IndraMotion MLC – The complete system for all control tasks

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Bosch Group

Agenda

- Fact Sheet
- Key Message
- Function principle and product description
  - Intelligent system components
  - High level efficiency in engineering
  - Seamless integration in Industry 4.0 environments
- Summary and highlights

Note: This presentation covers functional range of IndraMotion MLC 14VRS

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Fact sheet

OPEN CORE ENGINEERING

Customer benefits

- Maximum machine productivity due to application optimized solutions
- Cost saving thanks to high-level languages
- Future reliability due to an open system and the support of standards
- Seamless integration into Industry 4.0 / IoT environments

Features

- Complete system for all control tasks
- Scaled device portfolio
- Flexible integration in different topologies
- Integrated runtime system for motion, robot, and logic control in accordance with the open PLC standard IEC 61131-3
- Open Core Engineering as connection between PLC-based engineering and IT automation

Target applications

- PLC-based applications
- Motion logic applications
- Applications in industry 4.0 environments

Distinguishing features

- Optimum coordinated tool chain for all phases of the engineering workflow
- Extensive function toolkits with technology oriented solutions
- Easy implementation of modular machine concepts
- Open Core Interface
- Broad application know how in many sectors
- Global presence

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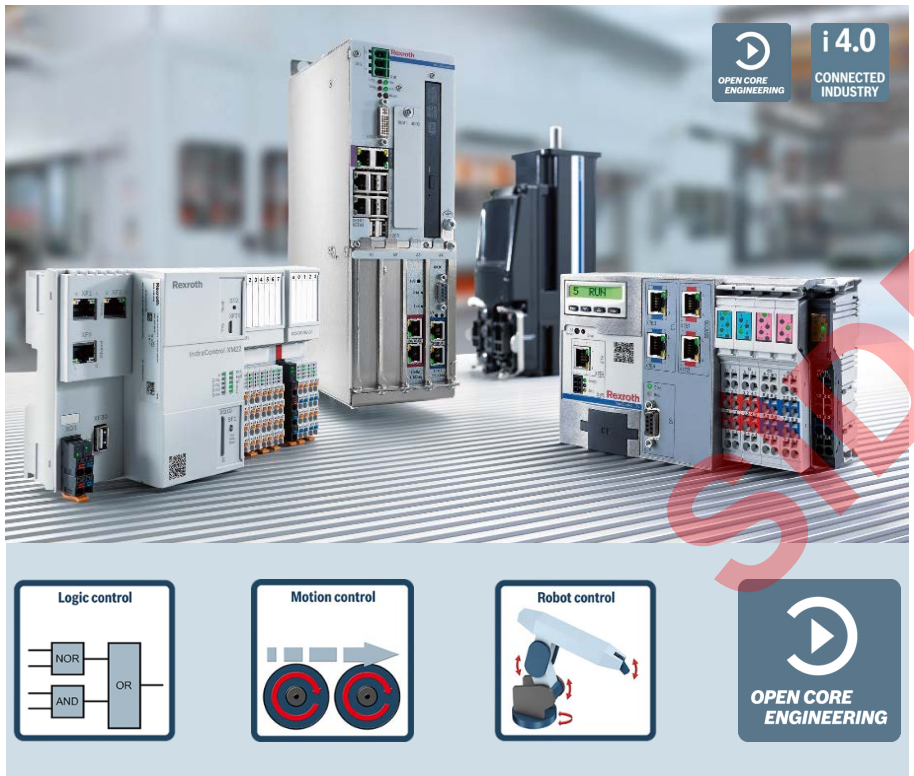
The complete system for all control tasks



- **Maximum machine productivity**
  Complete and universal automation solution for all motion logic applications
- **High-level efficiency in engineering**
  Simplified processes with the IndraWorks engineering framework and application-oriented function toolkits
- **Future-proof due to optimum integration into Industry 4.0 environments**
  Open Core Engineering as the connection between PLC-based engineering and IT automation

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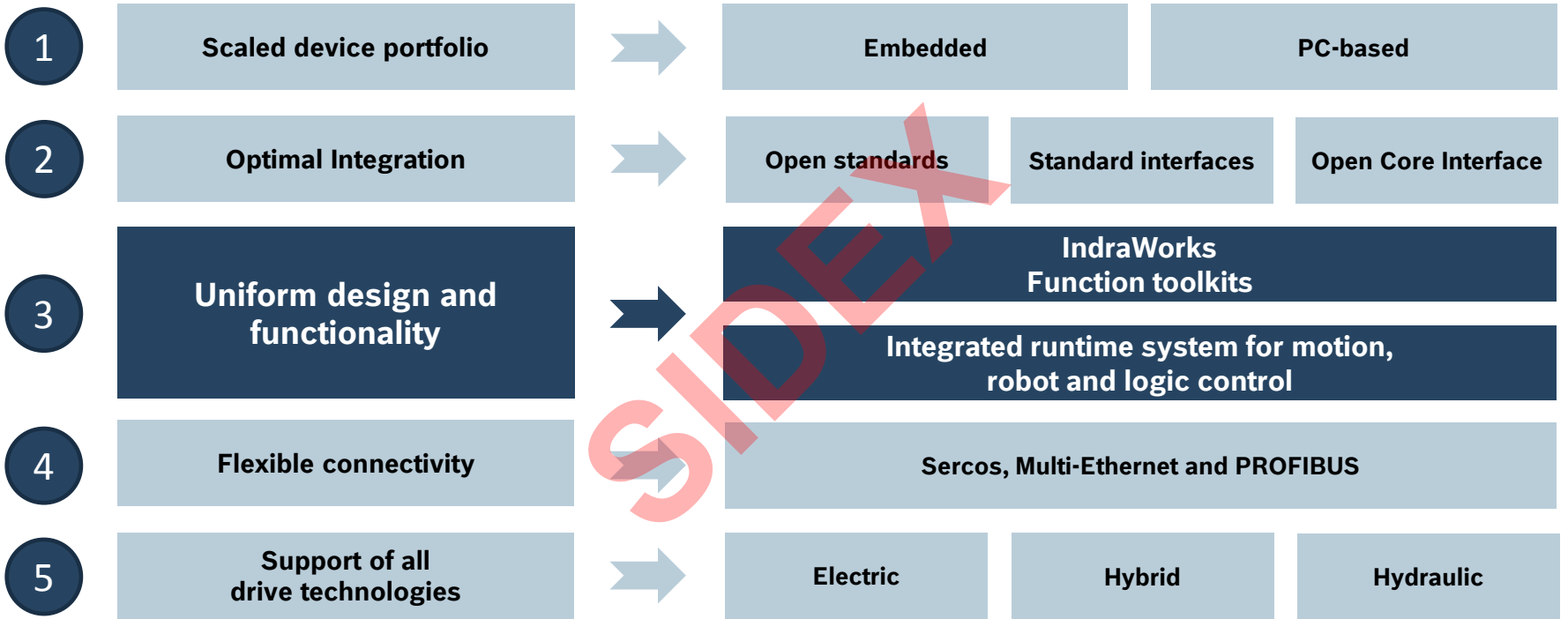
5 reasons for using the system



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Intelligent system components

