



+1000
credits

CHECKING SCORE
LEVEL UP!



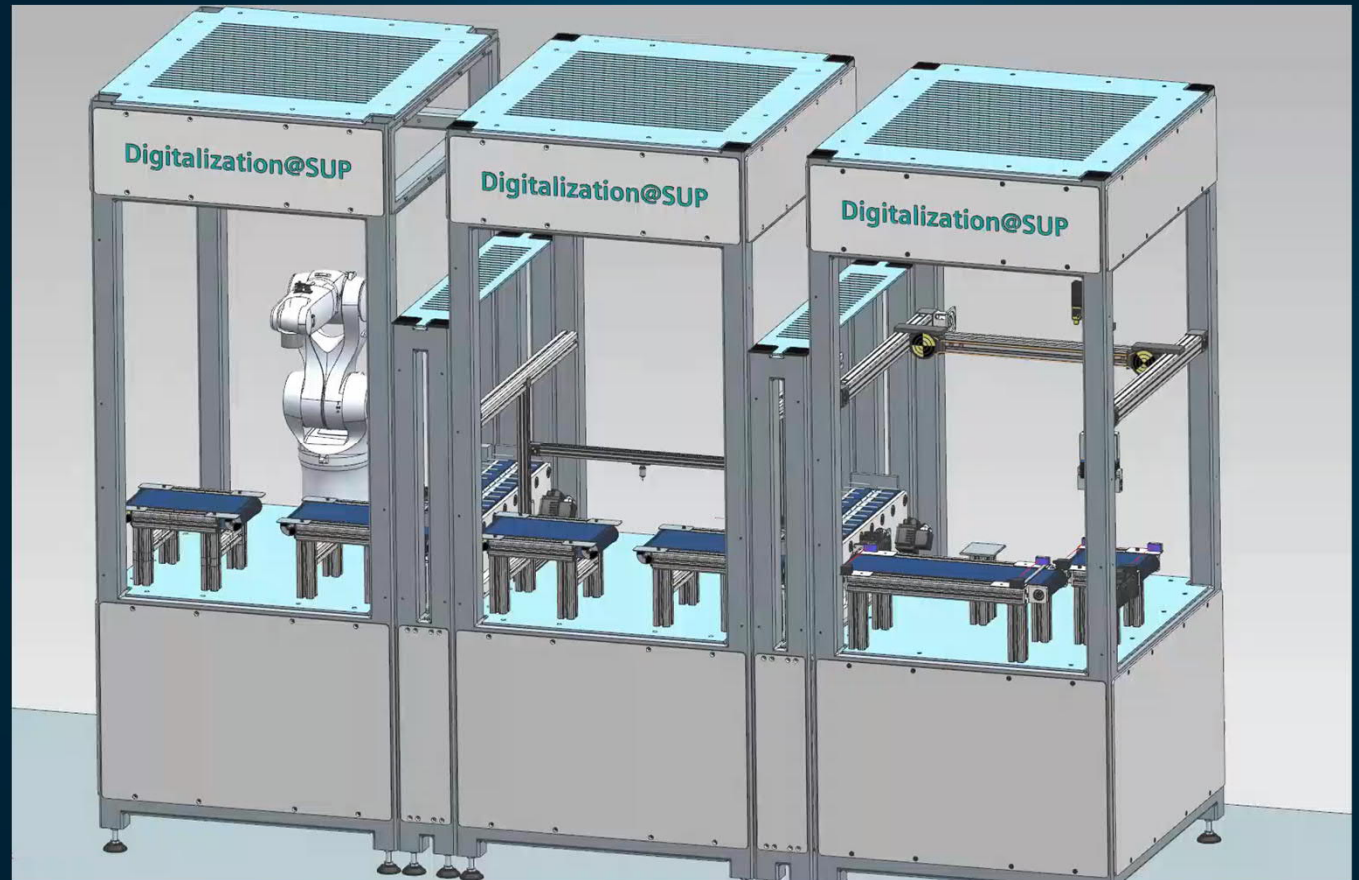
Kinematics

Multi-axis systems for cross-industry use

SIEMENS
Ingenuity for life



- Handling applications (e.g. pick&place, palletizing, etc.)
- Assembly applications (e.g. screwing, inserting, etc.)



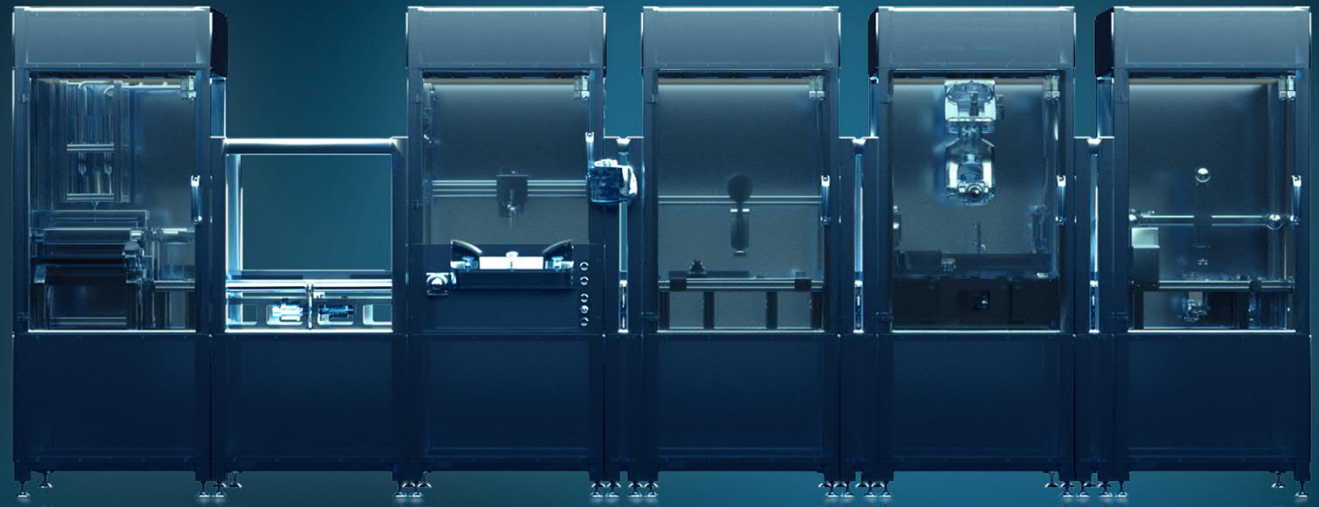
The challenge

Integration of different kinematics in one machine



Challenges

- Various controllers
- Different engineering tools
- Different HMI devices
- Large amount of engineering and commissioning work



SIMATIC



Denso



Kuka



Stäubli

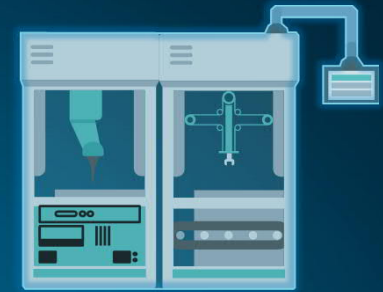
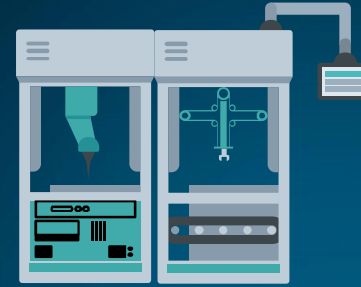
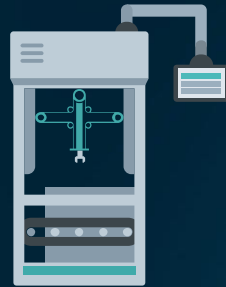
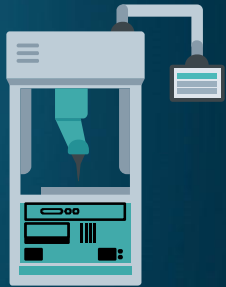
Kinematic applications Use instead of programming



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A large graphic on a dark blue background. At the top right is the Siemens logo. Below it is a grid of 12 icons representing various kinematic mechanisms, arranged in a 3x4 grid. To the right of the grid is a stylized illustration of a robotic arm. Below the grid is a white square with a blue checkmark and a white thumbs-up icon. At the bottom right, the text 'Integrated engineering of kinematics' is displayed.

"Our gear is packed and ready to go" From separate kinematics solutions to all-in-one solution



Challenge 1

Integration of robot systems from different manufacturers

Challenge 2

Integration of standard and user-specific kinematics

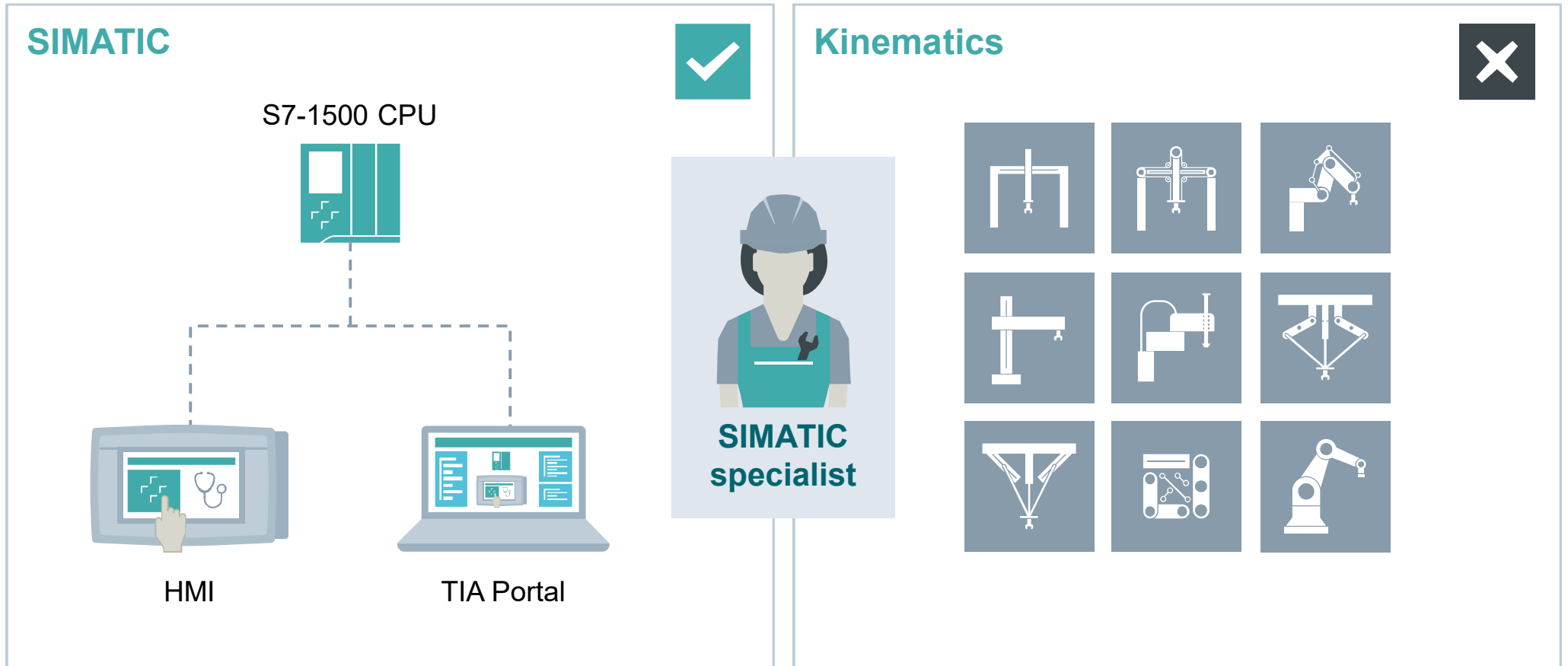
Challenge 3

"All-in-one" solution

Challenge 4

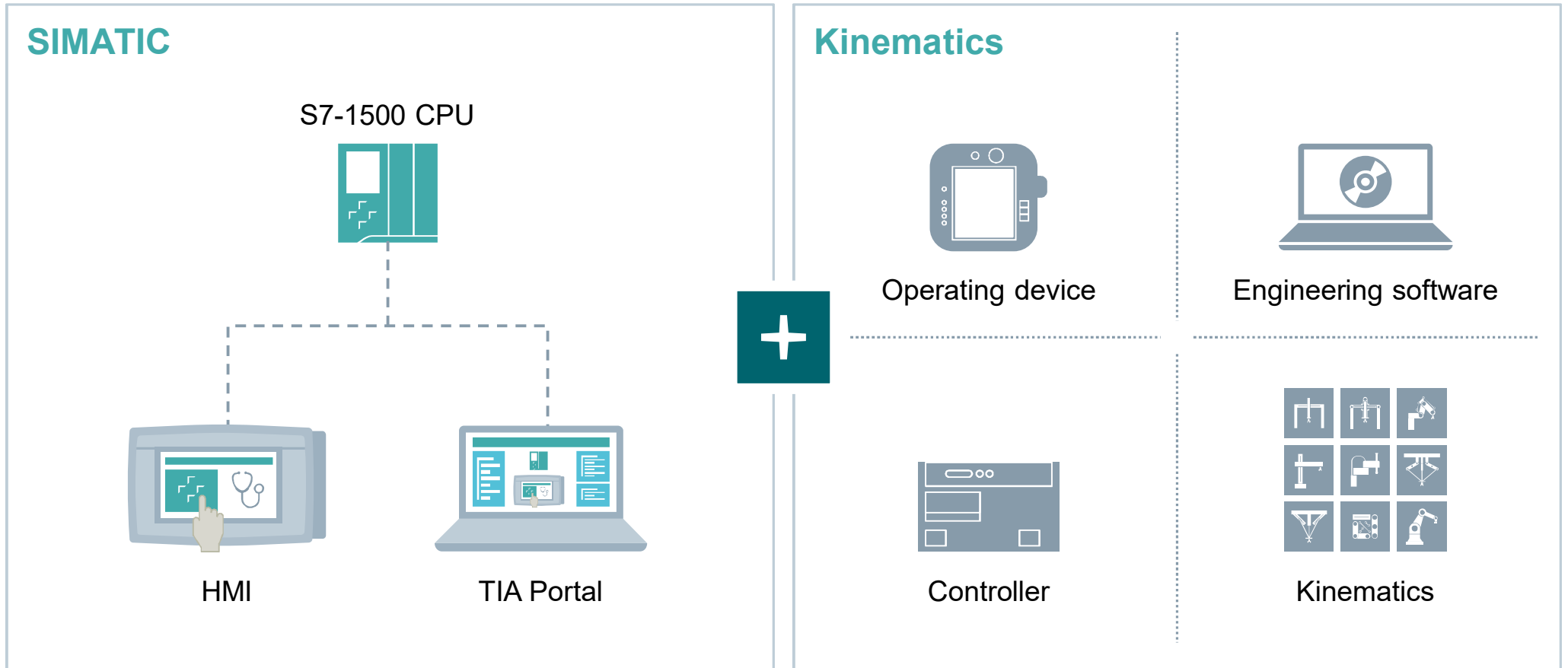
Simulation & validation of all kinematics

