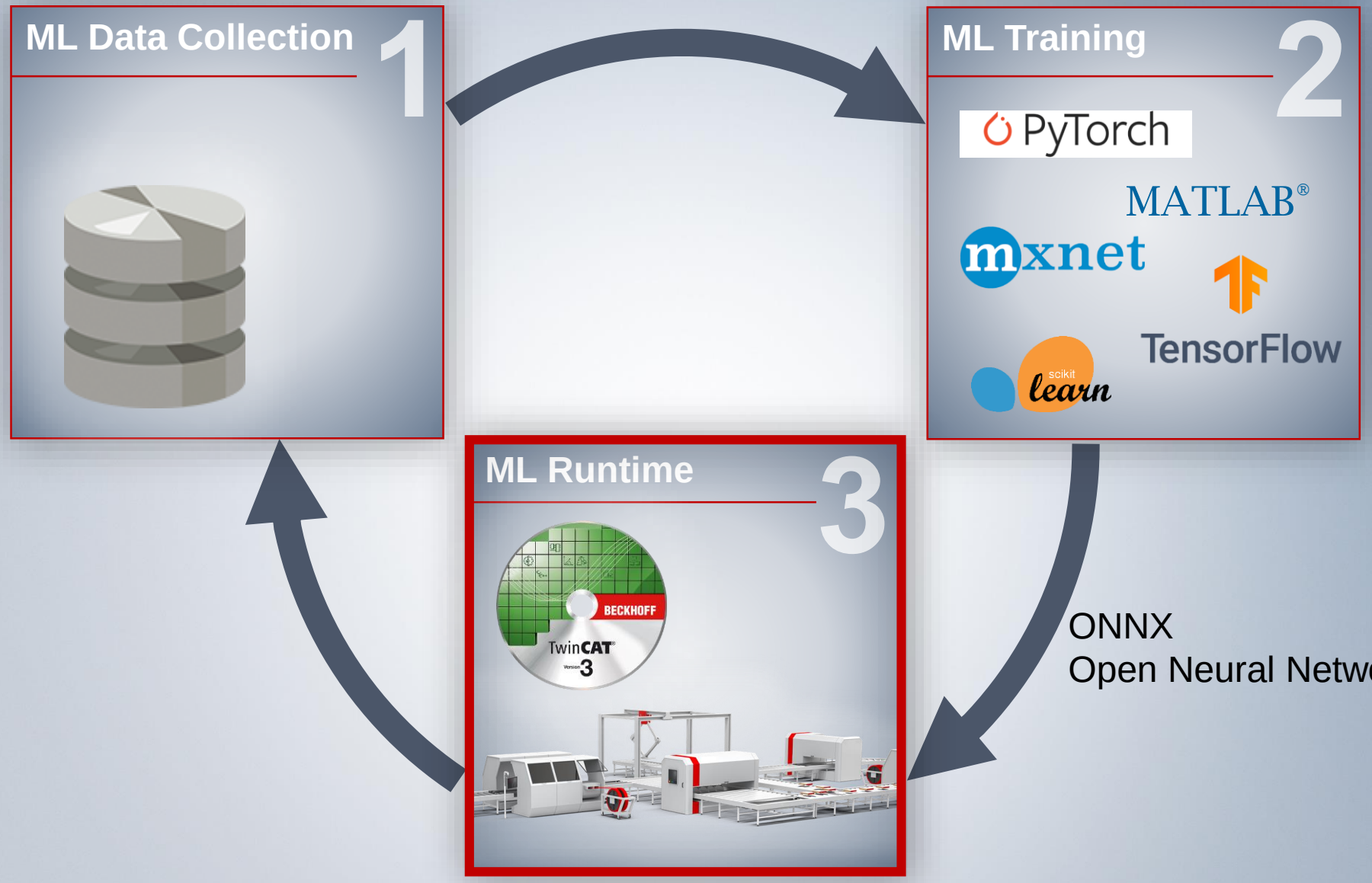

Neural motion profile
In Motion

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International automation business

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Connectivity

Openness

Agility

People

Leading Technologies

Competiveness

System provider

Opportunities arising from the Digital Transformation

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- Defining own world-standards