IndraControl L

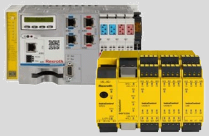
IndraControl XM

IndraControl V

Inline

IndraControl S20

IndraControl S67



Safety technology

HMI

Drives

Scaled device portfolio

IndraControl L

- Embedded control hardware

NEW

IndraControl XM

- Embedded control hardware

NEW

IndraControl VPB

- High-Performance IPC control hardware

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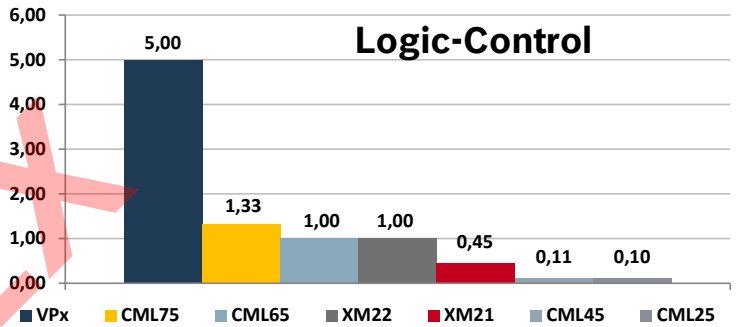
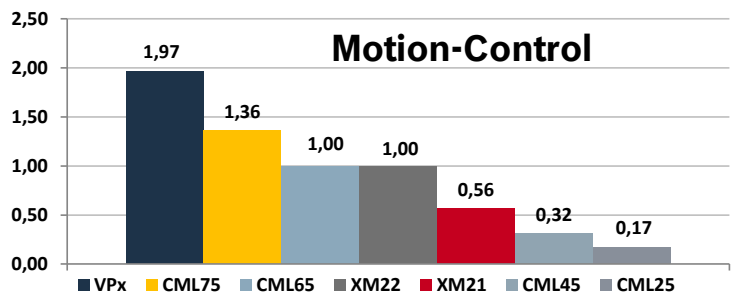
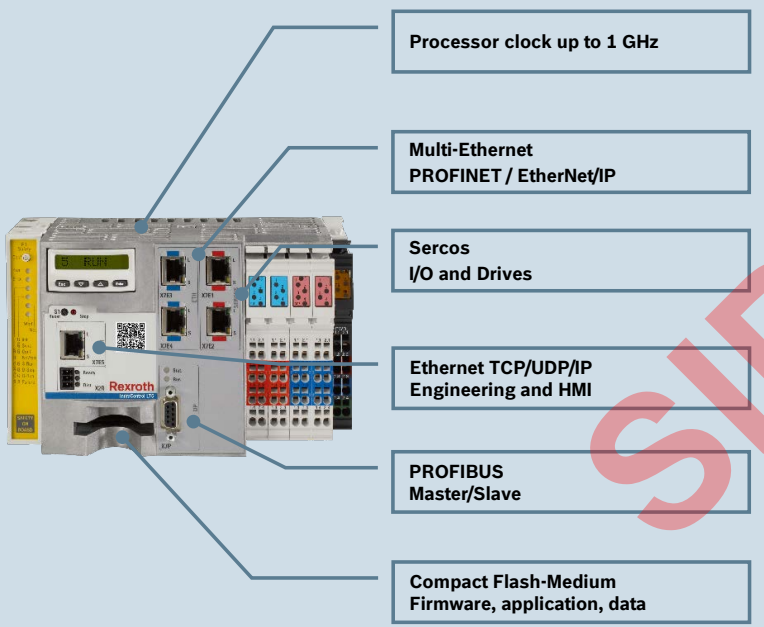
Scaled IndraMotion MLC performance





Note: Data for IndraMotion MLC 14VRS

Stepped performance in compact format



Example: IndraControl L75

- **High control performance** with INTEL technology
- **Future-proof embedded hardware architecture** with integrated boards according to COM-Express standard
- **Fail-safe** by automatic safeguarding of application data in case of power failure
- **Full Real-time Ethernet communication** with Sercos, PROFINET RT and EtherNet/IP
- **Maintenance-free** design, no wearing parts like fans, hard disks or batteries

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Overview

Function modules


Fast I/O


RT-Ethernet/ PROFIBUS


Programmable limit switches


SRAM


Sercos II / III


SafeLogic

Controls


IndraControl L25


IndraControl L45


IndraControl L65/75

I/O [IP20] – Inline


Bus coupler


Digital I/O

Analog I/O

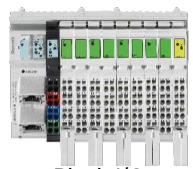

Counter


Communi-cation


Power supply


Relay


Technology


Block I/O Digital/Analog


Safety I/O

System performance – Hardware

L 25

Processor	Reneas SH7785 (SH4)
Remanent Data	128 kB / 128 kB (PLC/Motion)
Onboard I/O	-
Local I/O	512 I/O (64 Byte)
Function modules	2

Connectivity	Sercos PROFIBUS DP PROFINET RT EtherNet/IP EtherNet TCP/IP

L 45

Processor	AMD Geode LX800 / 500 MHz
Remanent Data	128 kB / 128 kB (PLC/Motion)
Onboard I/O	8 DI/8 DO
Local I/O	512 I/O (64 Byte)
Function modules	4

Connectivity	Sercos PROFIBUS DP PROFINET RT EtherNet/IP EtherNet TCP/IP

L 65

Processor	INTEL Celeron M / 1 GHz
Remanent Data	128 kB / 128 kB (PLC/Motion)
Onboard I/O	8 DI/8 DO
Local I/O	512 I/O (64 Byte)
Function modules	4

Connectivity	Sercos PROFIBUS DP PROFINET RT EtherNet/IP EtherNet TCP/IP

L 75

Processor	Intel E3827 dual-core 1.75GHz
Remanent Data	128 kB/ 128 kB (PLC/Motion)
Onboard I/O	8 DI/8 DO
Local I/O	512 I/O (64 Byte)
Function modules	4

Connectivity	Sercos PROFIBUS DP PROFINET RT EtherNet/IP EtherNet TCP/IP

System performance – IndraMotion MLC

L 25

User memory	12 MB (Code + Data)	**No. of tasks**		10
Processing time	typ. 35 µs for 1,000 mixed instructions		PLC:	1 ms
No. of axes	16 (4 Control axes, 4 Kinematics)	**Cycle times**	Motion:	2 ms
			Sercos:	1 ms

L 45

User memory	24 MB (Code + Data)	**No. of tasks**		20
Processing time	typ. 30 µs for 1,000 mixed instructions		PLC:	1 ms
No. of axes	32 (8 Control axes, 16 Kinematics)	**Cycle times**	Motion:	1 ms
			Sercos:	0,5 ms

L 65

User memory	36 MB (Code + Data)	**No. of tasks**		20
Processing time	typ. 5 µs for 1,000 mixed instructions		PLC:	1 ms
No. of axes	64 (32 Control axes, 16 Kinematics)	**Cycle times**	Motion:	1 ms
			Sercos:	0,25 ms

L 75

User memory	36 MB (Code + Data)	**No. of tasks**		20
Processing time	typ. 5 µs for 1,000 mixed instructions		PLC:	1 ms
No. of axes	64 (32 Control axes, 16 Kinematics)	**Cycle times**	Motion:	1 ms
			Sercos:	0,25 ms

IndraControl L75 – Successor for IndraControl L65

Replacement for IndraControl L65

- 100% function compatible
- Same technical system data
  - Memory, I/O, connectivity…
- Better performance: approx. +20 %
- Same price as IndraControl L65

Control system support

- IndraMotion MLC
- IndraLogic XLC
- IndraMotion MTX

… with 14VRS firmware

Project conversion

- New target in IndraWorks 14V08
- Project is code compatible

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IndraControl L function modules

Communication Interfaces

- PROFINET RT
- EtherNet/IP
- Ethernet TCP/IP
- PROFIBUS DP

Real-Time-Ethernet and PROFIBUS

Communication Interfaces

- Control cross-communication
- Ethernet-based Real-time-communication to drives and I/O-peripheral