SIMATIC and kinematics meet



SIMATIC and kinematics

Two separate worlds





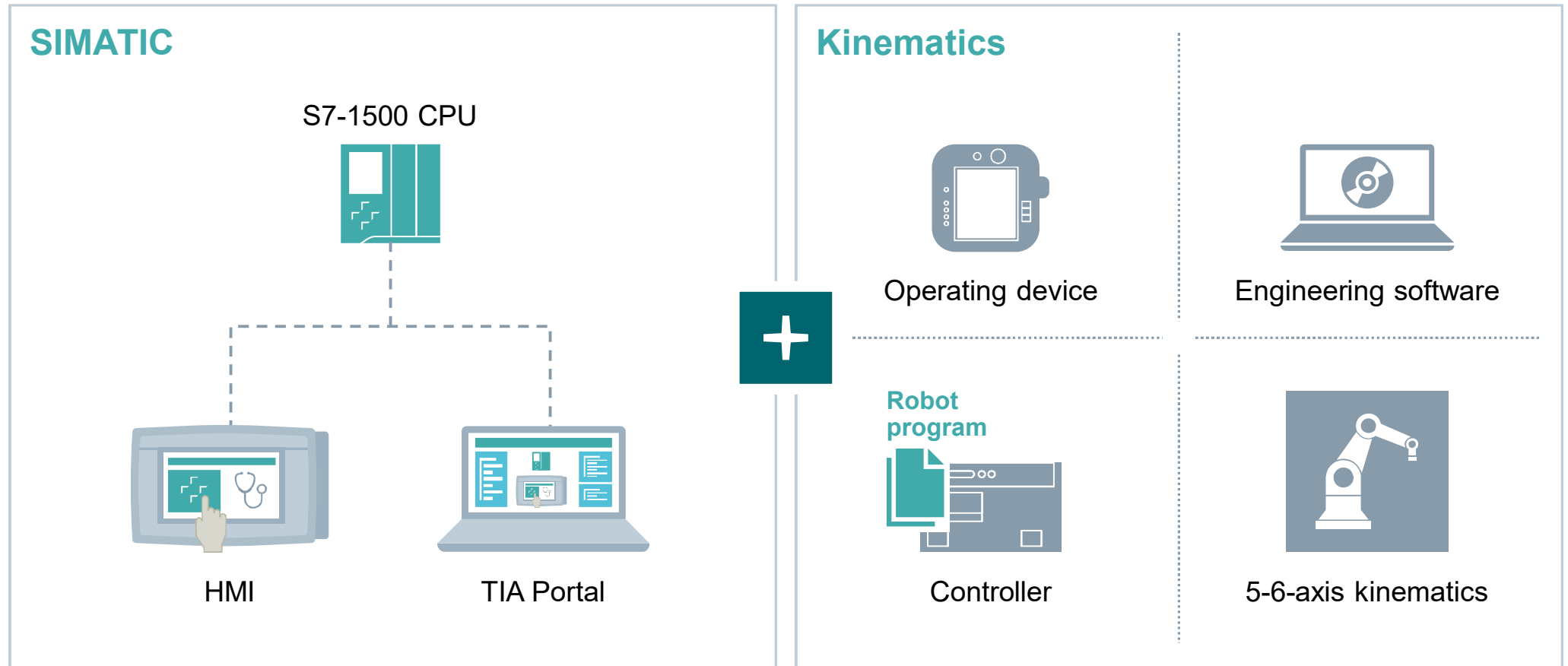
Challenge 1

Integration of robot systems from different manufacturers

SIMATIC and 5-6-axis kinematics

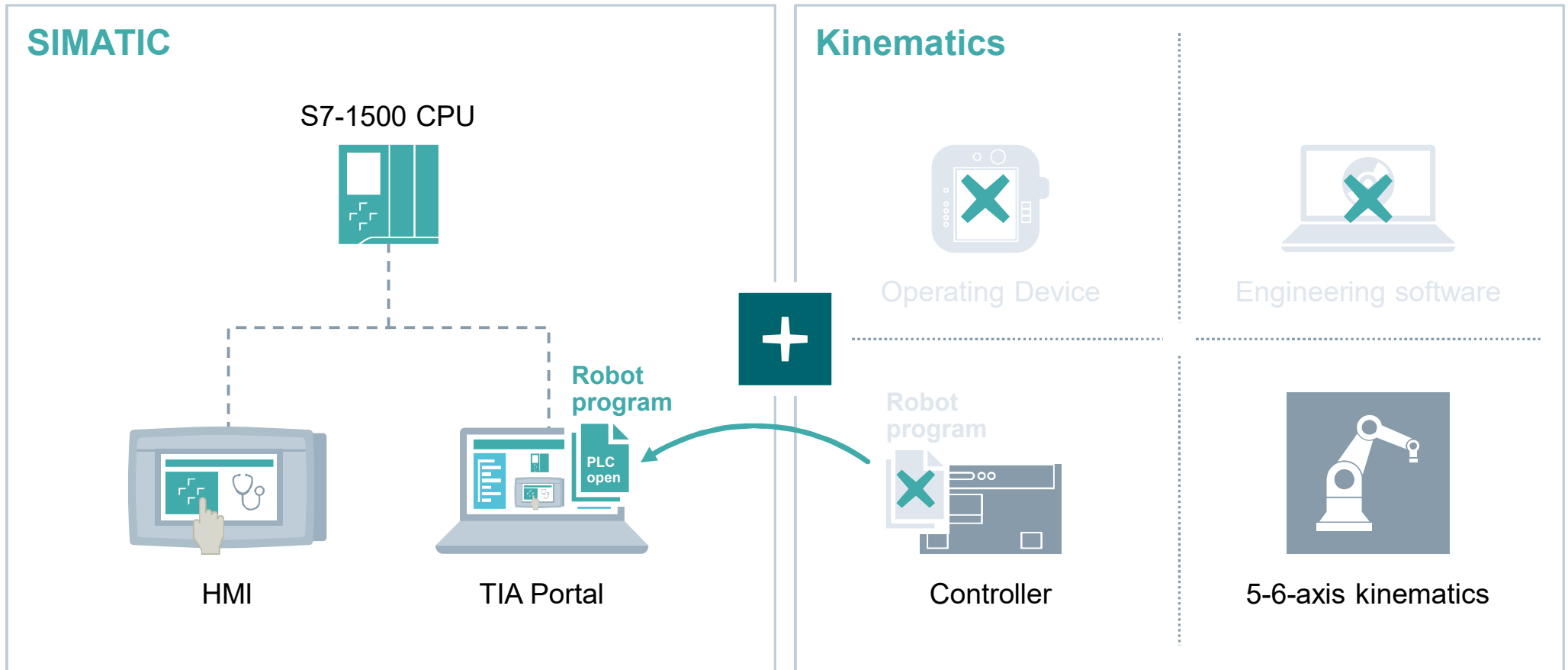
Two separate worlds

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Control of 5-6-axis kinematics SIMATIC and kinematics are growing together

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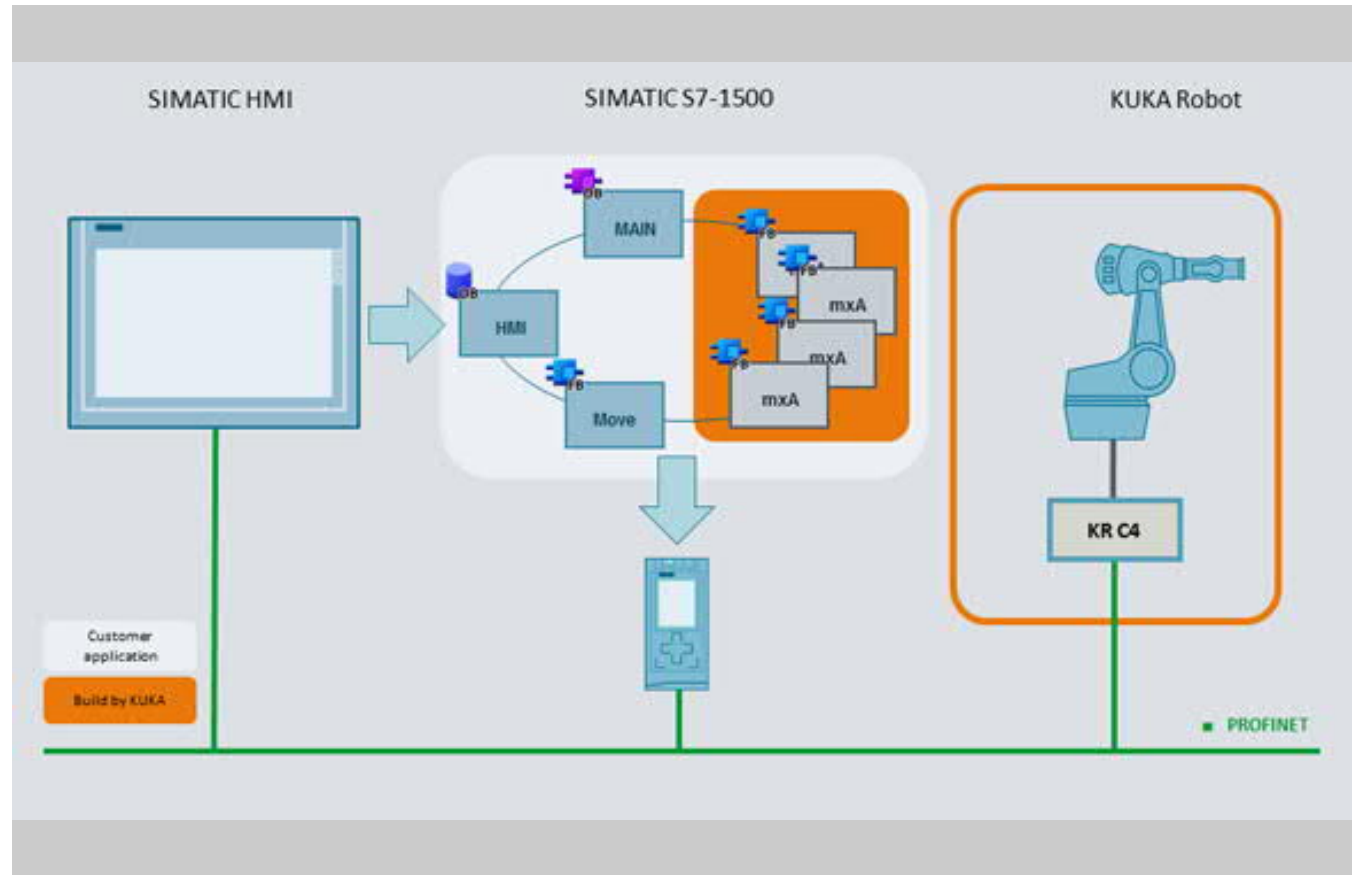
How do you control a KUKA robot with SIMATIC?



- Robot controlled by Function Blocks
- KUKA.PLC mxAutomation function package

FAQ

How do you control a KUKA robot with a SIMATIC controller? (Entry-ID: [109475194](#))



Control of 5-6-axis kinematics Siemens application example



- No programming in the engineering tool of the robot manufacturer
- "Ready-to-use" TIA Portal program example for the operation of robots
- HMI faceplates independent of the robot manufacturer
- Complete creation of the robot trajectory possible with the SIMATIC HMI

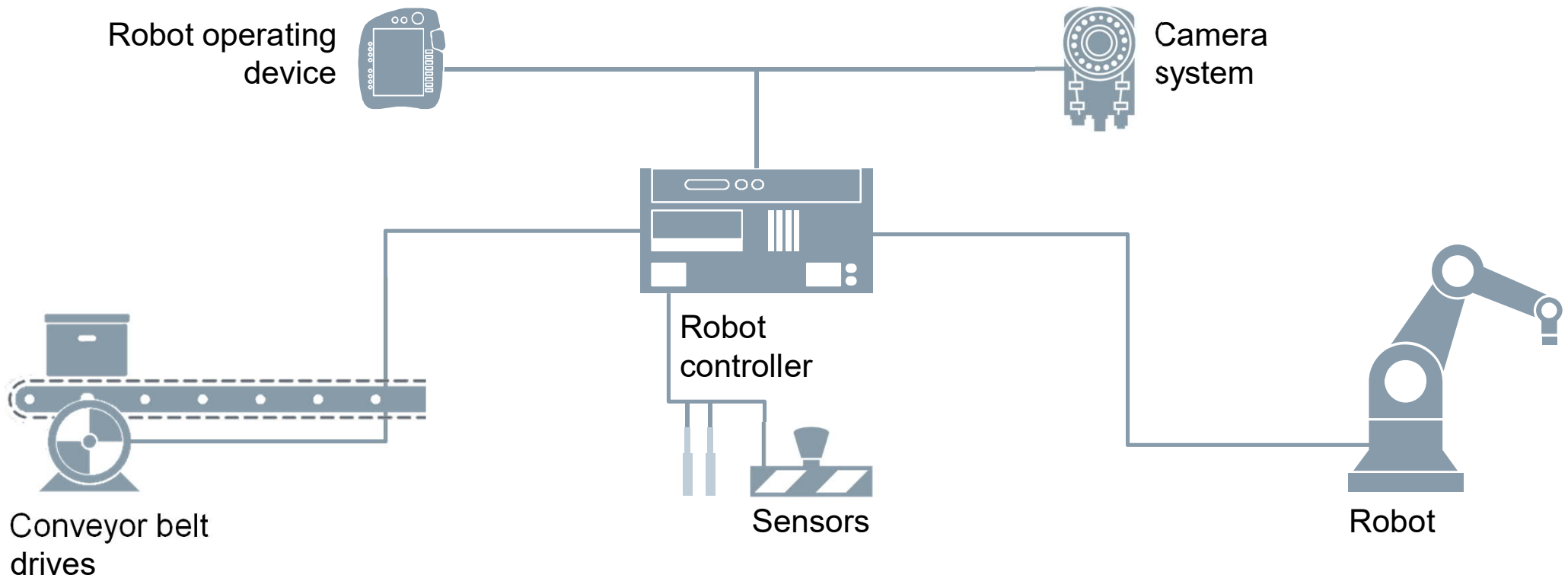
The screenshot displays the SIMATIC HMI interface for robot control. The top bar shows the application name 'Robot Control' and the robot name 'Robot 2'. The status bar includes 'S I R Ext' buttons, 'Tool : 1 Base : 1', 'Override 5 %', and 'Operator User Name'. The main interface is divided into several panels:

- Robot Power:** Shows 'Off' and 'On' buttons. Status indicators include 'Powered', 'No Error', and 'Robot is ready to move'. 'Reset' and 'Abort' buttons are also present.
- Cartesian Position:** Displays X (+280.00mm), Y (+179.72mm), Z (+550.00mm), A (+180.00°), B (+0.00°), C (-180.00°), S (2), and T (35). Includes a 3D model of the robot arm.
- Axis Position:** Displays A1 (-32.69°), A2 (-78.19°), A3 (+76.98°), A4 (+0.00°), A5 (+91.21°), and A6 (-32.69°). Includes a 3D model of the robot arm.
- Error IDs and Control Priority:** Shows 'Robot interpreter 0', 'Submit Interpreter 0', and 'Robot PLC 0'. Includes 'KR C4' and 'T1 T2 AUT EXT' buttons.
- Parameters:** Shows 'Active last no 1', 'Last order ID 6', 'Queue count 0', 'Online Lib. version 2. 1. 3', 'Offline Lib. version 2. 1. 3', 'IP Address robot controller 10. 17. 2. 112', and 'Active IPO Mode Flange'.
- Home Position:** Shows X (280.00mm), Y (0.00mm), Z (550.00mm), A (180.00°), B (0.00°), and C (180.00°). Includes a 'Save' button.