EtherCAT | The Ethernet Fieldbus

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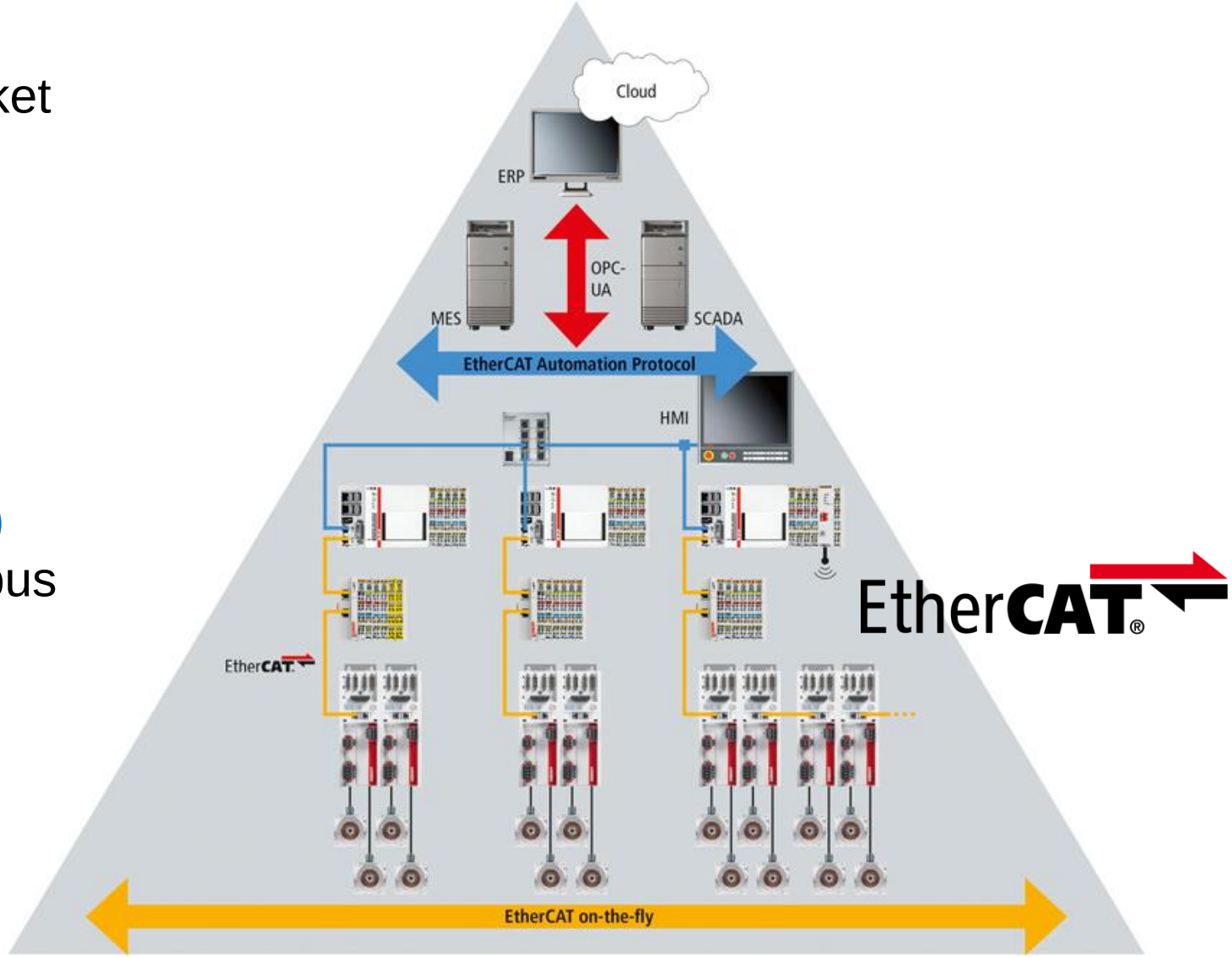
- EtherCAT is the fastest Industrial Communication System in the market
  - I/O cycle time down to 10 µs
- Beckhoff developed and published EtherCAT in 2003
- EtherCAT Technology Group (ETG) is the world largest Industrial Fieldbus organization



EtherCAT Technolog Group Members worldwide

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As of April 1, 2019:

ETG members from

65 countries and 6 continents

EtherCAT G: Processing on the fly now with 1 Gbit/s and 10 Gbit/s!