Sercos II / III

Memory module

- 8 MB SRAM, battery-backed
- Additional non-volatile memory for Motion Control applications

SRAM

Functional interface

- 16 fast digital outputs
- Programmable limit switches functionality

Programmable limit switches

Functional interface

- 24 fast digital Inputs/Outputs
- 8E / 8A / 8 variable
- Measuring probes functionality

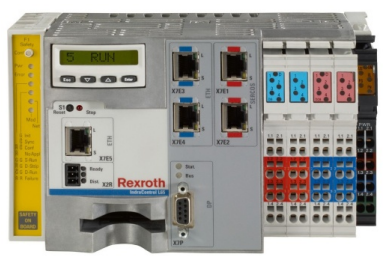
FAST I/O

Safety

- Safety CPU for dual-channel evaluation of safety application

SafeLogic

- **Functional extendibility** of technology and communication via modules
- **Up to 4 modules** can be used simultaneously (L25: 2 Modules)
- Controller-Interface PCI-Bus
- Logic power supply directly by system bus (PCI)



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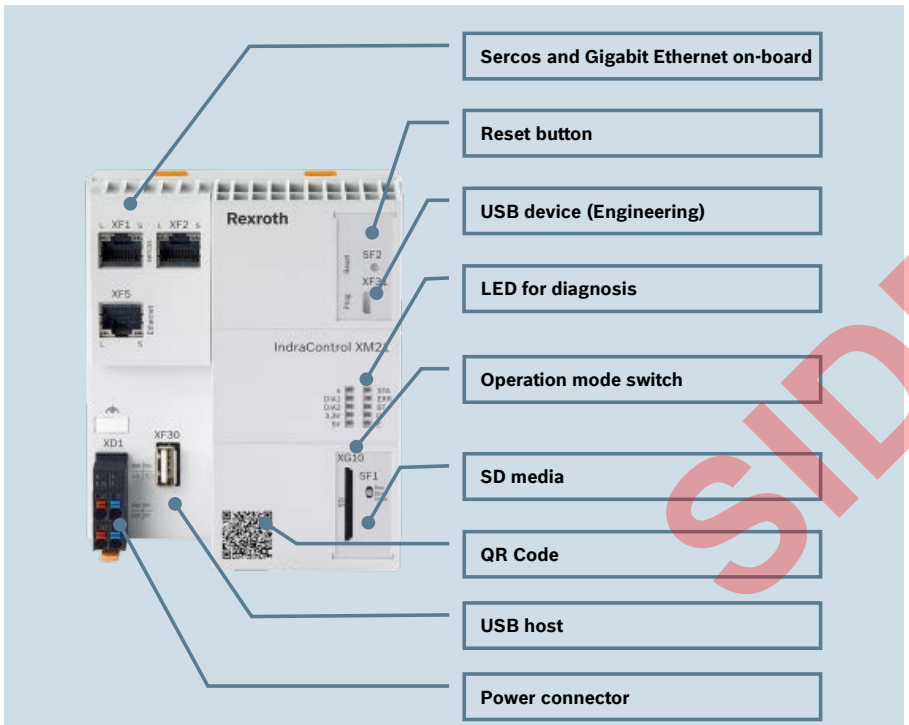
Flexible control in real-time



Example: IndraControl XM21

- **Scaled device portfolio**
- **Intel Atom CPU** up to 1300 MHz
- **Complete control** system with high-performance process data processing
- **Easy and flexible system configuration** with modular I/O expansion
- **Sercos as a universal automation bus** for system-wide networking
- **Maintenance-free** – no wear parts like fans, hard disks or batteries

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Overview

Extension modules


RT-Ethernet


SafeLogic


PROFIBUS


Sercos

Controls


IndraControl XM21


IndraControl XM22

I/O [IP20] – IndraControl S20


Bus coupler


Digital I/O


Analog I/O


Safety


Counter


Communication


Technology

System performance – Hardware

XM 21

Processor	Intel Atom E620, 600 MHz
Remanent Data	64 kB / 64 kB (PLC/Motion)
Onboard I/O	-
Local I/O	512 I/O (64 Byte)
Extension modules	3

Connectivity	Sercos EtherNet TCP/IP USB

XM 22

Processor	Intel Atom E660, 1.300 MHz
Remanent Data	64 kB / 64 kB (PLC/Motion)
Onboard I/O	-
Local I/O	512 I/O (64 Byte)
Extension modules	3

Connectivity	Sercos EtherNet TCP/IP USB

System performance – IndraMotion MLC

XM 21

User memory	36 MB (Code + Data)	**No. of tasks**	20
Processing time	typ. 35 µs for 1,000 mixed instructions		
No. of axes	40 (16 Control axes, 16 Kinematics)	**Cycle times**	PLC: 1 ms Motion: 1 ms Sercos: 1 ms

XM 22

User memory	36 MB (Code + Data)	**No. of tasks**	20
Processing time	typ. 18 µs for 1,000 mixed instructions		
No. of axes	40 (16 Control axes, 16 Kinematics)	**Cycle times**	PLC: 1 ms Motion: 1 ms Sercos: 0,25 ms

IndraControl XM Extension modules

Communication

- PROFINET RT
- EtherNet/IP

Real-Time-Ethernet

Communication

- PROFIBUS DP

PROFIBUS

Function

- Safety functions up to PL e/Cat. 4 in accordance with ISO 13849 respectively SIL3 in accordance with IEC 62061

SafeLogic (i.p.)

Communication

- Control cross-communication

Sercos (i.p.)

- **Functional extendibility** of technology and communication via extension modules
- **Up to 3 modules** can be used simultaneously
- Controller-Interface PCI-Bus

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New Features – Comparison with IndraControl L

✓ **Higher power density**
- More CPU power within same price-performance class

✓ **More compact design**
- Compact housing in IndraControl S20 form factor

✓ **Local IndraControl S20 I/O**
- Modularity and functionality of IndraControl S20 I/O system available for local connection
- High-performance and synchronous I/O process data processing

✓ **SD card for optional memory extension**
- Additional standard flash memory (only approved SD cards)
- No SD card necessary (Internal flash for system, project and application data)

✓ **Mode selector with Run/Stop/Clear**
- Easy and safe mode selection during commissioning and maintenance

✓ **Extended environmental conditions**
- Operating temperature -25°C - + 60°C
- EMC class B (Residential area)

✓ **USB device – interface for engineering**
- Easy and safe point-to-point connection to IndraWorks
- No network connection required for engineering and commissioning (IT Security)

✓ **USB host – interface for additional flash memory**
- More removable flash memory for backup & restore, core dump and so on

IndraMotion MLC – Firmware function packages

Function Package (FP)	Name	Brief description	Required FP
PLC	Programmable Logic Control	PLC runtime according to IEC 61131-3 3rd Edition	-
MOT	Motion	Firmware-based control of single and synchronized multi-axis movements	PLC
TEC	Technology	PLC function blocks for technology functions	PLC, MOT
ROCO	Robot Control	General kinematics and transformations for robot control	PLC, MOT
HYD	Hydraulics	Centralized control of hydraulic axes	PLC, MOT
OPC UA	OPC UA	OPC UA server functionality for IndraMotion MLC	PLC
OCI	Open Core Interface	Interface for high-level language programming	PLC

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Start-up – No system firmware in delivery status