The bottom navigation bar includes 'Power', 'Configuration', 'Robot Messages', 'Teach Path', 'Move Path', 'Position List', and 'Move'.

Devices around the robot Status Quo – Potential for Siemens products

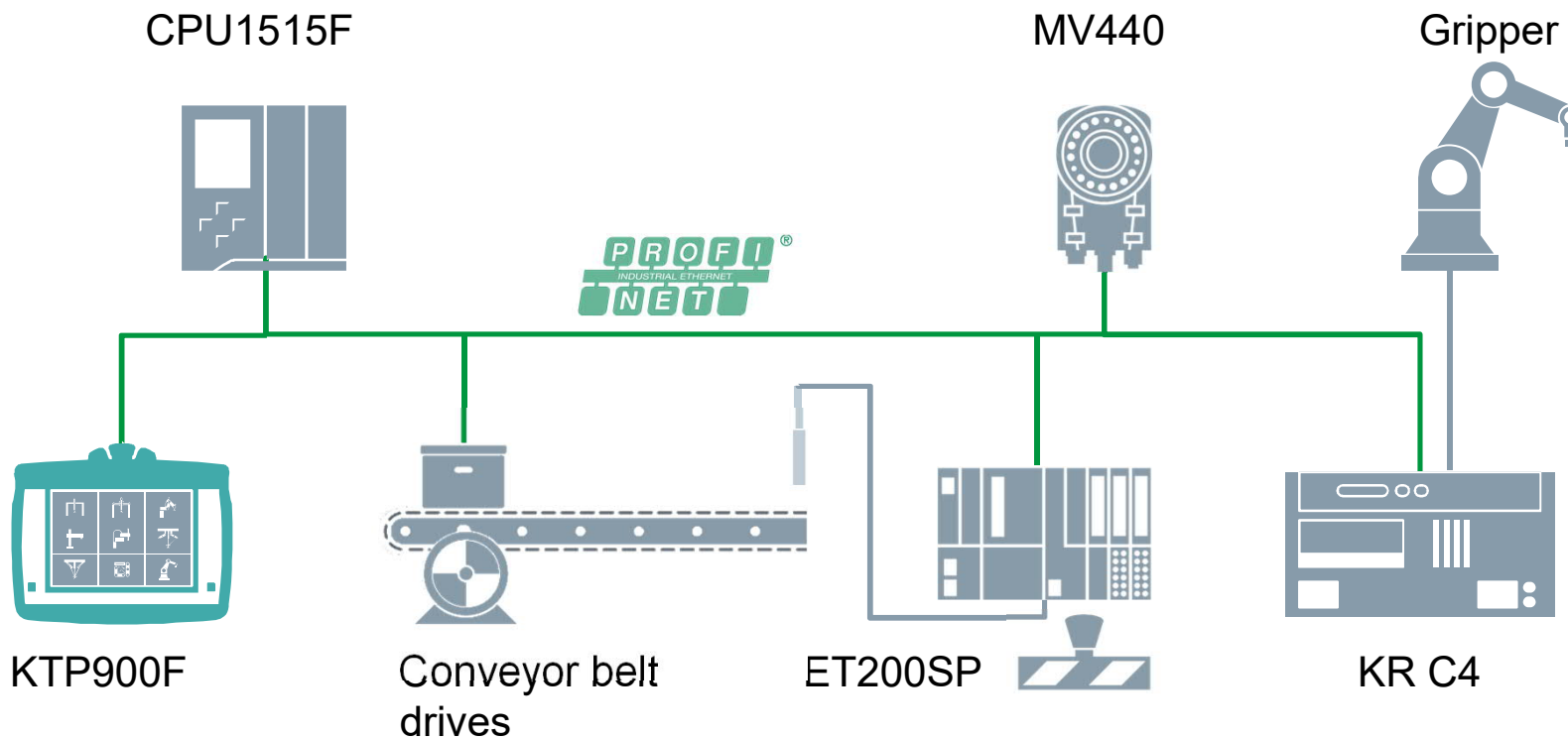
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Robot controller is the central controller of the robot cell

Devices around the robot Siemens as a provider of an all-in-one solution

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Additional sales

- Larger PLC
- Safety
- Mobile Panel
- Peripherals (I/Os)
- Camera system
- SINAMICS drives

SIMATIC is the central controller of the robot cell

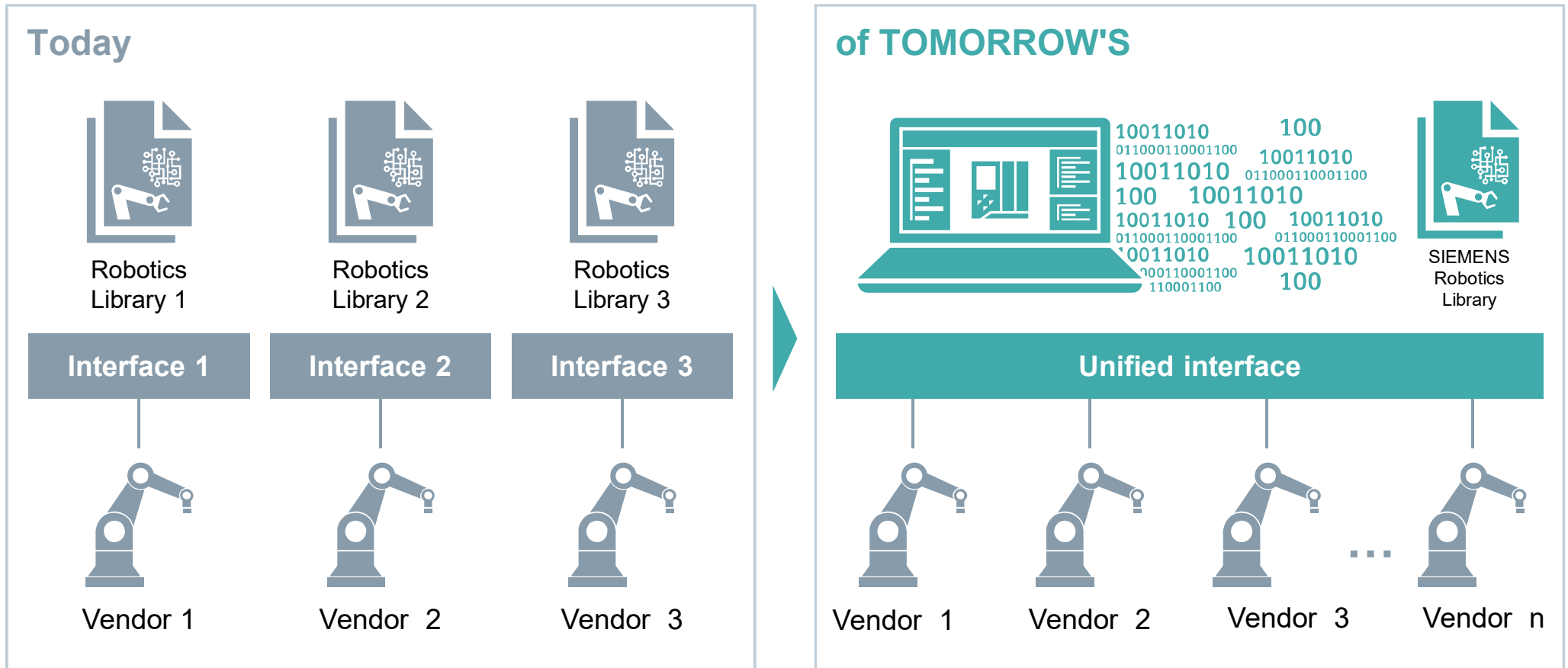
Integration of 5-6-axis kinematics into the SIMATIC Siemens Support



	YASKAWA	KUKA	DENSO	STÄUBLI
FAQ	In progress			
Programming Guide + Example	In progress			In progress
Commissioning Support	In planning			

Consulting and support for the libraries is the responsibility of the robot manufacturers

TIA Portal Robotics Library (PLCopen-compliant) Uniform robot interface with flexible robot selection





Challenge 2

Integration of standard and user-specific kinematics

The innovative solution for controlling kinematics with up to 4 axes

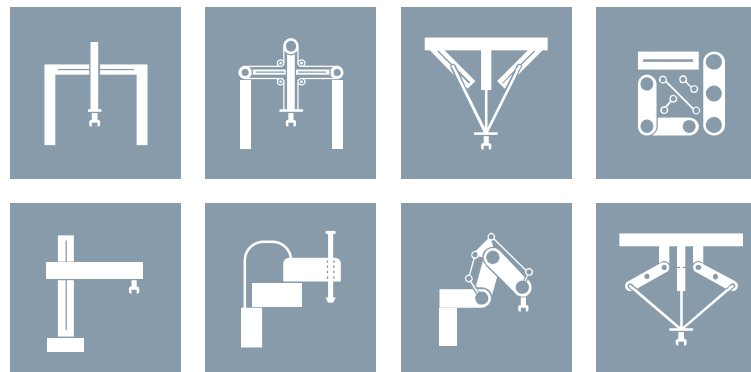
System-integrated function using technology object

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- Efficiently programming and automating typical kinematics (e.g. Cartesian portal, role picker, etc.)
- Integrated diagnostics and zone monitoring
- Programming with function blocks according to PLCopen in the familiar SIMATIC environment

System-integrated function

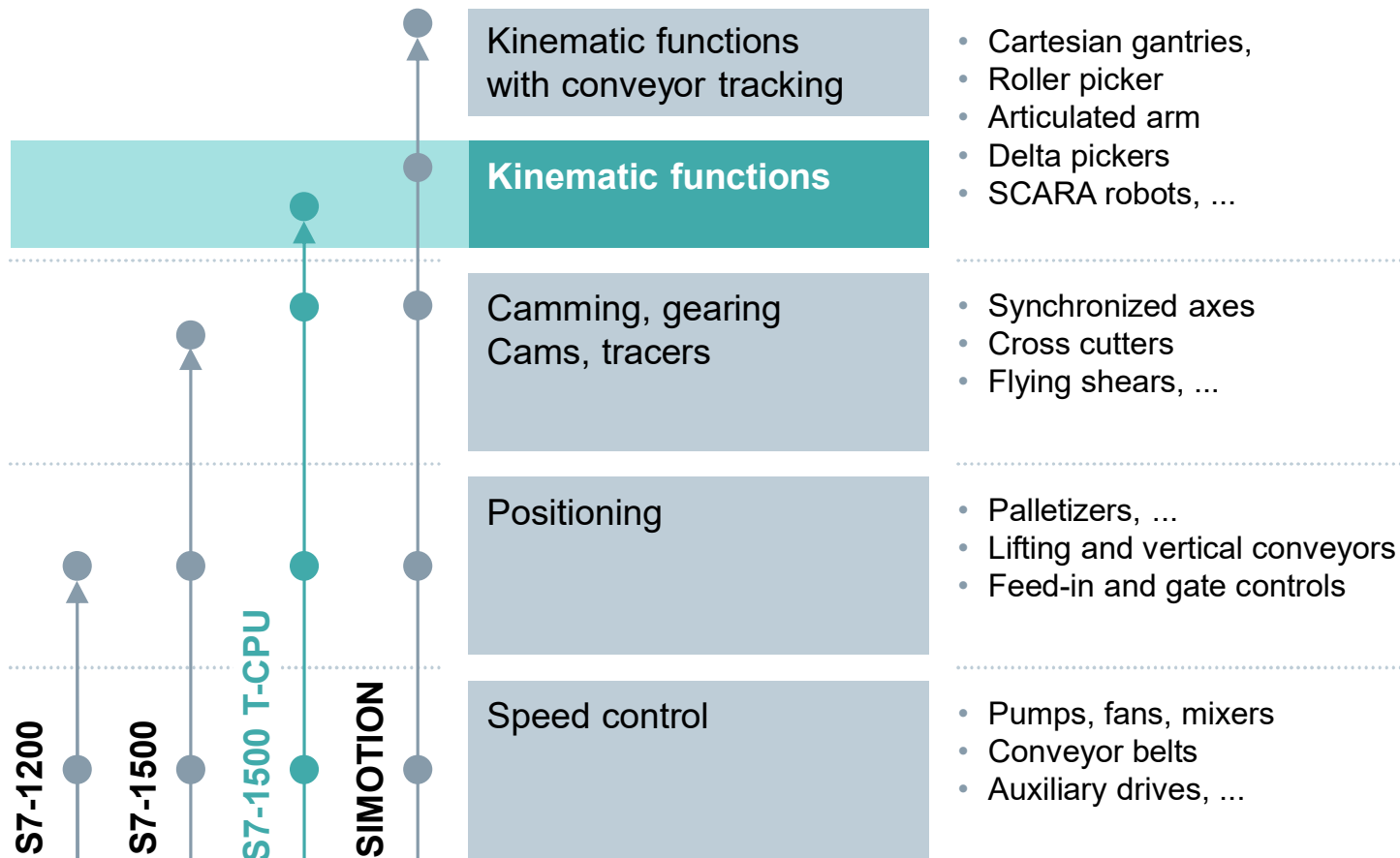


SIMATIC S7-1500 T-CPU



Motion Control functions and typical applications

Overview



- Cartesian gantries,
- Roller picker
- Articulated arm
- Delta pickers
- SCARA robots, ...

- Synchronized axes
- Cross cutters
- Flying shears, ...

- Palletizers, ...
- Lifting and vertical conveyors
- Feed-in and gate controls

- Pumps, fans, mixers
- Conveyor belts
- Auxiliary drives, ...