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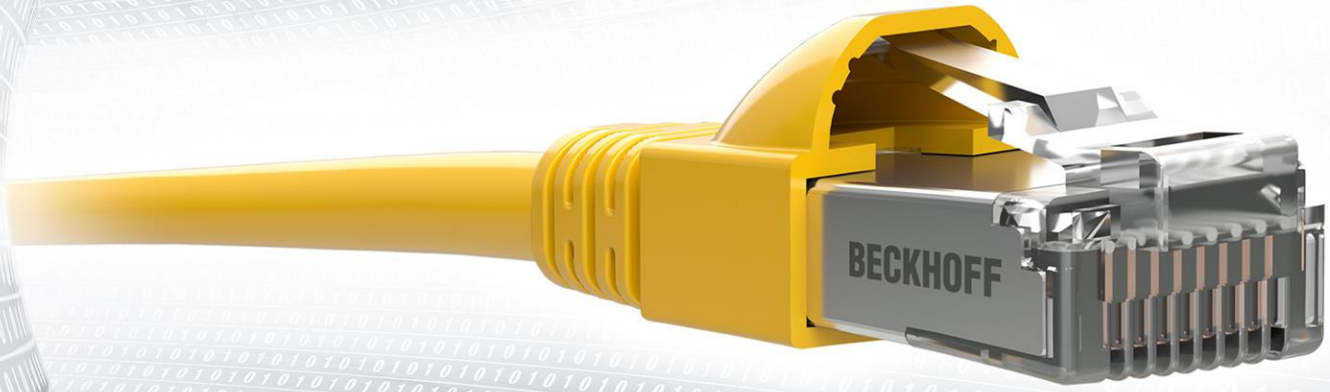
Enhancement published on
SPS/IPC/Drives November 2018



10 Gbit/s
1 Gbit/s
100 Mbit/s

EtherCAT® G

Opportunities arising from the Digital Transformation

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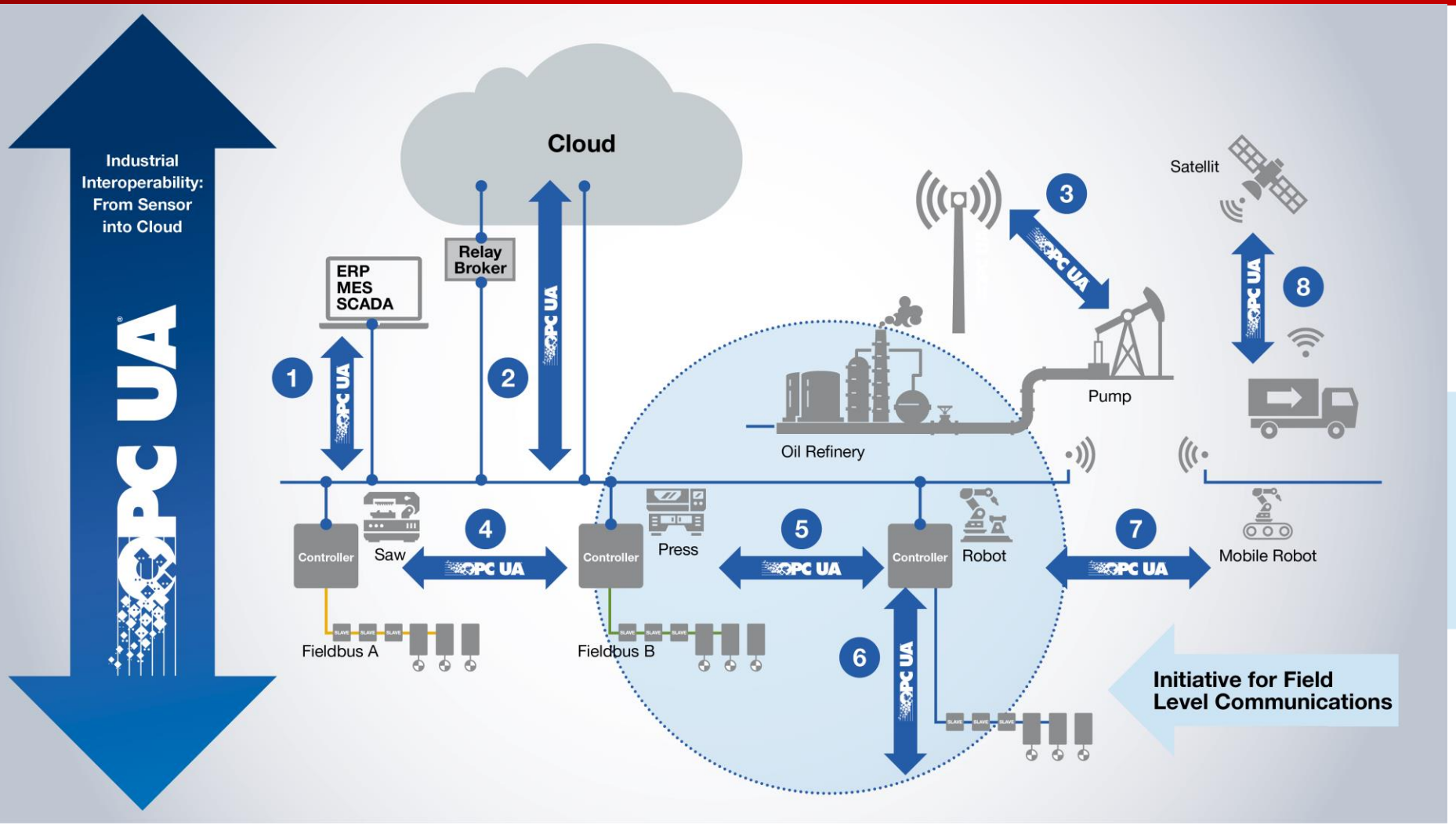
- Defining own world-standards
- Integration in complementary technologies