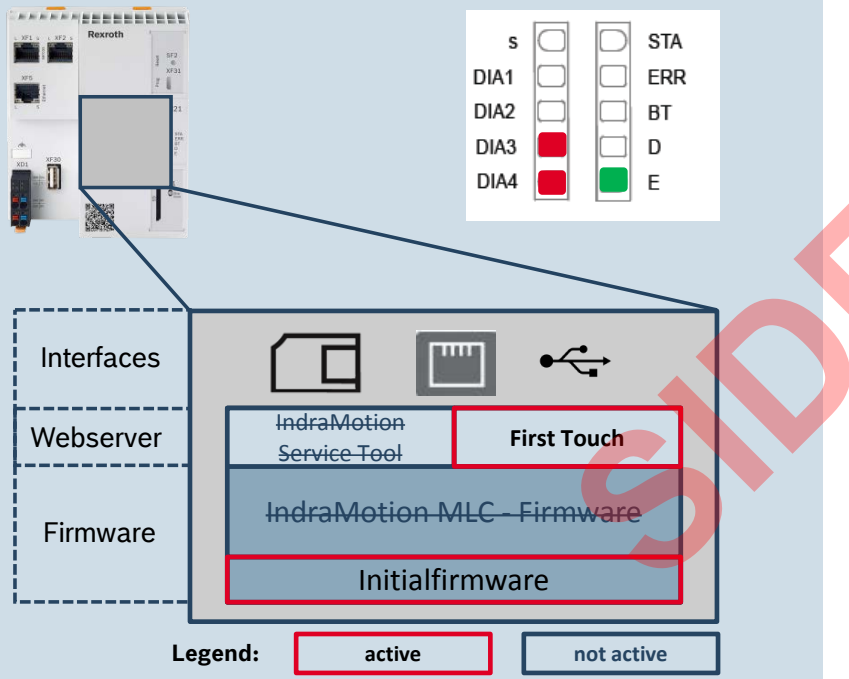


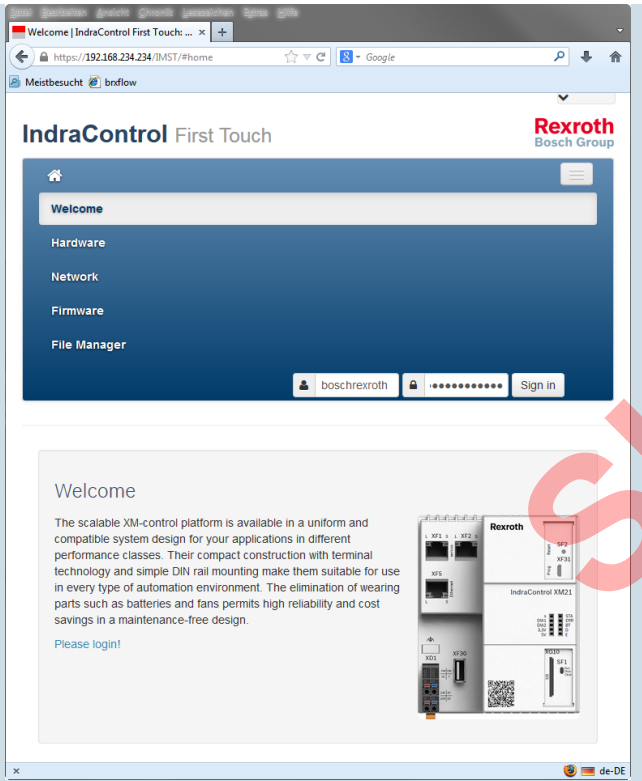
Figure: Schematic diagram – IndraControl XM

Basic functions IndraControl XM without system firmware:

- Reset IP address
- Reset user name and password
- Reset control to delivery status
- Support of IndraWorks start-up mechanisms
- Web-based commissioning tool “First Touch“

NEW

First Touch – Web-based commissioning



Features:

- Display electronic nameplate
- Network settings
- Firmware management
  - Install updates
  - Backup & Restore
  - Boot system firmware
  - Reset to factory settings
- File manager
  - Browse directories
  - Create and delete directories
  - Transfer files

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NEW

Serial commissioning without engineering PC

1. Create backup (System image) of existing control to SD card
2. Insert SD card in new control
3. Switch on power supply
4. Control installs backup (System image)
5. LED “E“ flashes green after successful installation

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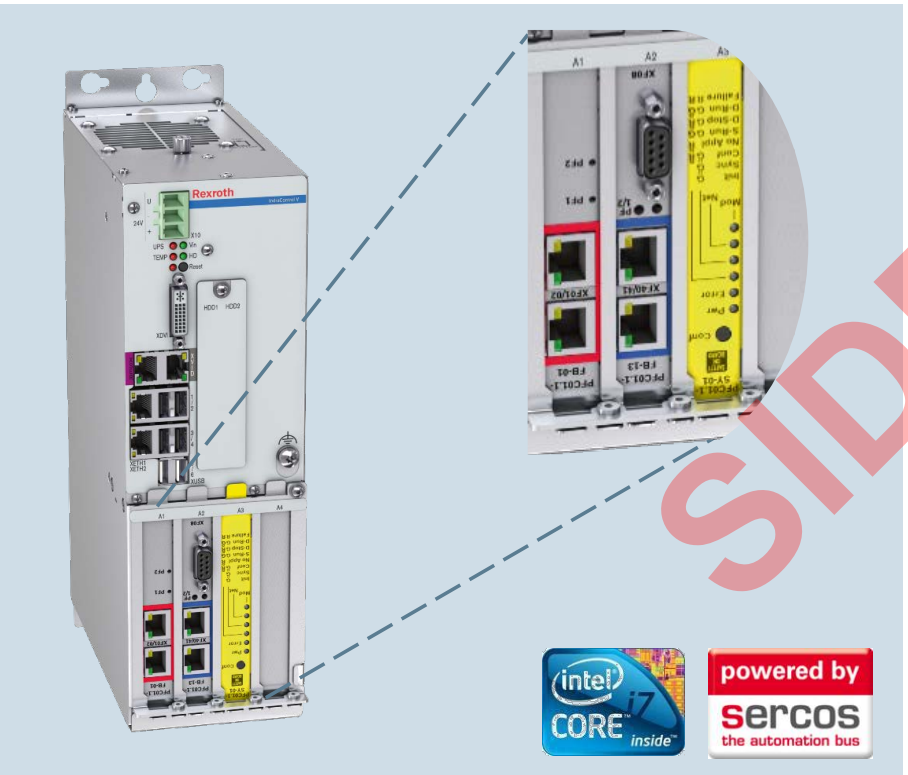
IPC control platform for IndraMotion MLC



- **High-performance IPC control** using Intel i7 chip technology
- **Extension modules** for Sercos and field bus communication (PROFINET, PROFIBUS, EtherNet/IP)
- **Leading RTS hypervisor technology** combining Windows and RTOS VxWorks
- **Complete control functionality** – logic, motion and robotics on one real-time firmware
- **Free PCIe slots** can be used by customer

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IPC control platform for IndraMotion MLC

Fields of application:

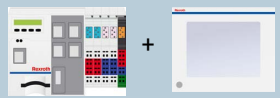
- High CPU power requirements
- Motion-Control: 64 ➔ 99 axes
- One device for
  - Windows & RTOS functionality
  - Motion-Logic and HMI

CPU performance

High-end Motion control

Windows & RTOS in one device

i4.0 CONNECTED INDUSTRY



One device for Motion logic and HMI

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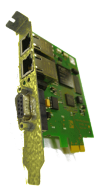
Overview

Extension modules

Sercos

RT-Ethernet
PROFIBUS



SafeLogic
(i.p.)