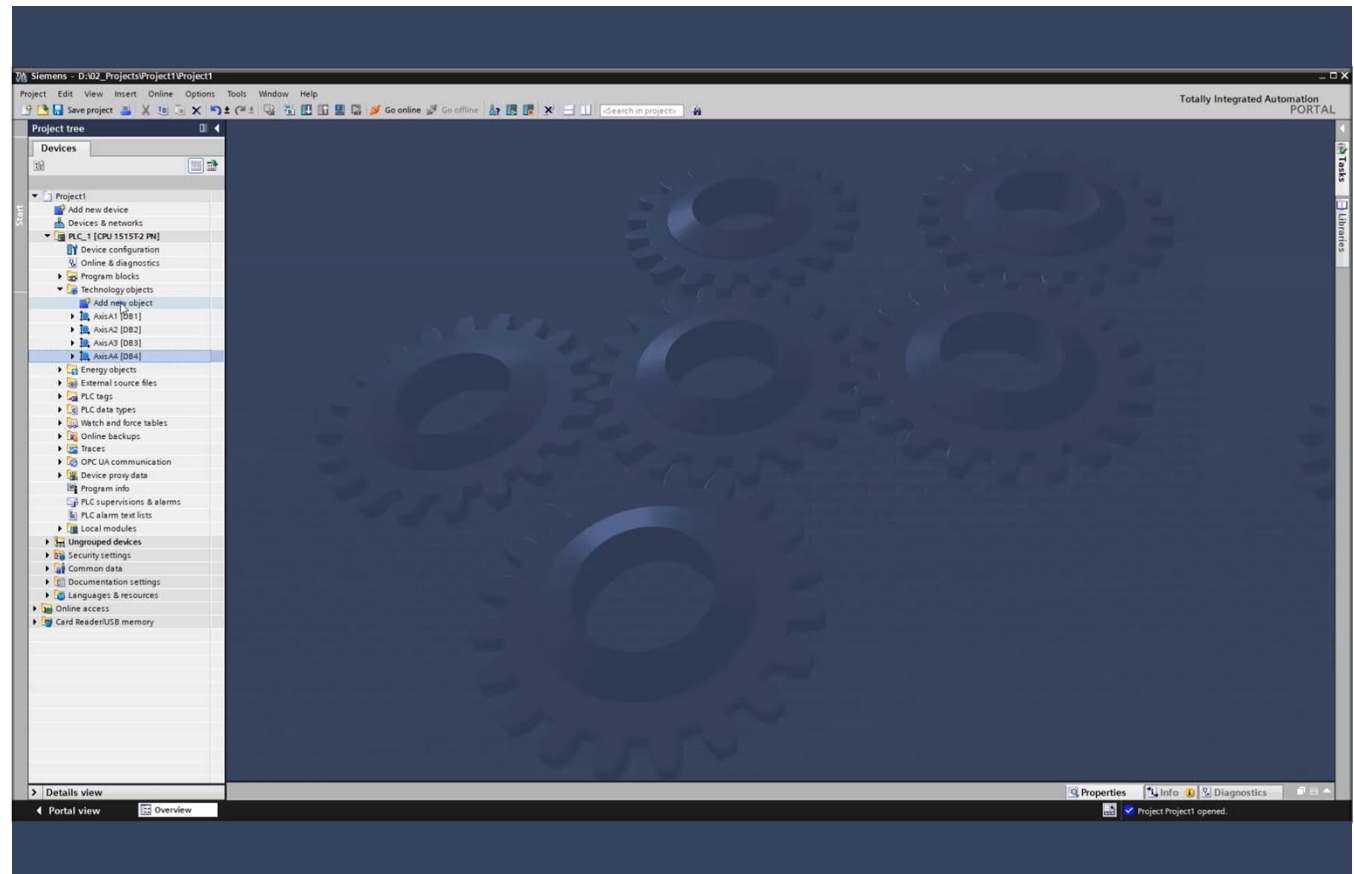


Kinematics in the TIA Portal

Easy programming of the kinematics motion



- Uniform project planning in one engineering system
- Intuitive parameter assignment using graphical support

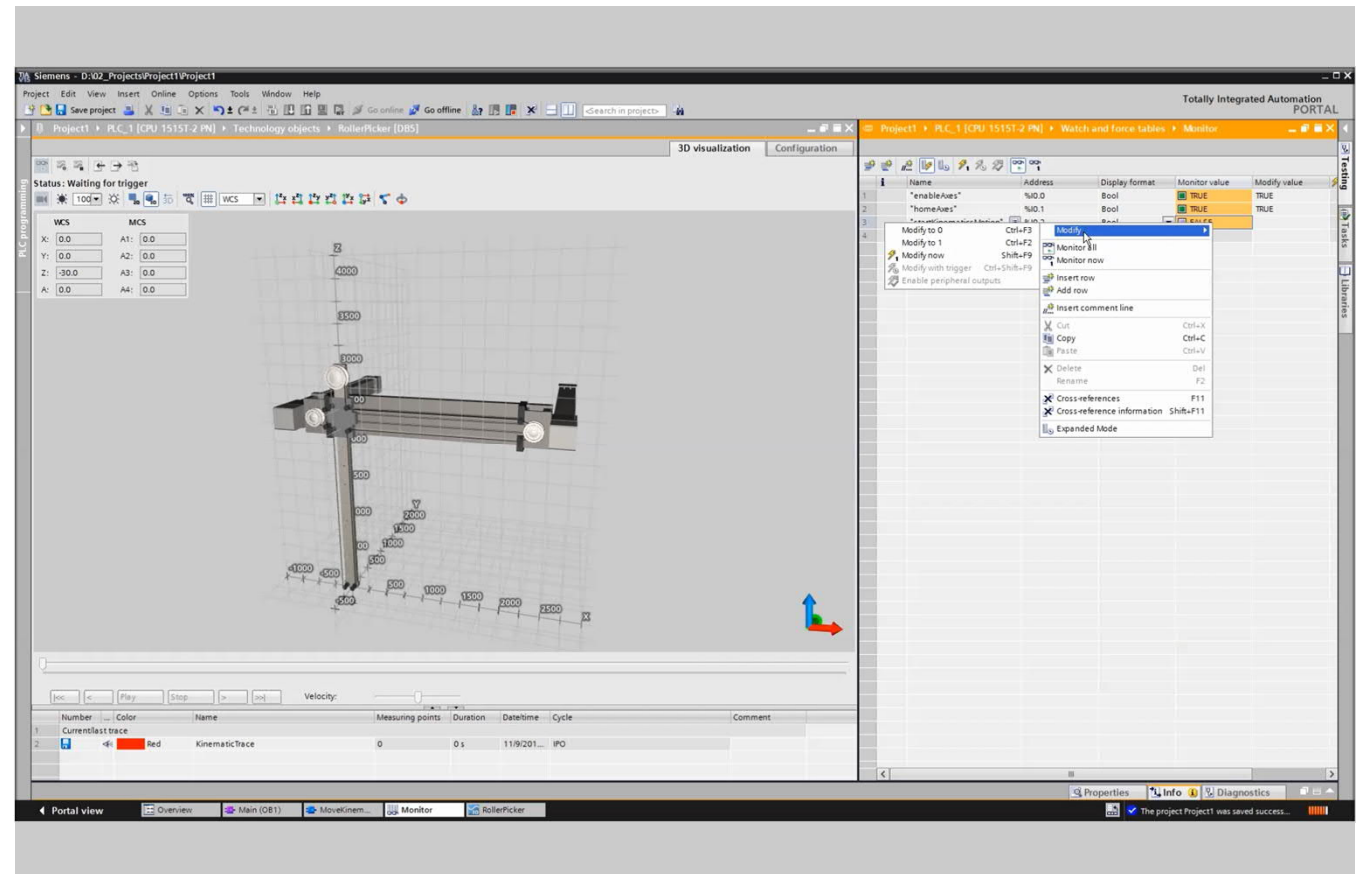


Kinematics trace in the TIA Portal

3D visualization and validation of the kinematics motion



- 3D display and recording of motion control
- Graphic validation
- Optimization of the motion control



Contents

- Create Kinematics TO
- Programming a path
- Optimization of the web with the Kinematics Trace

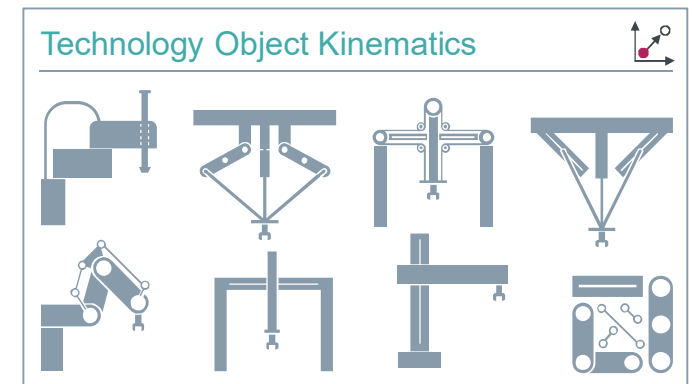
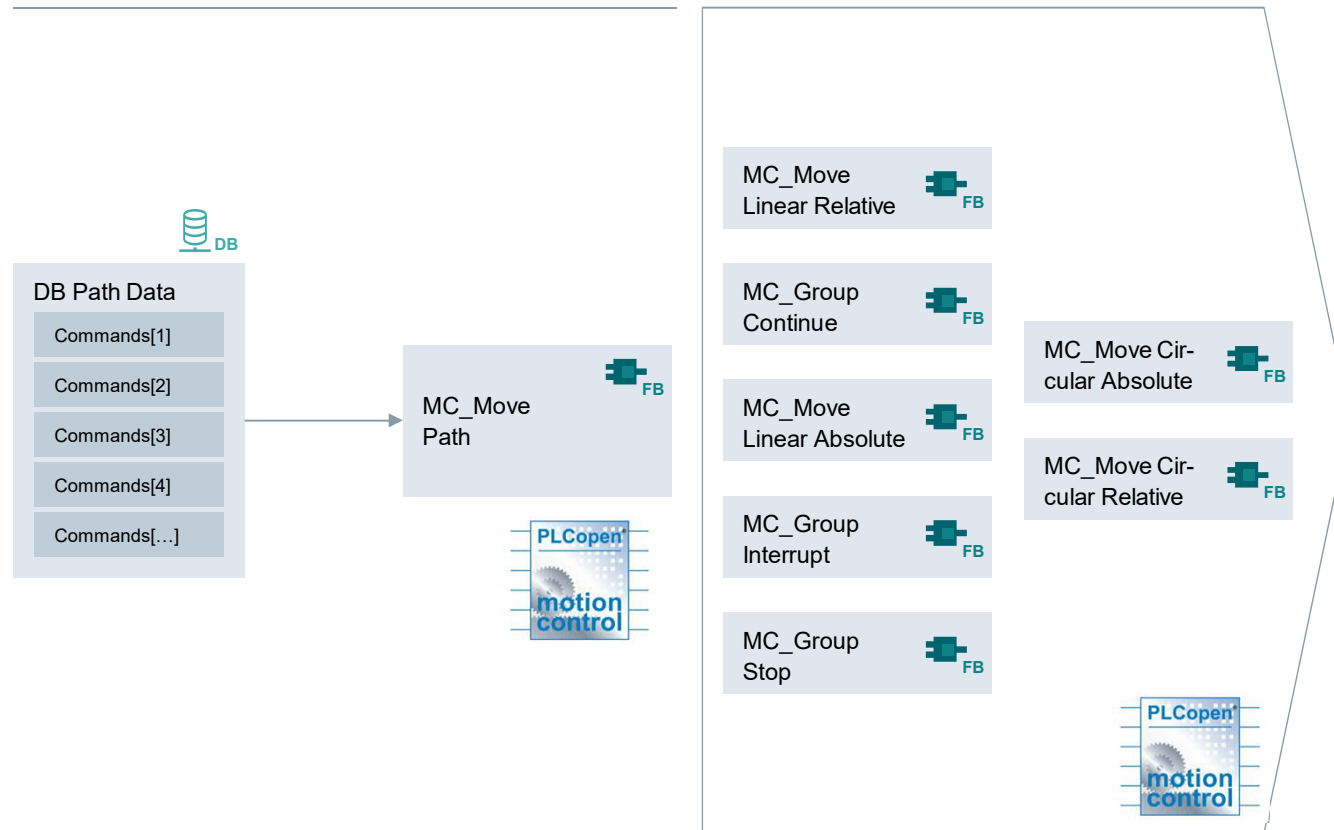
Kinematics TO

Live demo

Technology Object (TO) Kinematics Motion Programming – PLCopen

Application

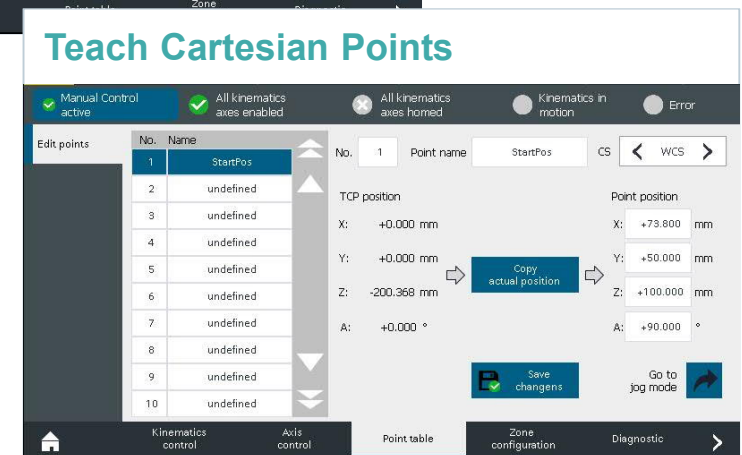
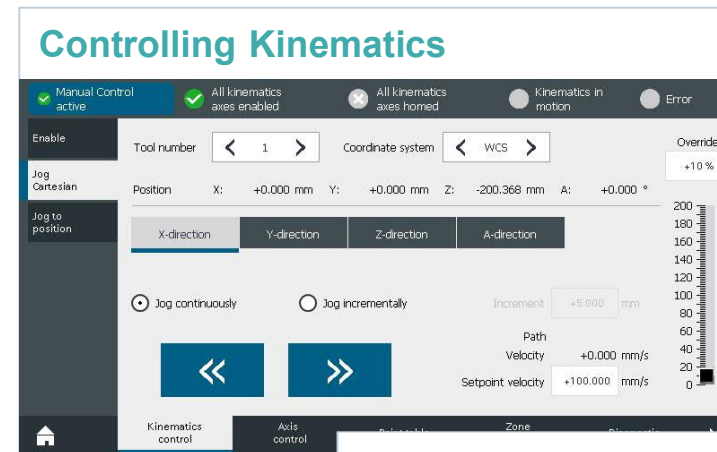
System



All major kinematics functions are available in a predefined HMI faceplate



- Commissioning functions like jogging and homing/referencing
- Teaching of points
- Easy integration and adaption of faceplate
- Getting diagnostic information
- Configuration and monitoring of zones, dynamics, limits
- Possibility to control machines from different HMI devices
- Possibility to implement user level management