OPC UA | Connecting Industries



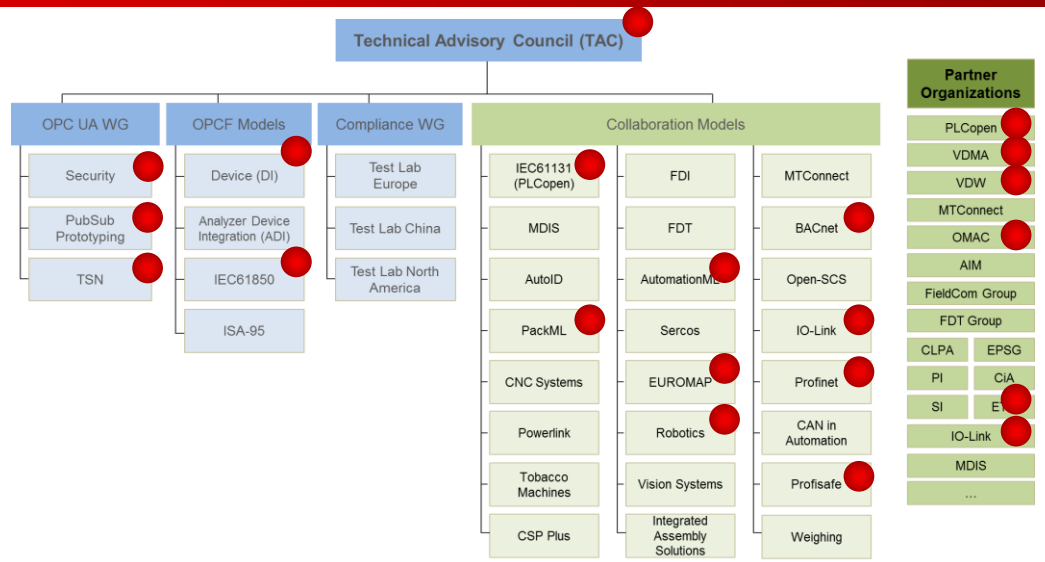
1. IT / OT Communication
2. Cloud Integration
3. Secure Remote Access
4. Local OT Communication
5. Controller to Controller
6. Controller to Field Device
7. Wireless Integration (5G)
8. Future Ready