Control

IndraControl VPB40

Decentralized I/O [IP20] – IndraControl S20

Bus coupler

Digital I/O

Analog I/O

Safety

Counter

Communication

Technology

Decentralized I/O [IP67] – IndraControl S67

Bus coupler
Input M8

Digital M12
Input

Digital M12
Output

Analog M12
Input

Analog M12
Output

Analog M12
Input RTD

Analog M8
Output U/I

Digital M8
Input

Digital M8
Output

Power

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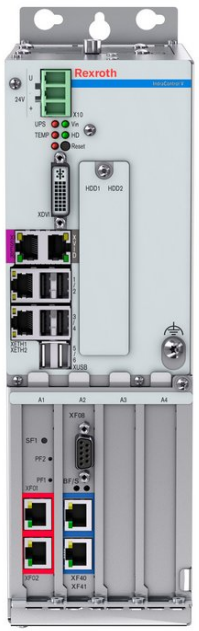
Performance – Hardware / System



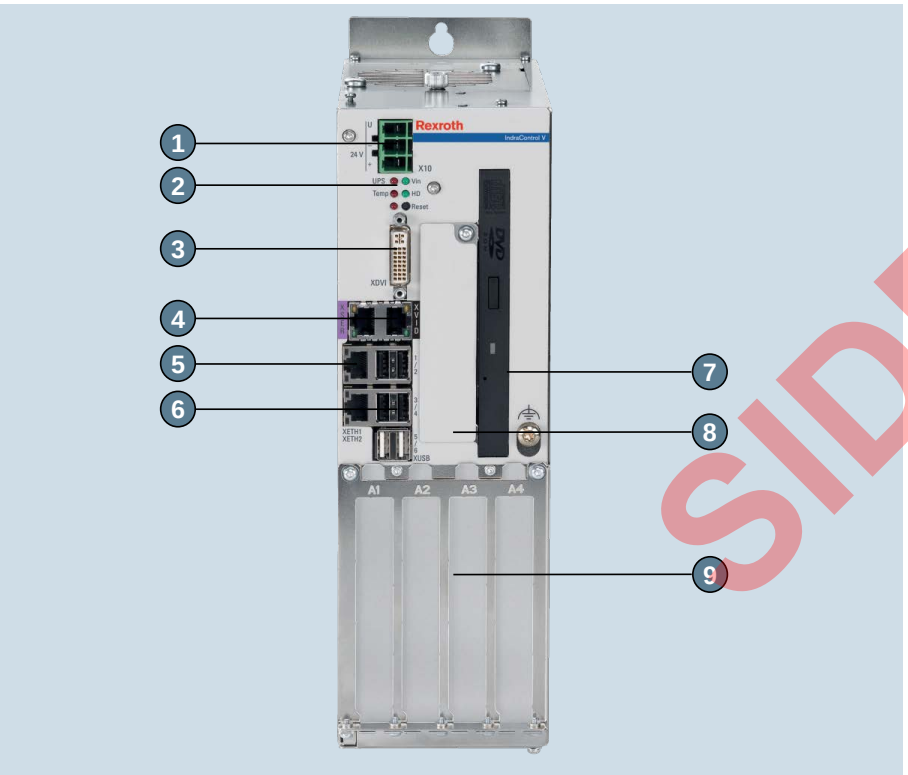
VPB40.3 (example)

Processor	Intel® Core i7-620M 2,66 GHz
Remanent data	1 MB / 1 MB (PLC / Motion) [UPS required]
Internal Flash	1 GB
PCIe Slots	4
Operating system	VxWorks, Windows embed. Standard. 7

Connectivity	Sercos PROFIBUS PROFINET EtherNet/IP EtherNet TCP/IP USB

User memory	64 MB (Code + Data)	**No. of tasks**	20
Processing time	typ. 4 µs for 1.000 mixed instructions		
No. of axes	99 (64 Control axes, 16 kinematics)	**Cycle times**	PLC: 1 ms Motion: 0,5 ms Sercos: 0,25 ms

Box PC with 4 Slots



1. 24 V DC power supply
2. Status LED
3. DVI
4. CDI interface for operator display
5. 2x GBit LAN
6. 6x USB 2.0
7. DVD Burner (Option)
8. Mass storage
   - Hard disk
   - Solid-State Disk (Option)
9. Expansion slots
   - 4x PCIe — Available
   - 2x PCI + 2x PCIe (Option) — On request

IndraControl VPB extension modules

Communication interface

- Sercos III
- Cross-Communicaton (i.p.)

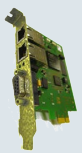
Sercos

Communication interface

- PROFINET RT
- PROFIBUS
- EtherNet/IP

Real-Time-Ethernet
PROFIBUS

Safety Control



- Safety functions up to PL e/Cat. 4 in accordance with ISO 13849, respectively SIL3 in accordance with IEC 62061

SafeLogic (i.p.)

- **Functional extendibility** of technology and communication via extension modules
- **Up to 4 modules** can be used simultaneously
- **PCI-Express** as bus interface

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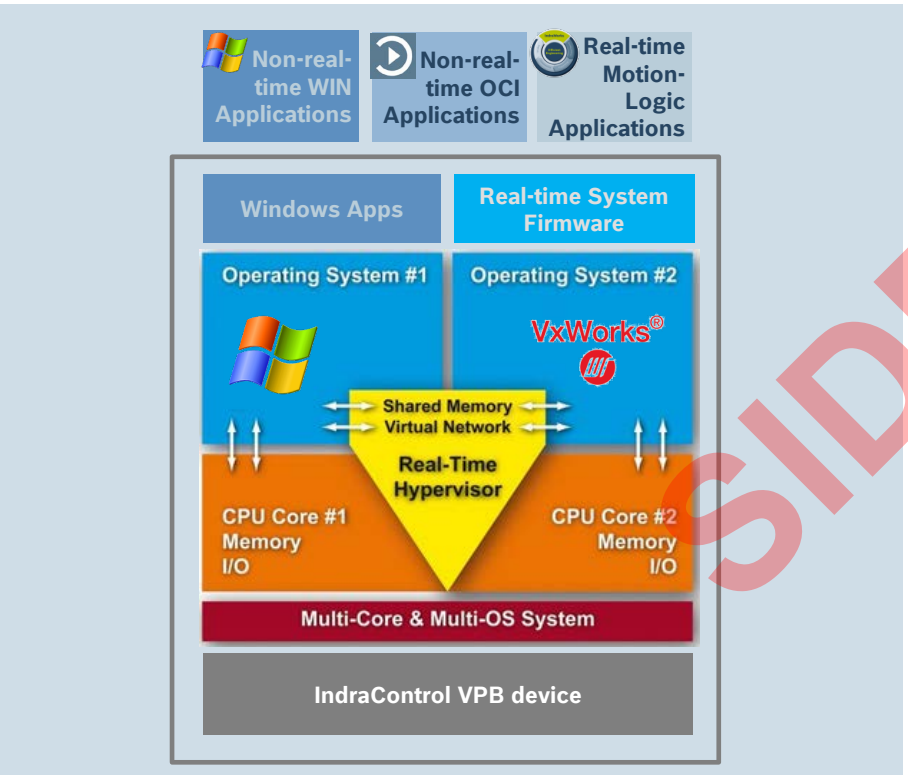
Secured operation of RTOS and Windows



- **One control platform combining** RTOS VxWorks and NRT Windows 7
- **Deterministic real-time performance** guaranteed using RTS hypervisor
- Usage of **standard OS device drivers**
- **Completely independent execution** of both operating systems
- **100% memory separation** of OS with prior memory/cache access by RTOS
- **Secured RTOS operation**
  - no access to RTOS memory, even on Windows driver level
  - all devices and I/O assigned to RTOS are hidden, blocked and protected