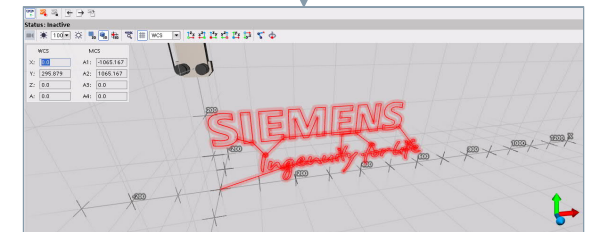
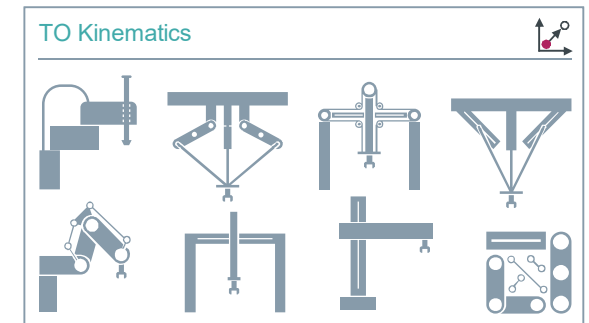
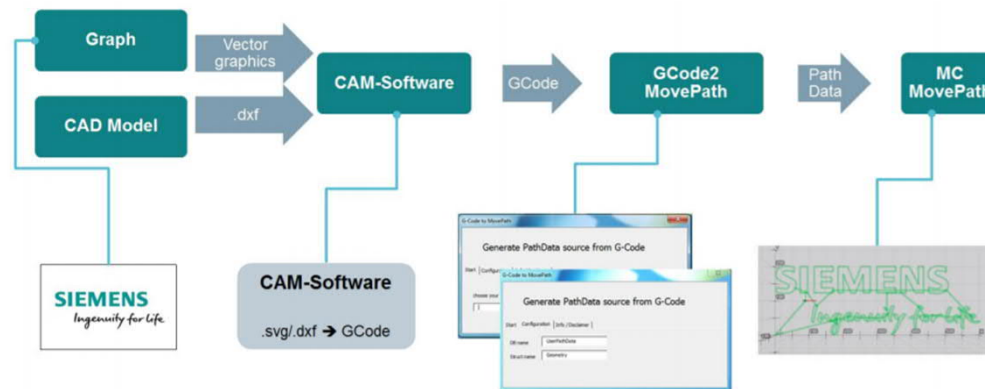


“Kinematics Language” closes toolchain for automatic path generation

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Added value by closed toolchain

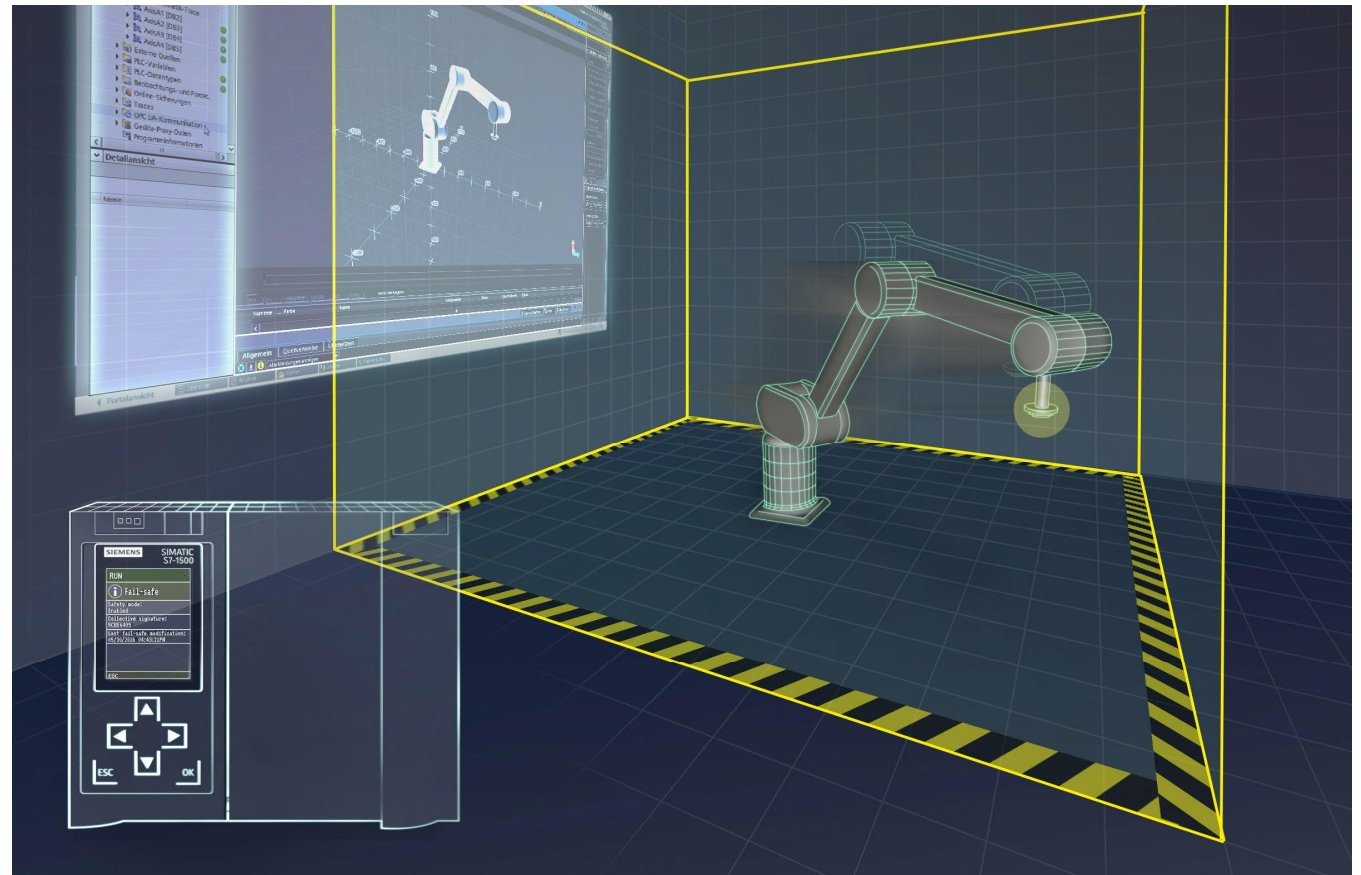


SIMATIC Safe Kinematics V1.0

Safe monitoring of selected kinematics



- Safe velocity monitoring of various points of the kinematics
- Safe collision check between kinematics and workspace zones (workspace and protection zones)
- More compact design for machines possible



Integration of 2-4-axis kinematics into the SIMATIC

Competitive advantages



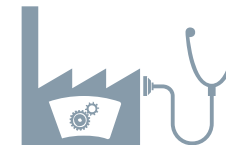
Competitive advantages



Safety Integrated



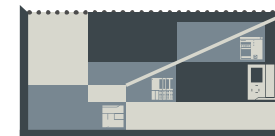
Integrated diagnostics



Integrated engineering





Scalable controller portfolio

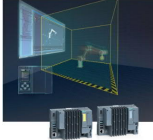



Motion Control in SIMATIC S7-1500 T-CPU


Expansion of functions & portfolio



TIA Portal V15	Software <ul style="list-style-type: none"> • Handling • ... 	Hardware <ul style="list-style-type: none"> • S7-1500 T-CPU CPU 1516-3PN/DP T CPU 1516-3PN/DP TF 		
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TIA Portal V15.1	Software <ul style="list-style-type: none"> • Safe Kinematics V1.0 • ... 	Hardware <ul style="list-style-type: none"> • Open Controller CPU 1515SP PC2 T CPU 1515SP PC2 TF 		
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Outlook

TIA Portal V16	Software <ul style="list-style-type: none"> • Distributed gearing • Handling V2.0 • Safe Kinematics V2.0 • Distributed trace • ... 	Hardware <ul style="list-style-type: none"> • Drive Controller CPU 1504D TF CPU 1507D TF 	
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...			
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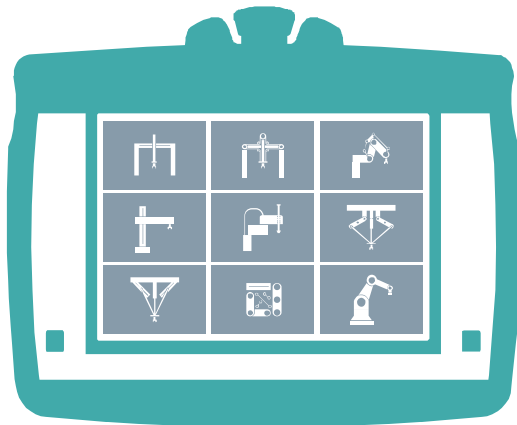
Challenge 3

"All-in-one" solution

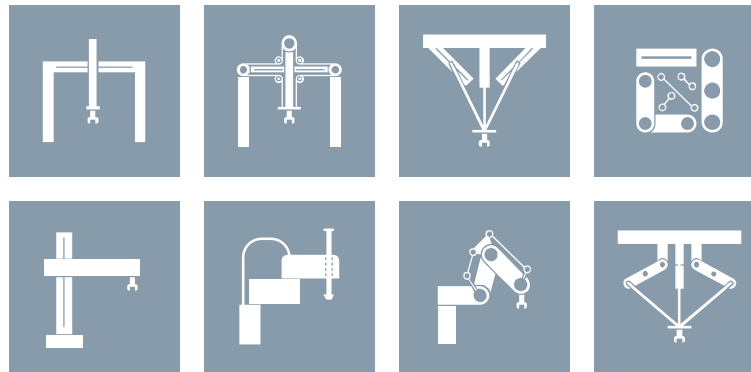
The common solution

One HMI device for all kinematics with 2 - 6 axes

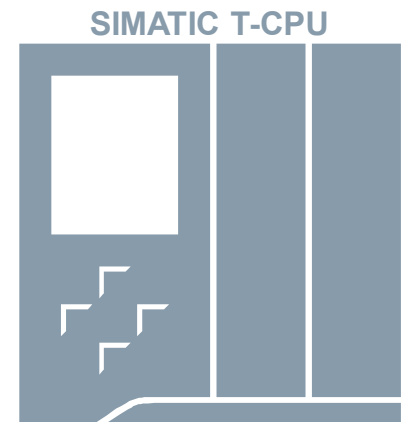
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System integration



Program integration

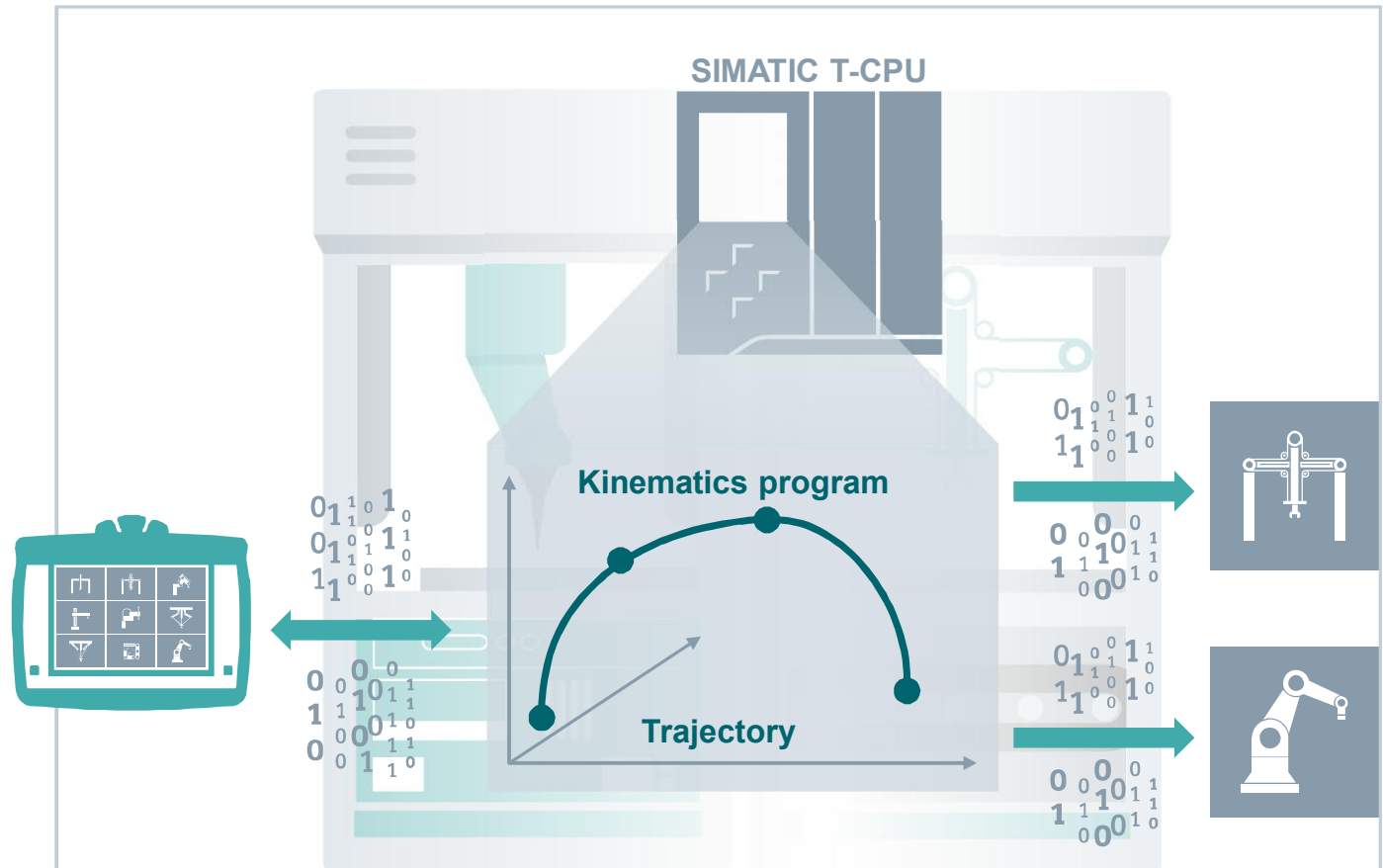


Siemens application example for kinematics

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- Uniform operating philosophy for all kinematics
- Display of Cartesian and axis positions
- Traversing in jog mode
- Teaching the path points
- Defining the trajectory



Contents

Teaching the positions
of a selected kinematics

- Kuka robot
- Cartesian portal
- Roller picker

"teaching" kinematics

Live demo

Integration of 2-6-axis kinematics into the SIMATIC

Competitive advantages



Competitive advantages



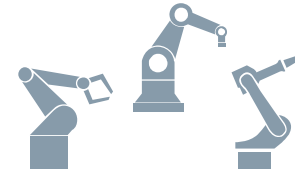
Uniform operation and engineering of different kinematics



Consistent and seamless integrated Siemens solution



Support when using dedicated robot libraries





Extensive application examples



Integration of 2-6-axis kinematics into the SIMATIC

Functions and restrictions

What we are offering ...