Integration in complementary standards | OPC UA

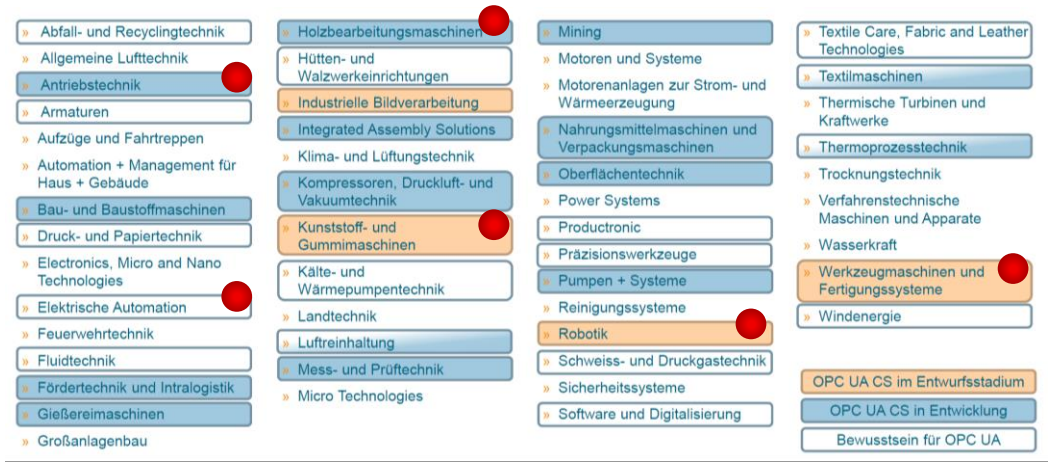
- OPC is *the* interoperability standard for the secure and reliable exchange of data in the industrial automation space and in other industries

- Beckhoff is actively forming the OPC UA standard
  - Stefan Hoppe is President of OPC Foundation
  - Beckhoff is member of several working groups

- OPC for Field Level Communications
  - Initiative started in November 2019
  - Beckhoff is founding member
  - Machine-2-Machine communication
  - For Factory and Process Automation



OPC Foundation working Groups



VDMA Companion specifications

Integration in complementary standards | Further Activities (examples)

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- International Standardization
  - IEC Standardization
  - IEEE Standardisation
  - Integration of EtherCAT and TSN

- 5G-ACIA
  - 5G Alliance for Connected Industries and Automation

- VDMA
  - Mechanical Engineering Industry Association
  - VDMA Electrical Automation Board member

- Open Industry 4.0 Alliance

OPEN INDUSTRY 4.0 ALLIANCE

Opportunities arising from the Digital Transformation

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- Defining own world-standards
- Integration in complementary technologies
- Staying ahead through innovations

Beckhoff strategy | Technology leadership

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- New approaches for motion
  - XPlanar
  - XTS | eXtended Transport System

Flying Motion: XPlanar

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XPlanar principle:
free-floating movers for non-contact movement