Inline – modular I/O system, IP20

- **Flexible and scalable I/O-system** in protection class IP20 for cabinet installation
- Standard and high-density terminals in **compact design**
- Usable as **field bus or local I/O**
- **Quick and easy assembly**
- **Cost-reduction** by multi-wire connection
- **Intelligent voltage distribution**

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Inline – Overview portfolio

Bus coupler

Digital Inputs

Digital Outputs

Analog Inputs

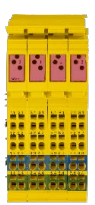
Analog Outputs

Function

Communication

Power Supply

Safety



Inline Block I/O

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IndraControl S20 – distributed I/O system, IP20

- **Modular I/O system** for decentral topologies
- **Fastest signal processing**
- **Performant system provider** via real-time Ethernet
- Optimized design for **extreme operating conditions**
- **Highly robust** electro mechanics
- **Tool-free and simplified wiring**

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IndraControl S20 – Overview portfolio

Bus coupler

Digital Inputs

Digital Outputs

Power supply

Analog Inputs

Analog Outputs

Technology

Safety

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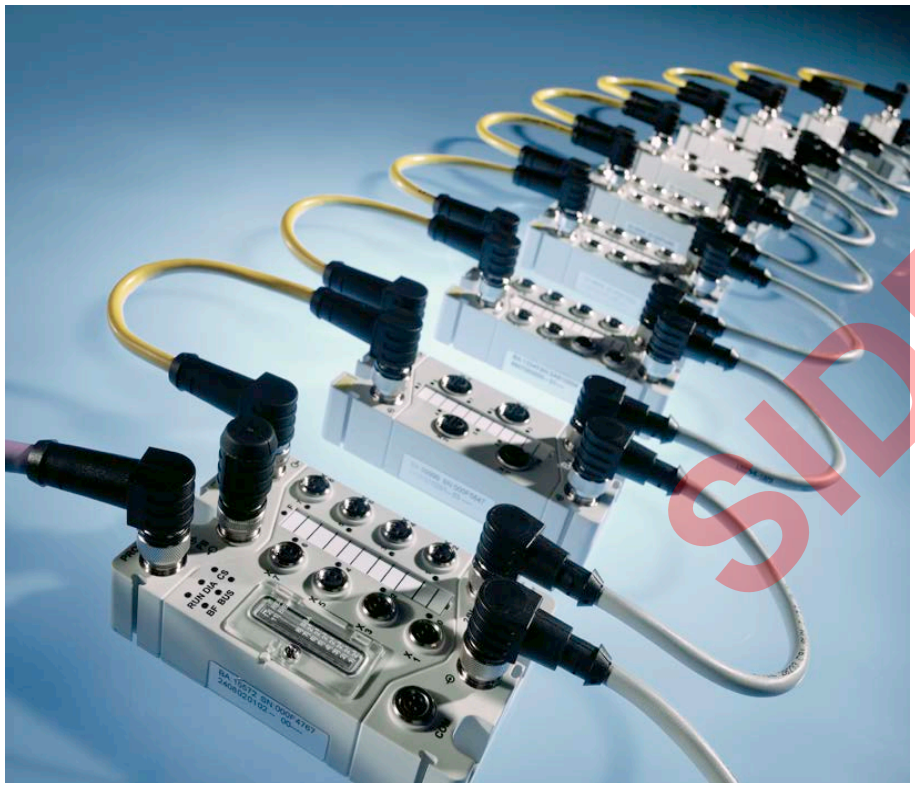
IndraControl S67 – modular I/O-system, IP67



- **Flexible configuration and setup** for individual applications
- **Comprehensive portfolio** with standard and technology modules
- **Compact and fully encapsulated housing** with optimal EMC protection
- **Optional connection technology** for M8 and M12
- **Flexible Screw or DIN rail mounting**
- **Latest hardware architecture** for fast and optimized data management

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IndraControl S67 – Overview Portfolio

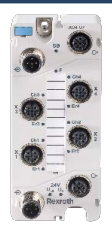
Bus coupler

Digital Inputs

Digital Outputs

Power Supply

Analog Inputs



Analog Outputs

Technology

Accessories

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Scalable solutions

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Scalable solutions in comparison


SafeMotion


SafeLogic compact


SafeMotion


SafeLogic


SafeMotion

	IndraDrive *1 with optional „Safety Zone Module *1 Safety Zone Module not available with IndraDrive Mi	IndraDrive with safe communication	SafeLogic compact with safe communication	SafeLogic with safe communication
Axes	35		32 (2 x 16)	64
Safety-I/O	16 inputs 3 outputs	2 inputs 1 output	96 inputs 48 outputs	256 inputs 256 outputs
Safety Bus		CIP Safety on Sercos	CIP Safety on Sercos	CIP Safety on Sercos PROFIsafe
Safe Logic	Simple Logic Functions (Inhibit Restart, Safety Door Lock with Monitoring, AND, OR)		CFC (Basic-Library with function blocks)	FUP (PLC open Safety)
Safe Motion	16 motion profiles selectable			

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Central Safety Control

- **Powerful**
  Logic processing up to Cat. 4 PL e / SIL3 for mid-size and large machines and wide machinery
- **Expandable**
  Standard controls can be easily expanded to a safety control by attaching the Safety-Function-Module
- **Flexible**
  CIP Safety on Sercos and PROFIsafe to integrate distributed safety peripheral devices
- **Seamless**
  For all system solutions IndraLogic XLC, IndraMotion MTX, and IndraMotion MLC
- **Completely**
  Engineering in IndraWorks for standard and safety application