- Uniform application for almost all kinematics
- Integrated diagnostics 
- Safety Integrated 
- Scalable controller portfolio
- Easy implementation of Motion Control applications in the TIA Portal



What we still need to do ...

- TIA Portal robotics library (in planning)
- Full integration of the entire SINAMICS drive portfolio into TIA Portal
- Integration of additional Motion Control functionalities into the T-CPU (e.g. conveyor tracking, interpolation of 5-6-axis kinematics)



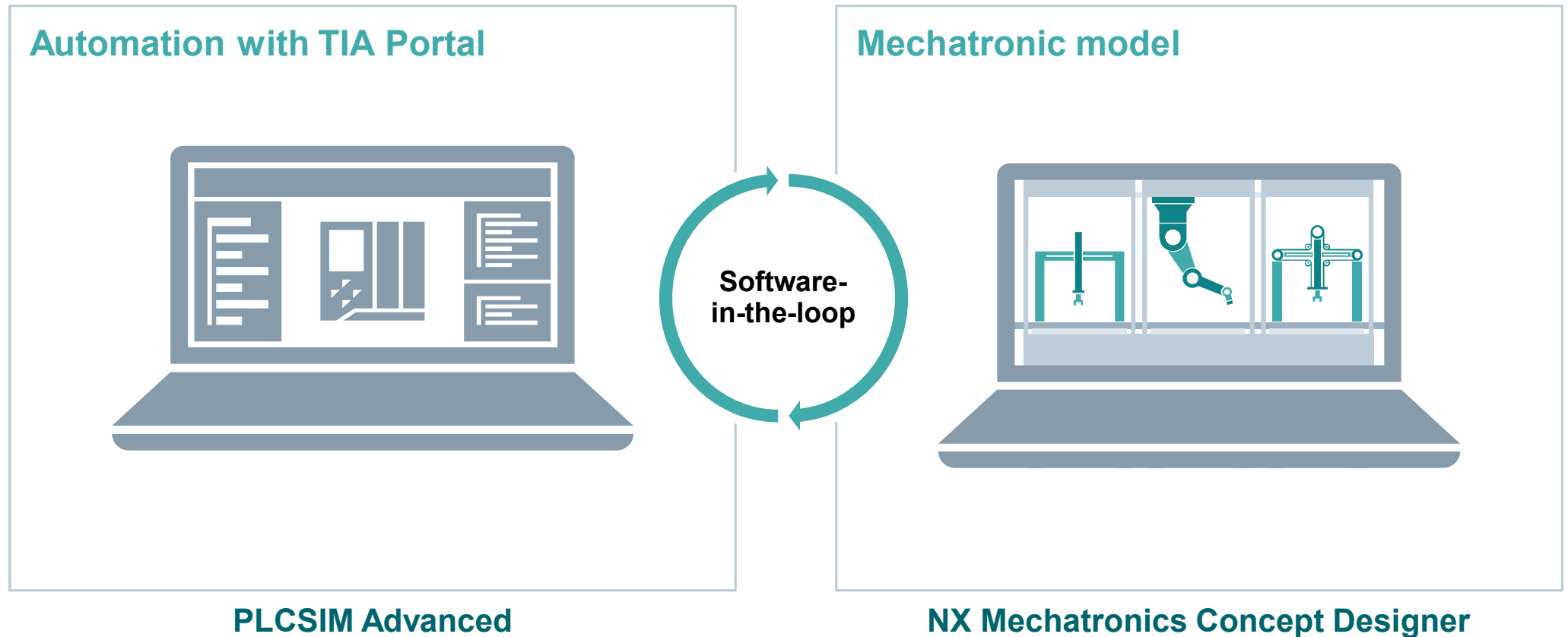


Challenge 4

Simulation and validation
of the kinematics program

This is how it works

Simulation and validation of the kinematics functionalities



Kinematics toolbox V1

Virtual commissioning of kinematics

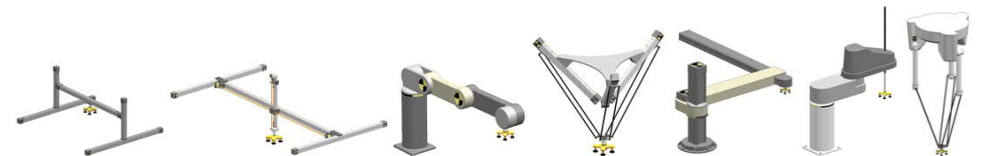


- Application example with all kinematics implemented in the Kinematics TO
- Extensive TIA Portal projects
- NX MCD models for all kinematics implemented in Kinematics TO

TIA Portal – kinematics programs

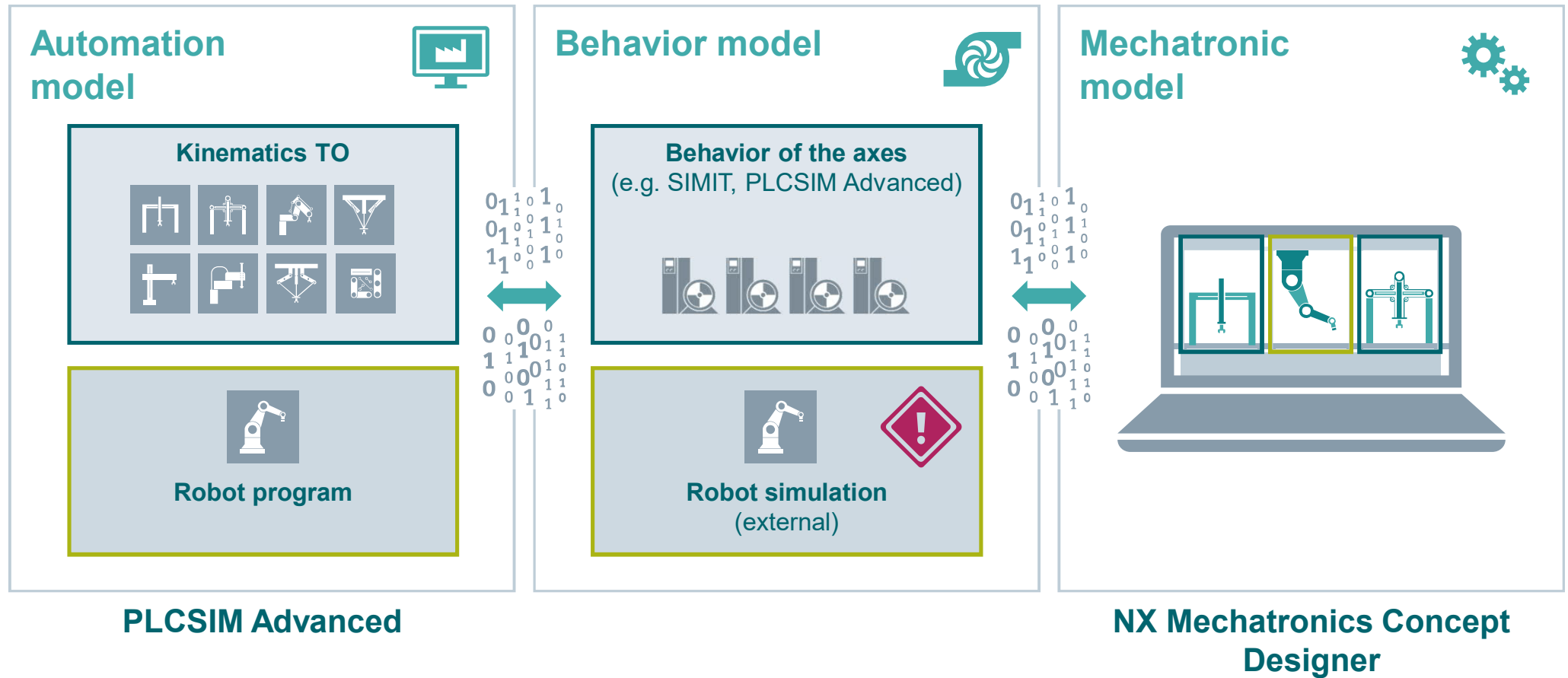


NX Mechatronics Concept Designer

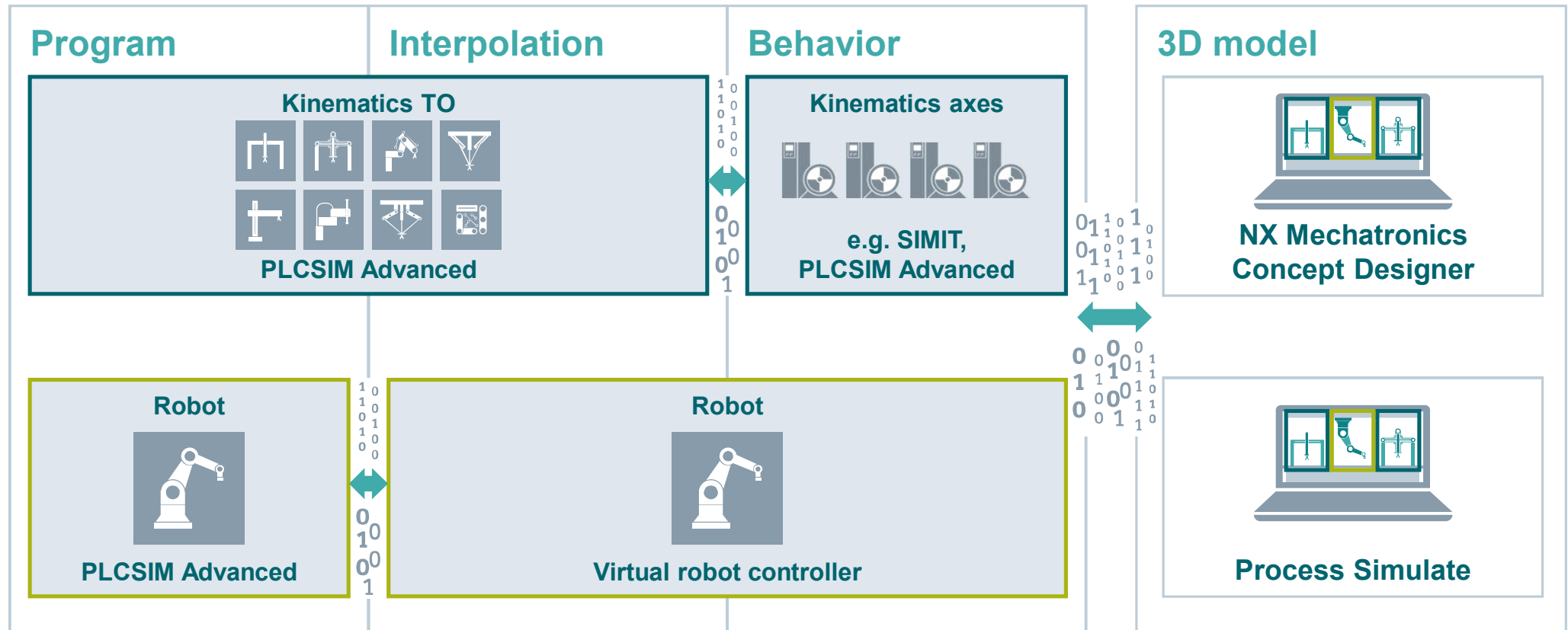


This is how it works

Simulation and validation of the kinematics functionalities



This is how it works – Simulation and validation of kinematics programs



Kinematics toolbox V2

Virtual commissioning of kinematics

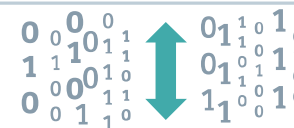


- Application example with all kinematics implemented in the Kinematics TO
- Extensive TIA Portal projects
- Behavior model of the axes in SIMIT (closed-loop)
- NX MCD models for all kinematics implemented in Kinematics TO

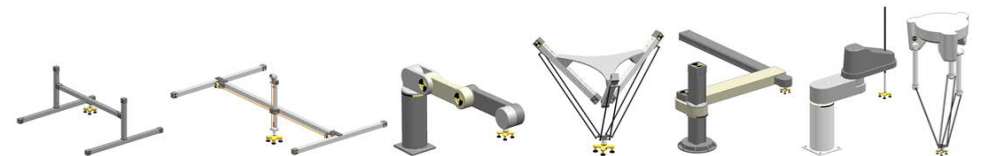
TIA Portal – kinematics programs

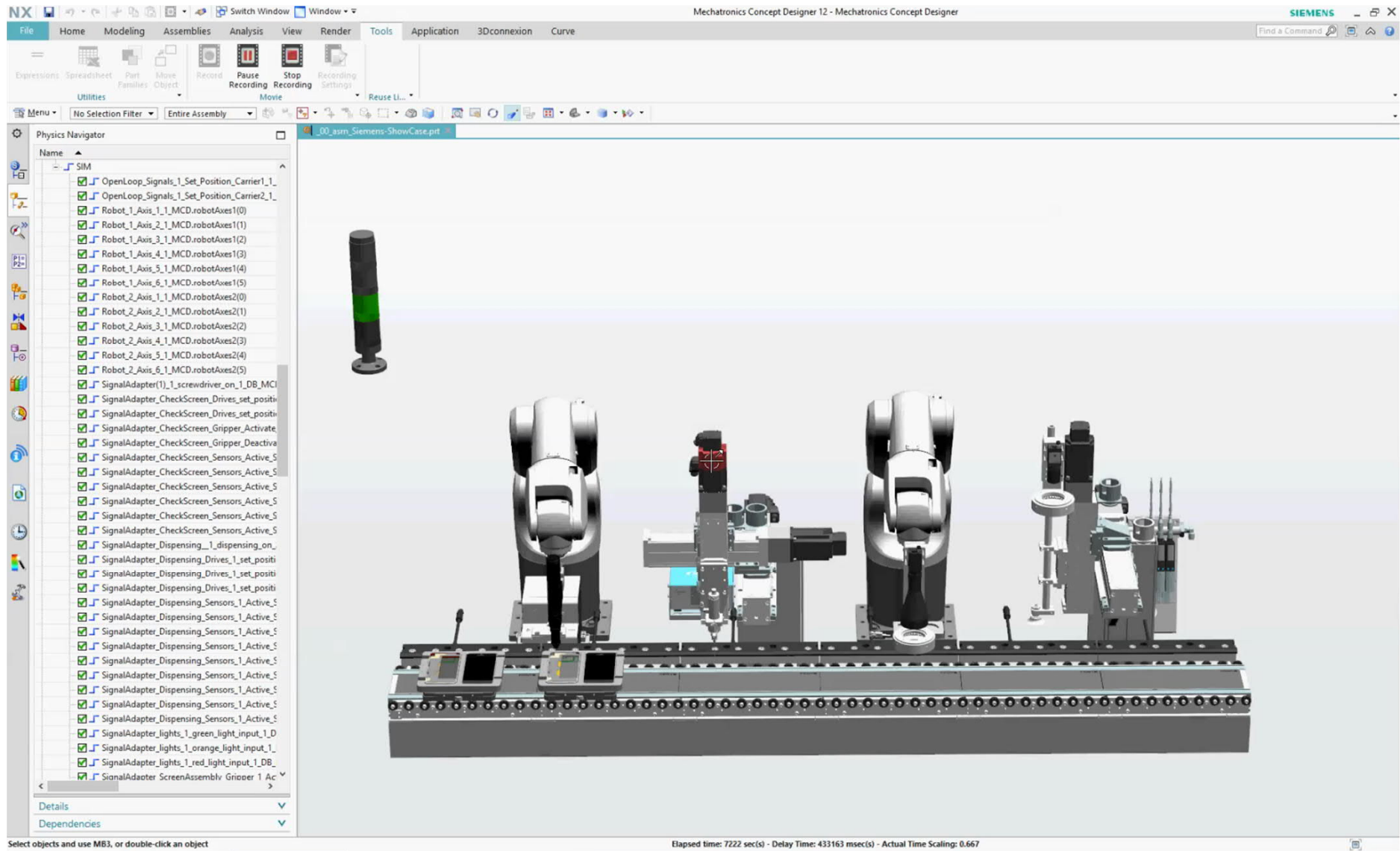


Behavior of the axes (SIMIT, or Crosslink)