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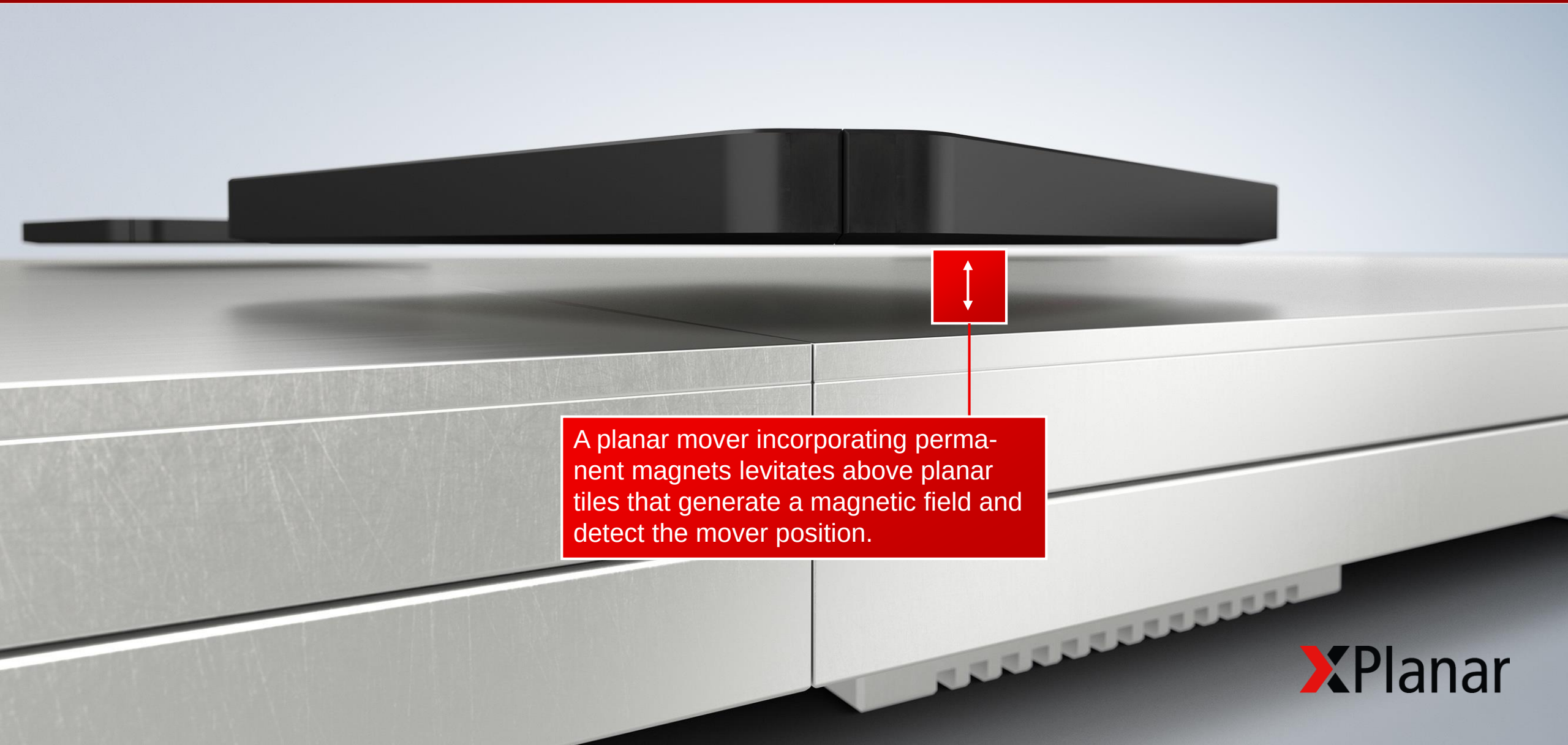