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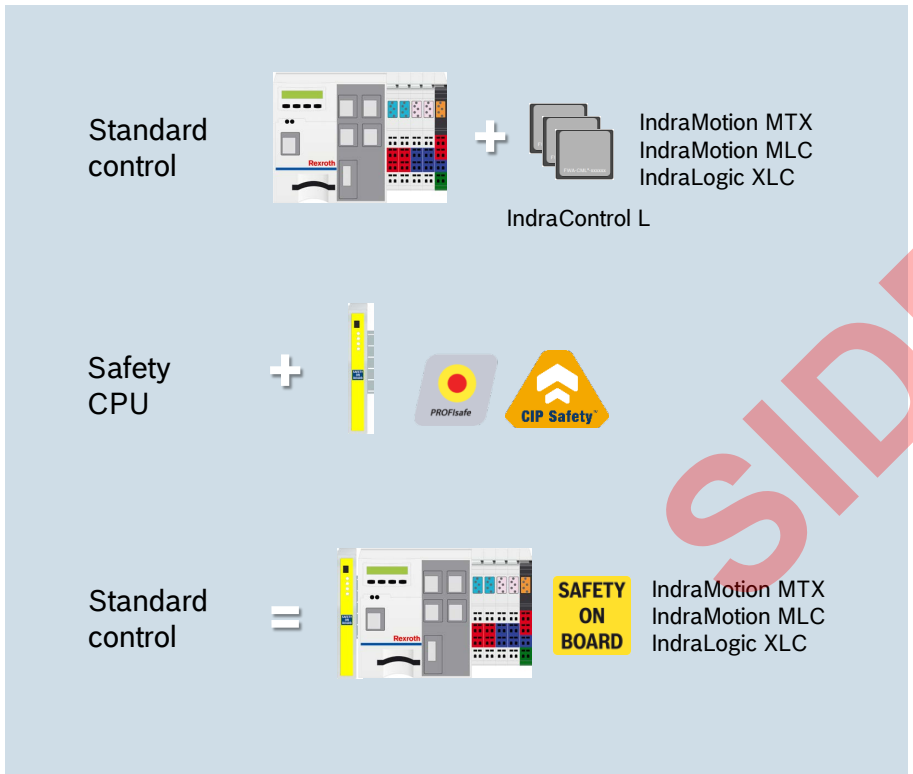
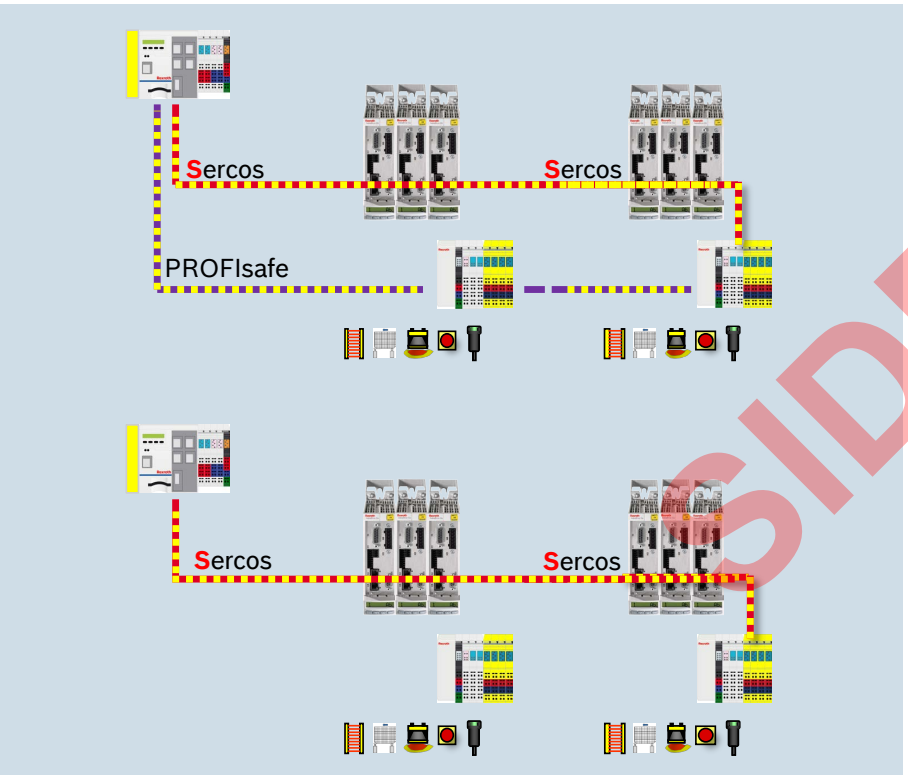
Safety and standard homogenously integrated



- Safety function module converts standard controller into a safety controller
  - Optional extendible
  - No interference (constant cycle times, standard program and safety program have no influence on each other)
- No need for synchronization interfaces between the safety controller and the standard controller
  - Eliminates hardware
  - Minimizes application programs
- Consistently for all automation systems
  - IndraMotion MLC
  - IndraMotion MTX
  - IndraLogic XLC

Flexible machine integration



- From mid-size to large machines and wide machinery
- Modular machine topology with distributed safety peripherals
  - Drives
  - I/Os
- Multi Safety Master for homogeneous and heterogeneous system topologies
  - CIP Safety on Sercos
  - PROFIsafe

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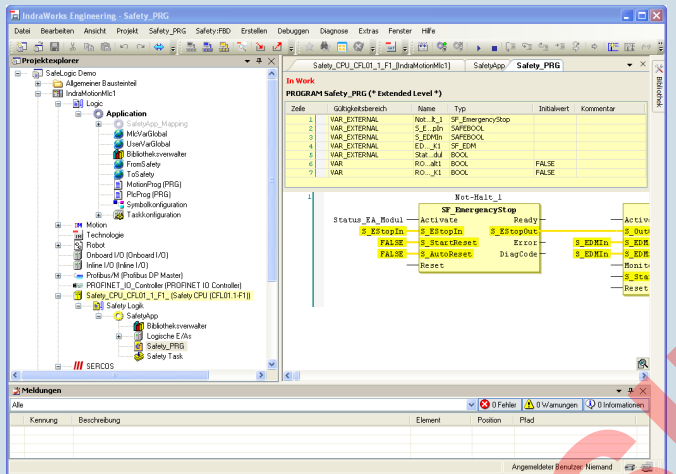
Easy, safe and compliant engineering



- Safety manager contains everything to
  - Project
  - Parameterize
  - Program the safety project
- Full, seamless integration with the standard tool
  - Same look and feel
  - Comprehensive diagnostics
- Systematic safety integrity features built into the tool
  - User management
  - PLCopen safety compliance
  - Certified libraries

Safety control in compact design

- **Economical**
  Logic processing up to Cat. 4 PL e / SIL 3 for compact and mid-size machines
- **Integrated**
  Safe integration into the Sercos network via CIP Safety on Sercos
- **Versatile**
  For all system solutions IndraLogic XLC, IndraMotion MLC/MTX and MLD as well 3rd party controls
- **Easy to use**
  Powerful engineering tool for fast configuration by drag and drop
- **Efficient**
  Simulation and report function for fast verification and complete documentation

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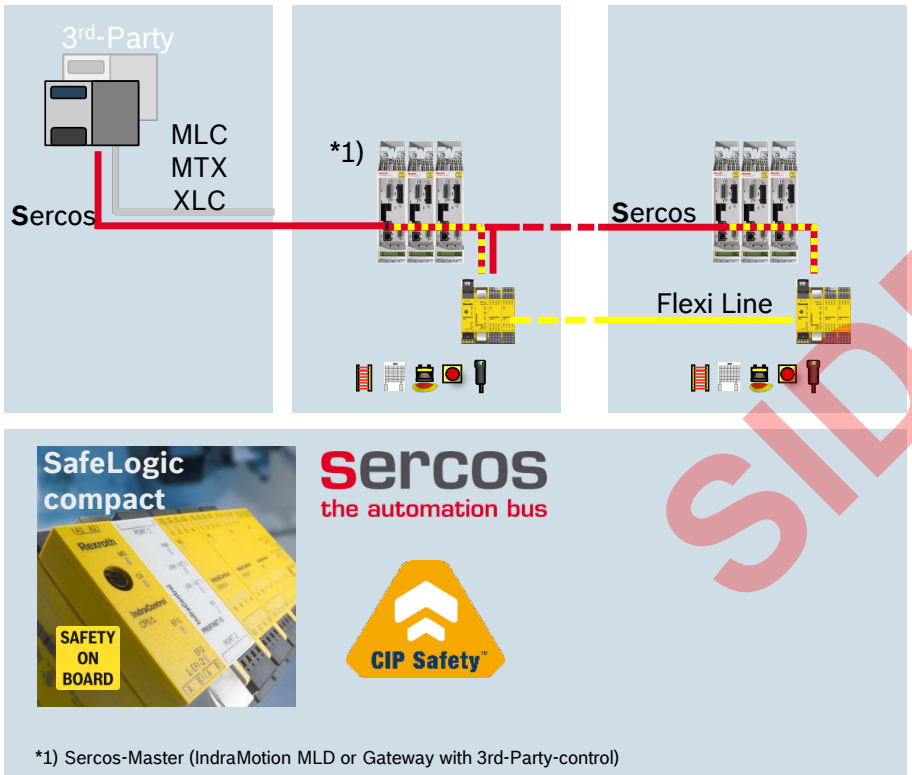
Versatile machine integration



- From small to mid-size machines and machinery
- Modular machine topology with distributed safety controller and locally connected safety I/Os
- Direct integration into Sercos network
  - Safe communication to control the drive-based safety functions
  - Standard communication with machine control
- Safe networking of up to 32 SafeLogic compact stations with up to 96 bit data width and up to 1,000 m between 2 stations