NX Mechatronics Concept Designer

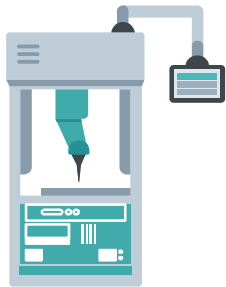




Integrated engineering of kinematics

Core message and "Sales Action"

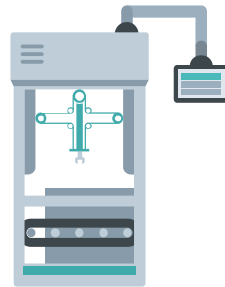
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Challenge 1

Sales increase by opening up new potentials

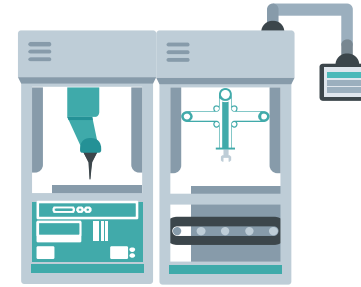
Programming of 6-axis robots in the TIA Portal



Challenge 2

Sales increase with the SIMATIC T-CPU

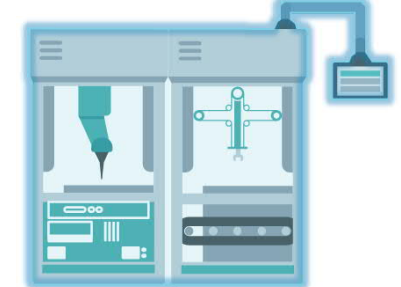
Simple system integration of 2-4-axis kinematics in SIMATIC S7-1500 T-CPU



Challenge 3

SIMATIC as an integrated solution for all kinematics

Easy entry into the world of kinematics for your customers



Challenge 4

Sales increase with simulation tools for kinematics applications

Reduction of commissioning time and commissioning risks of kinematics through digital twin

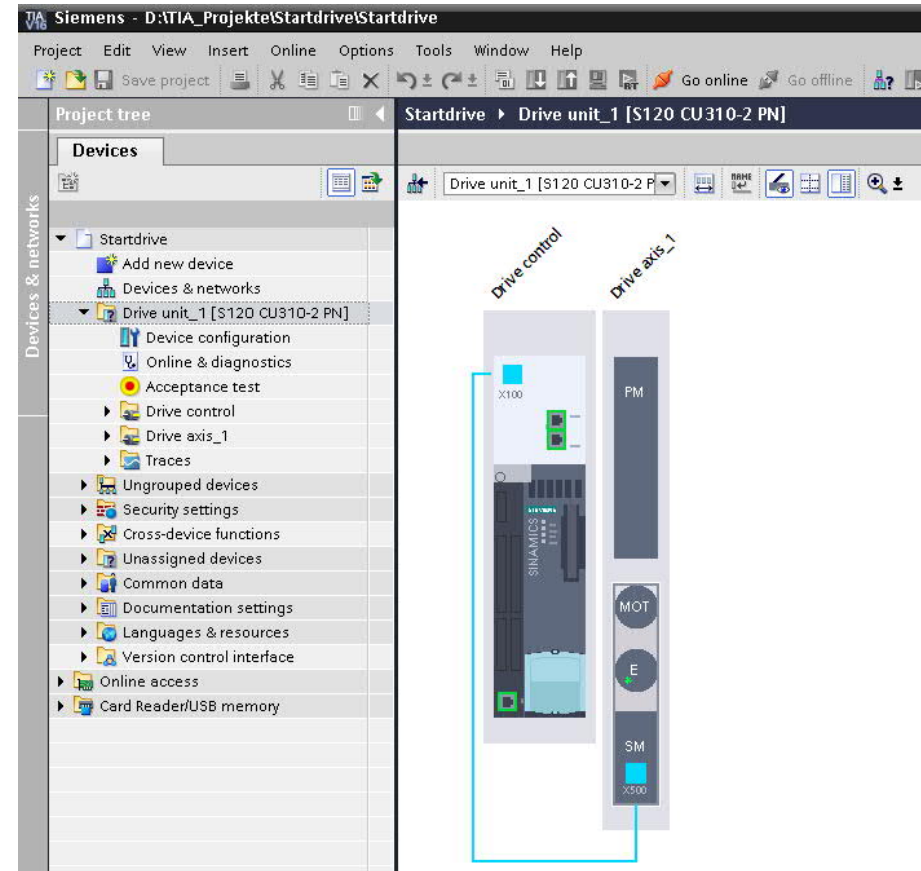


NEWS Motion Control

Startdrive V16 - Innovations



- Support of **CU310-2 PN with PM240-2**
- Support of **CU Adapters CUA31/32**
- Support of SINAMICS **Integrated** for **SIMATIC Drive Controller**
- Support of SINAMICS **Know-How and Write protection** (SINAMICS S)



SIMATIC MICRO-DRIVE 24V/48V DC&EC drive system



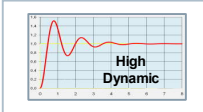

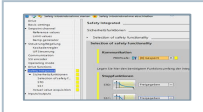

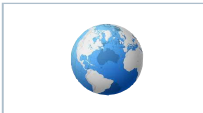
Siemens product portfolio for drive systems

Extra-low voltage DC	Low voltage AC			DC	AC
Basic	Basic	Midrange	High-End	Simple and complex applications	Complex applications with high performance classes
24 V DC / 48 V DC SIMATIC MICRO-DRIVE PDC 	<ul style="list-style-type: none"> SINAMICS V20 SINAMICS V90 	<ul style="list-style-type: none"> SINAMICS G120C SINAMICS G120P SINAMICS G120 SINAMICS G110D/G120D / G110M SINAMICS G130 / G150 SINAMICS G180 SINAMICS S110 SINAMICS S210 	<ul style="list-style-type: none"> SINAMICS S120 SINAMICS S150 	<ul style="list-style-type: none"> SINAMICS DCM 	<ul style="list-style-type: none"> SINAMICS GL150 / SL150 SINAMICS SM120 CM / SM 150 / GM 150 SINAMICS GH150 / GH180
50 – 1000 W	0.05 – 30 kW	0.12 – 6,600 kW	0.12 – 5,700 kW	6 kW – 3 MW	6 kW – 14.2 MW

SIMATIC MICRO-DRIVE

Features and benefits



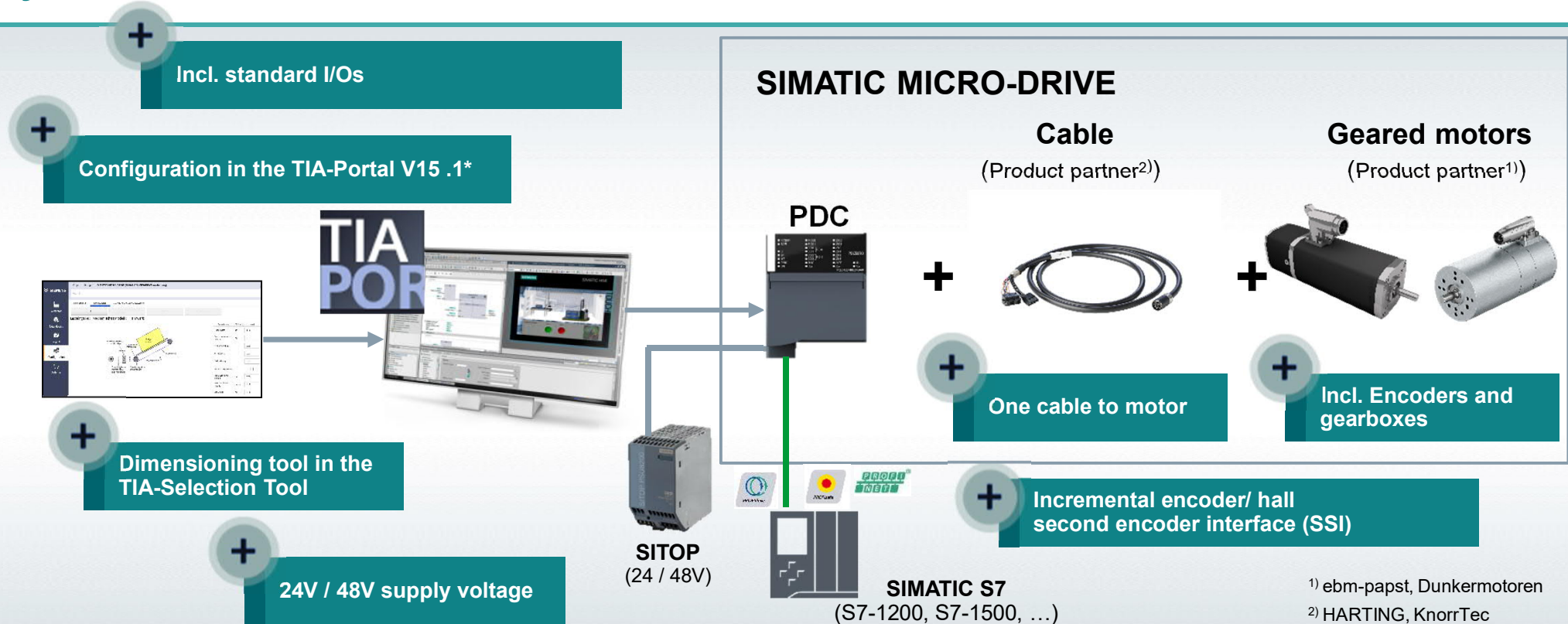
Feature/Function	Benefits
<ul style="list-style-type: none"> Flexibility and combinability of system components¹ PROFINET IRT (1ms) 	<ul style="list-style-type: none"> Universally applicable Increased performance 
<p>Safety Integrated: STO, SS1, SLT, SLS, SBC, SSM via PROFIsafe</p>	<p>Fulfills high demands for safety</p> 
<ul style="list-style-type: none"> TIA Portal integration “One Button Tuning” 	<p>Easy engineering</p> 
<ul style="list-style-type: none"> One cable to motor² Integrated C1 EMC-Filter 	<p>Saves time on installation</p> 
<ul style="list-style-type: none"> 24 – 48 V: 0.05 – 1.00kW Battery supply incl. energy recovery UL and Marine certification 	<p>Ready for various markets</p> 

¹ Product partner: Dunkermotoren & ebm-papst (motors)/HARTING & KnorrTec (connecting cables) | ² Dunkermotoren up to 200W & ebm-papst up to 400W

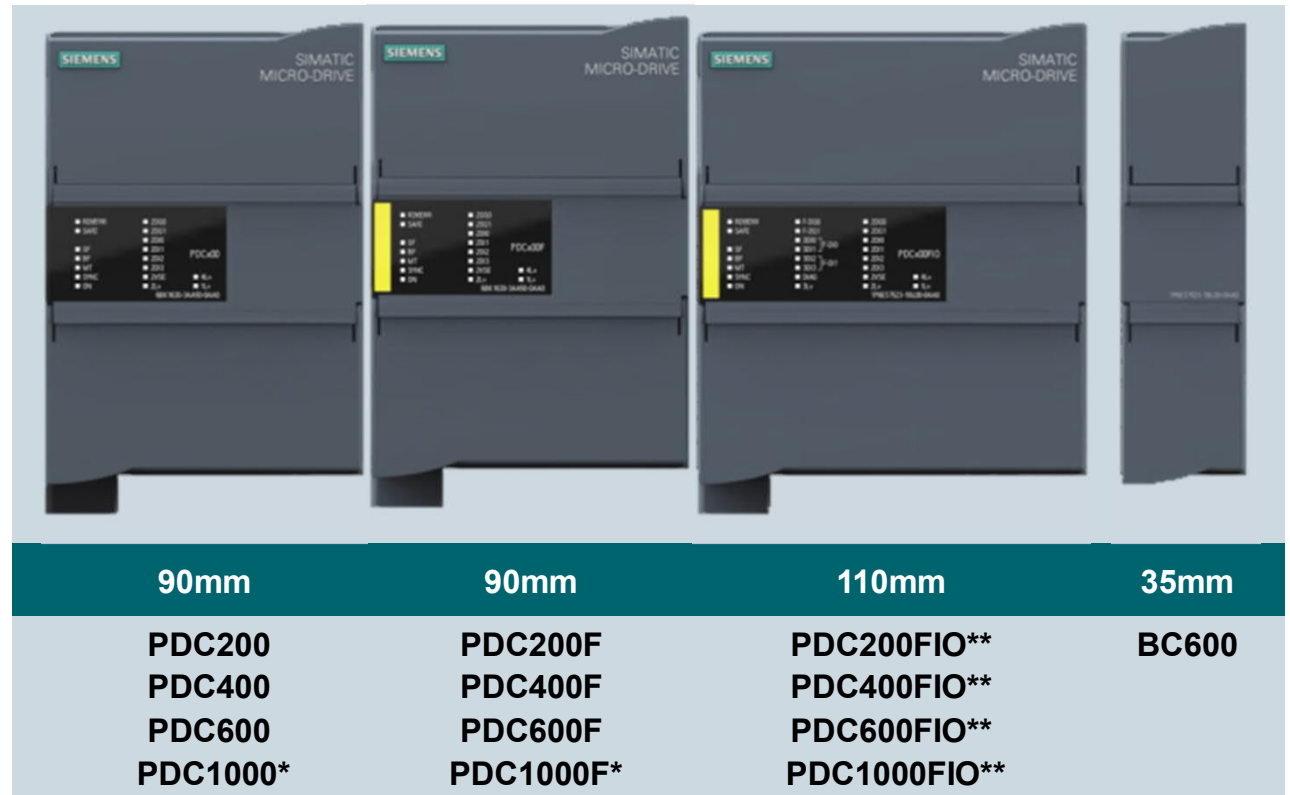
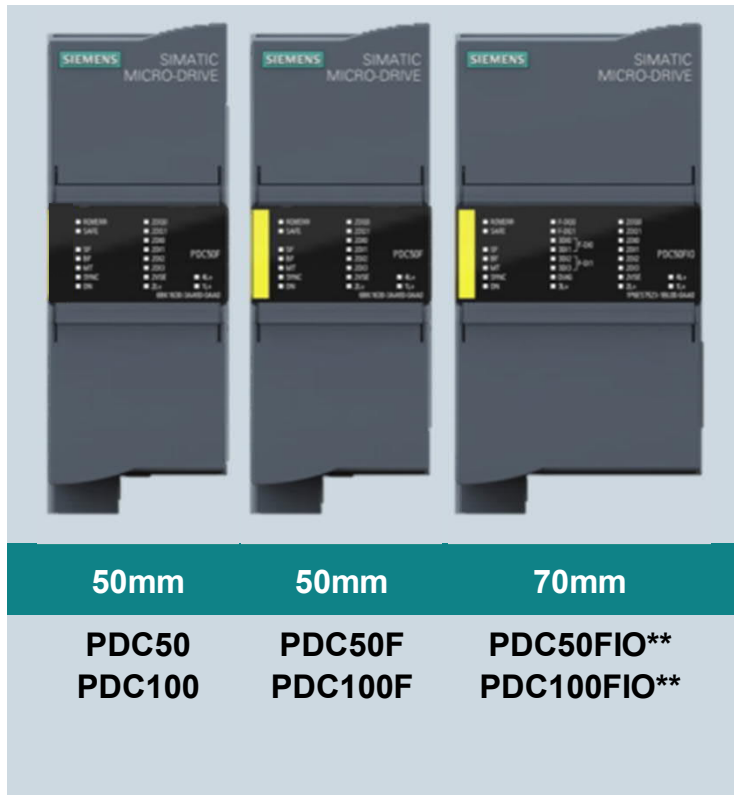
SIMATIC MICRO-DRIVE 24V/48V DC&EC drive system