XPlanar mover:
reaches every point in every way

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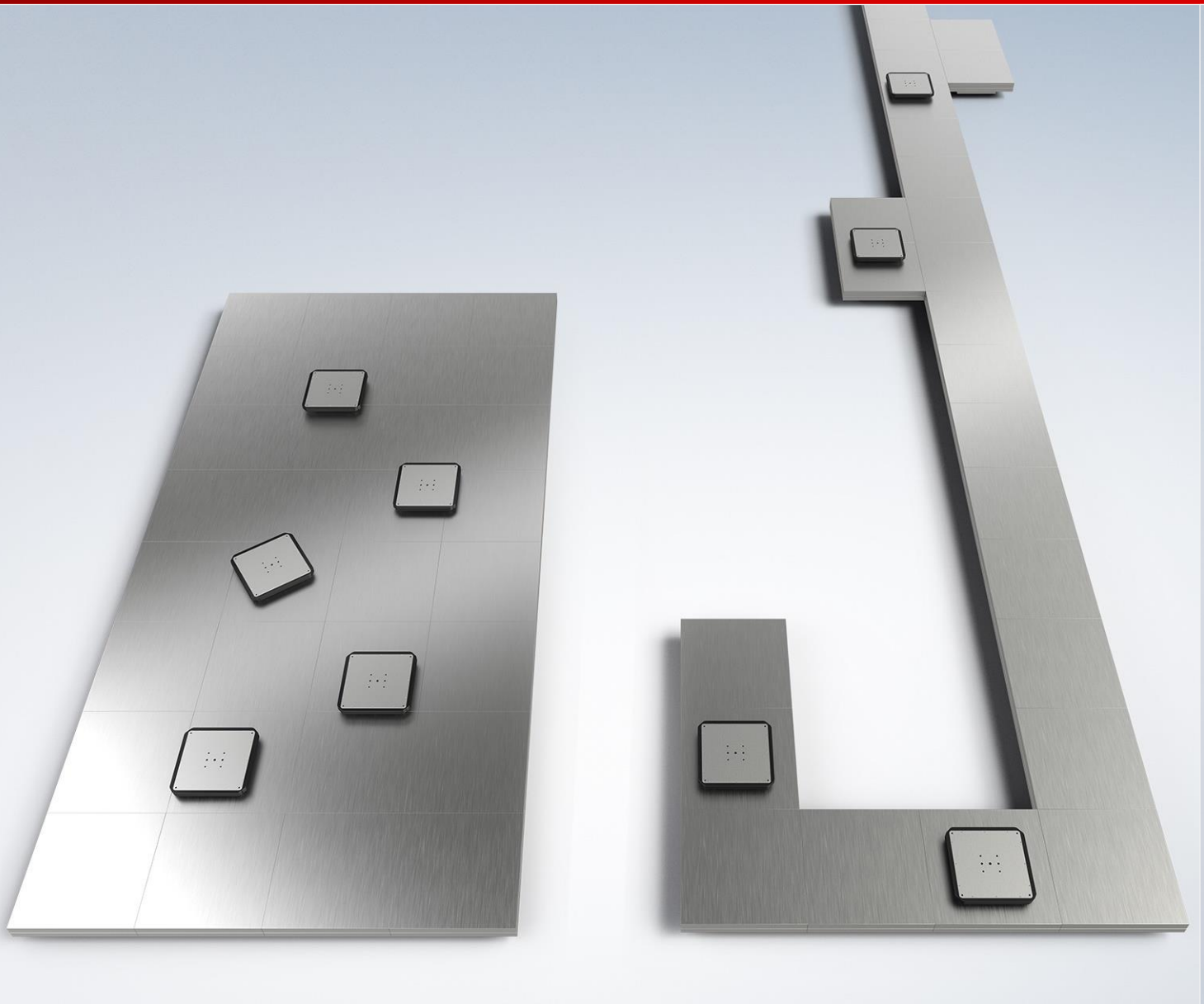

overhead movement

vertical movement

Opportunities arising from the Digital Transformation

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- Defining own world-standards
- Integration in complementary technologies
- Staying ahead through innovations
- Supporting international acting customers

Supporting international acting customers

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- As a system provider we try to understand the problem of our customers
- With the goal of finding optimal solutions to solve the given application
  - Creating new system approaches and machine concepts

- Worldwide support from (local) application engineers
  - Local language support
  - Fast response times in case of urgency
  - Remote access for maintenance or set-up

- System Engineering department for turnkey cabinet solution
  - Planning, electrical and software engineering, cabinet building, test, electrical installation, set-up
  - Support and training for System Integrators

Use Case: Consumer Electronic Industry

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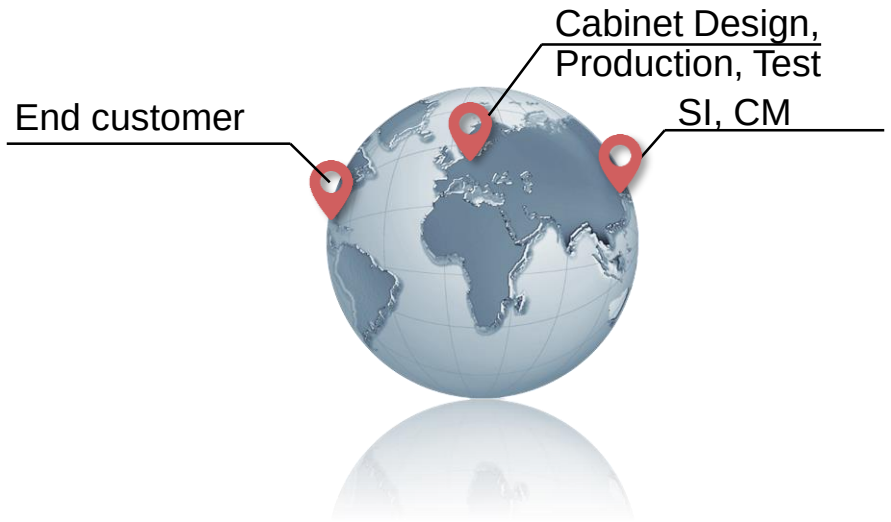
- (volatile) Project business in Consumer Electronic Industry for testing machines
- International business relations:
  - End customer from the **USA**
  - Machine design in **Europe** or **China**
  - Several System integrators (SI) and Contract manufacturers (CM) in **China**
- Cabinet Production at Beckhoff Headquarters in **Germany**
- Beckhoff support Team in **US, China and Germany**