System overview



SIMATIC MICRO-DRIVE PDC Enclosure Sizes



General dimensions

H: 125 mm depth: 120 mm width: variable

SINAMICS S210 Servo Drive System, positioning within SINAMICS “Discontinuous Motion” Portfolio

SIEMENS
Ingenuity for life



Basic: SINAMICS V90 Servo Drive System

Single axis AC/AC drive with **basic functionality** and connectivity for standard numeric and motion controllers

Midrange: SINAMICS S210 Servo Drive System

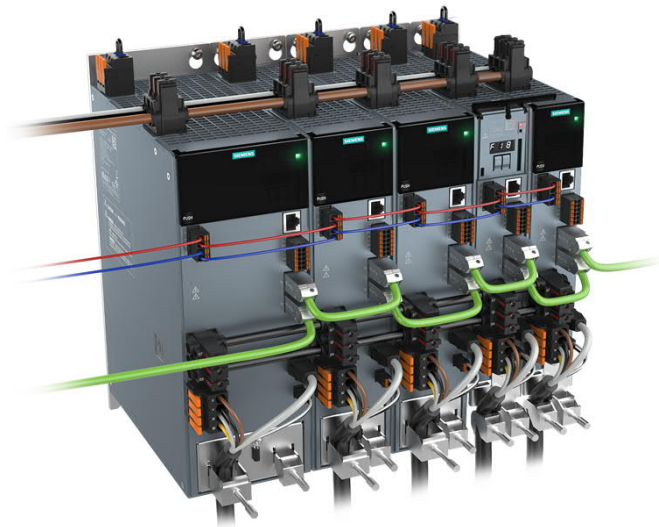
Single axis AC/AC drive with **high dynamic and performance** for motion applications in the mid range segment.

High-End: SINAMICS S120 Servo Drive

Modular DC/AC multi axis system with **most advanced drive based technology** and connectivity to high end numeric and motion controllers

SINAMICS S210 servo drive system

Features and benefits



Feature/Function

- Dedicated S-1FK2 motors (Compact or high dynamic)
- PROFINET IRT (250 μ s)

Basic and **Extended** Safety integrated functions via PROFIsafe

- Integrated Webserver
- »One Button Tuning«
- **TIA Portal (V15.1)**

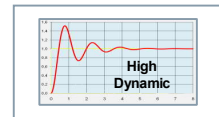
- One-Cable-Connection (OCC)
- Integrated EMC (C2) Filter

- 1AC 230V (200 – 240V) 0,05 – 0,75kW
- **3AC 400V (200 – 480V) 0,40 – 7,00kW¹**
- UL Certification

NEW!

Benefits

Increase performance



Fulfill high demands for safety



Easy engineering



Saves time on installation



Ready for world wide markets



¹ FSA (FY19 Q2); FSB (FY19 Q3); FSC (FY19 Q4)

SINAMICS S210

New Power Range regarding frame size

SIEMENS
Ingenuity for life



NEW!



1AC 200-230V

3AC 200-480V

FSA
0.1; 0.2kW
at 1AC-230V

FSB
0.4kW
at 1AC- 230V

FSC
0.75kW
at 1AC- 230V

FSA
0.4; 0,75; 1.0kW
at 3AC-400V

FSB
1.5; 2.0kW
At 3AC-400V

FSC
3.5; 5.0; 7.0kW
at 3AC-400V

SINAMICS G120X

SIEMENS
Ingenuity for life

Water & Wastewater



Heating, Ventilation, Air-conditioning



SINAMICS G120X Features



- Seamless power range **up to 630 kW/ 700 HP**
- Long cable lengths **up-to 450m**
- Harsh environment **3C3 coating**
- Firmware functions: **Deragging mode, pipe-filling mode, multi-pump control**
- **PN, Profibus, Modbus RTU, EtherNet/IP**

SINAMICS G120X Features



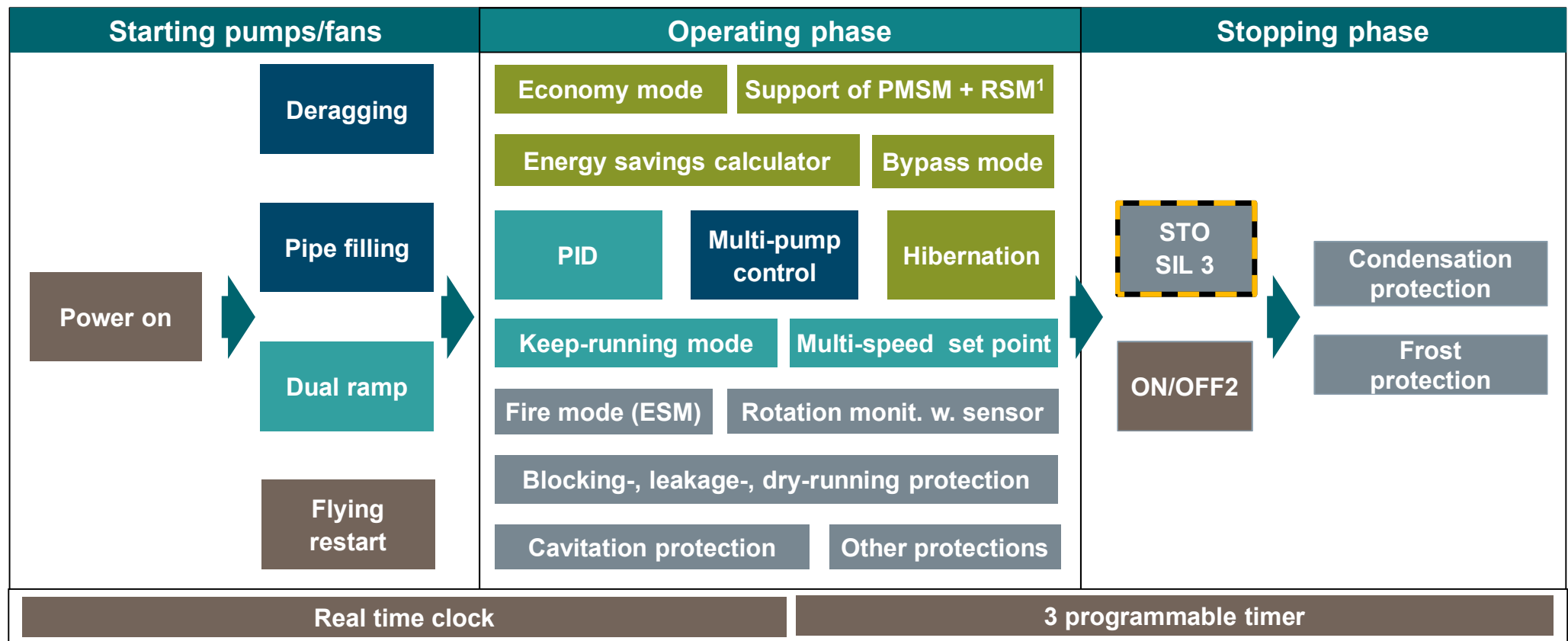
- Time saving, easy to setup: **“Out of the box”**
- High EMC requirements – **C1 class (filter B)**
- High protection degree **IP55¹**
- Firmware functions: **ESM (Fire Mode), automatic restart, skip frequency bands**
- **BACnet MS/TP, Modbus RTU, USS**

¹ In preparation

SINAMICS G120X brings the best pump and fan control ensuring energy-saving and protection



Selected FW functions



SIMATIC Drive Controller S7-1500 Technology-CPU

The scalable SIMATIC Motion Controller Portfolio

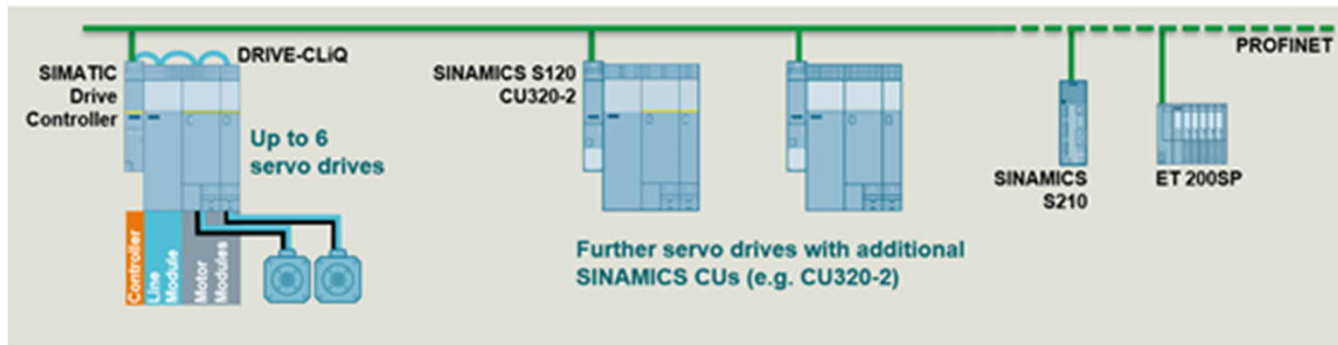


SIMATIC CPU 1504D TF & CPU 1507D TF / Handling V2.0 / Cross PLC synchronous operation



Feature / Function	Benefit
<ul style="list-style-type: none"> • Compact & Close-to-Drive SIMATIC controller Portfolio extension optimized for production machines: CPU 1504D TF and CPU 1507D TF 	<ul style="list-style-type: none"> ▶ Motion Control PLC, drive control and technology I/Os in one device for compact & high performance multiaxis machines
<ul style="list-style-type: none"> • Extensive connection options for communication, HMI and peripherals 	<ul style="list-style-type: none"> ▶ Complete machine control close to the drive incl. reduced assembly and programming efforts
<ul style="list-style-type: none"> • Control of kinematics with up to 4 interpolating axes incl. synchronization to moved belts 	<ul style="list-style-type: none"> ▶ Simple programming of pick & place, assembly or handling tasks based on PLCopen
<ul style="list-style-type: none"> • Cross PLC synchronous operation 	<ul style="list-style-type: none"> ▶ Synchronized movements over several CPUs allow modular automation concepts
<ul style="list-style-type: none"> • Universal functionality & programming from S7-1500 to S7-1500 T-CPU 	<ul style="list-style-type: none"> ▶ Seamless extension of the motion control functionality of a standard CPU in TIA Portal
<ul style="list-style-type: none"> • Fail-safe CPU with extended motion control functions incl. safe monitoring of movements 	<ul style="list-style-type: none"> ▶ Automation, Motion Control and Safety Solutions with one CPU

SIMATIC Drive Controller System Overview



The controller for applications with the SINAMICS S120 multi-axis drive system

SIMATIC Drive Controller Features



	Technology CPU					MFP CPU	Open Controller	Drive Controller CPU ⁶	
CPU types	1511TF-1 PN	1515TF-2 PN	1516TF-3 PN/DP	1517TF-3 PN/DP	1518F-4 PN/DP MFP		1515SP PC2 TF PN	1504D TF	1507D TF
Interfaces									
Program/Data memory	225/225 KB 1 MB	750/750 KB 3 MB	1,5/1,5 MB 5 MB	3/3 MB 8 MB	4/6 MB 20 MB ¹		1/1,5 MB 5 MB	2 MB 4 MB	6 MB 20 MB
Bit performance	60 ns	30 ns	10 ns	2 ns	1 ns		10 ns	Scale with motion control performance	
Functions	Display, S7-1500 backplane bus							SINAMICS S120 Integrated (incl. 12 DI, 8 DI/DQ) additional PLC technology I/Os (8 DI/DQ)	
Positioning axes									
▪ Typical ²	5	7	55	70	128		30	8	80
▪ Maximum ³	10	30	80	128	128		30	30	128
Motion Control Ressources ⁴	800	2.400	6.400	10.240	10.240		2.400	2.400	10.240
Extended Motion Control Ressources ⁵	40	120	192	256	-		120	120	300
									NEW

1 50 MB add. for C/C++ (PLC-RT)+500 MB for C/C++ appl. (RT/appl.)
 4 Resources for Motion Control technology objects:
 5 Resources for Extended Motion Control technology objects:
 6 V16: CPU 1504D TF, CPU 1507D TF; further CPUs >V16 planned

2 At 4 ms Servo/IPO cycle time and 35 % CPU load due to Motion Control
 Speed axis = 40 | Positioning axis = 80 | Synchr. Axis = 160 | Output cam= 20 | Output cam track= 160 | Measuring input= 40
 Cams = 2 | Kinematic objects= 30 | Leading axis proxy = 3
 3 No further TO's applicable

PROFINET IO with IRT PROFINET IO with RT PROFINET basic communication (1 Gbit) PROFIBUS

Q&A