- Fully custom designed cabinet
  - Connectorized design for easy installation
  - 100% electrically tested
- 5,000 Cabinets shipped in 4 months

Flexible Production | Startup

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Flexible Production | Running production

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Flexible Production | End test

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Summary

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- The Digital Transformation provides challenges and offers opportunities
  - PC-based control fits well
- Actively forming standards and innovations are good strategies to shape the ecosystem
  - Staying ahead of competition
- People are still most valuable – even with Digital Transformation
  - Providing solutions and new system approaches

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Forming new ecosystems for the Digital Transformation

Challenges and opportunities for a medium-sized company to shape the international automation landscape

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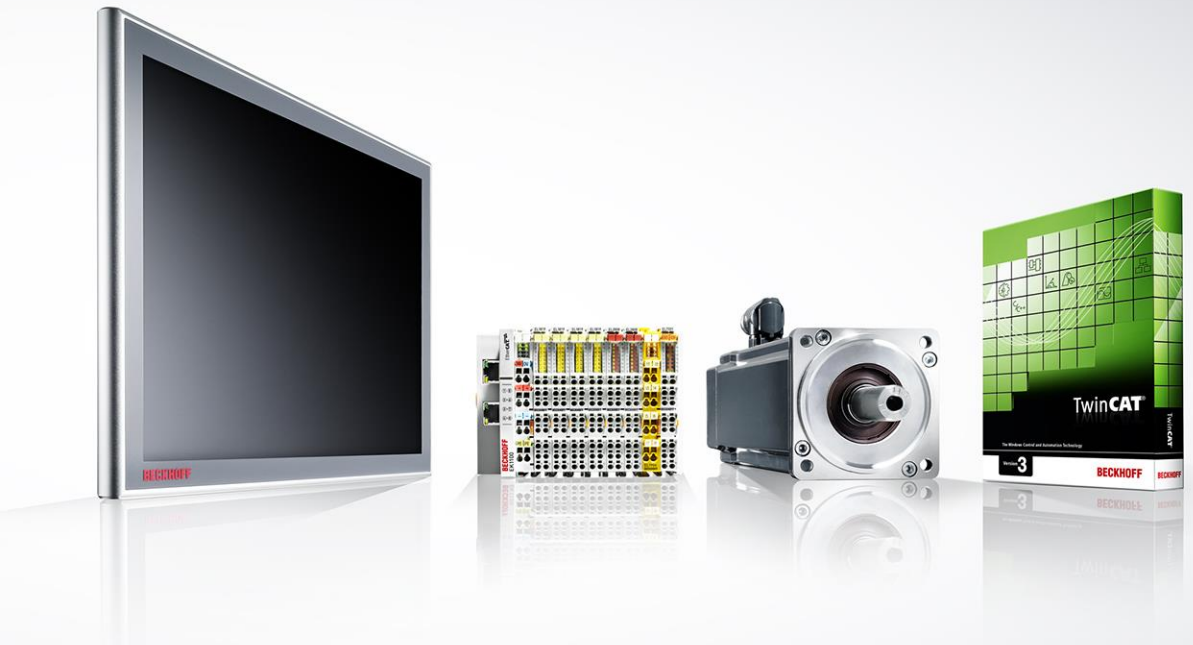

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