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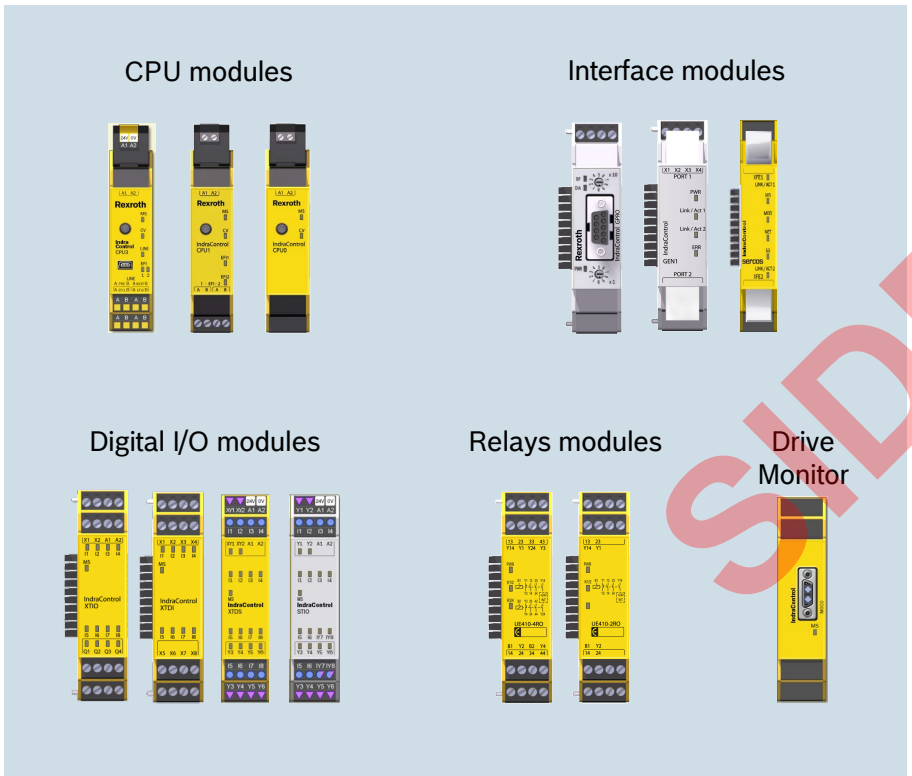
Components



- Modular system design for optimal adaptation to the application
  - Up to 96 inputs and 48 outputs
  - Parameterization test/diagnosis functions
- Wide product portfolio
  - CPU modules with/without safe cross communication
  - Interface modules
  - Digital input/output modules
  - Relays modules with monitoring contacts
  - Drive Monitor for frequency converters and hydraulic axes
- Guaranteed reaction time for fast switching-off
- Memory plug allows to transfer application data without a PC

Powerful engineering tool

- SafeLogic Designer for easy
  - Configuration
  - Parameterization
  - Programming
  - Set-up and diagnosis
- Intuitive graphic user interface
  - Drag and drop
  - Library for peripheral components for configuration of inputs and outputs
  - Programming by graphical wiring
  - Symbolic variables
- Extensive function block libraries, e.g. for press applications

Drive-integrated safety technology

- **Extensive**
  Drive-integrated safety functions for stopping, holding, moving and position monitoring
- **Flexible**
  Activation of safety functions optionally using:
  - CIP Safety on Sercos
  - Fail Safe over EtherCAT
  - Or discrete 24V signals
- **Clever**
  Safe logic functions inside the drive
- **Efficient**
  Increased machine productivity with reduced costs
- **Seamless**
  For all IndraDrive product families Cs, C, M, Mi, ML

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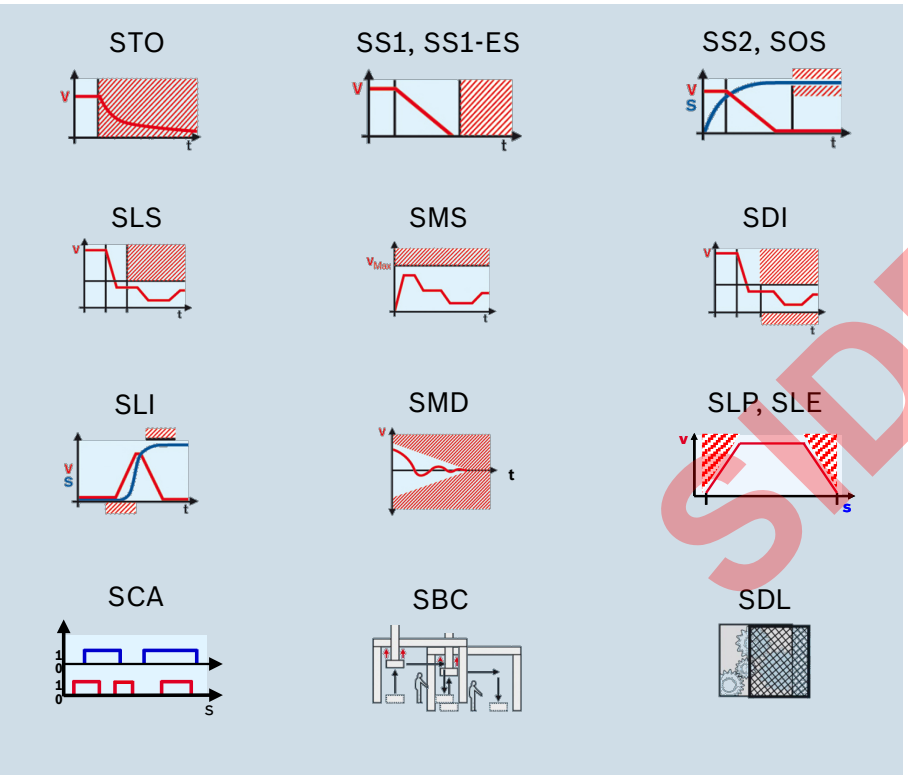
Drive-integrated safety functions



- Drive-integrated safety functions for stopping, holding, moving and position monitoring
  - Safe Torque Off, Safe Stop 1, Safe Stop 2, Safe Operating Stop, Safely Monitored Deceleration
  - Safely Limited Speed, Safe Maximum Speed, Safe Direction, Safely Limited Increment
  - Safely Limited Position, Safe CAM, Safely Limited End Position
  - Safe Brake Control
  - Safe Door Locking
- Maximum safety level for safety functions
  - Cat. 4 PL e according to ISO 13849-1
  - SIL3 according to IEC 61062
- Increased flexibility due to 16 selectable movement profiles

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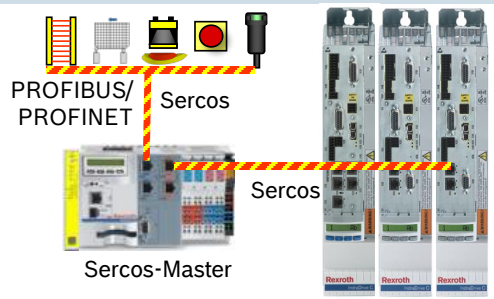
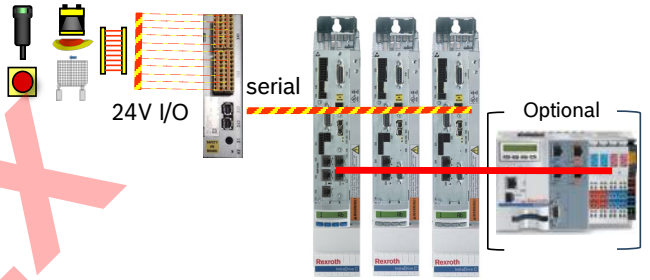
Activation of the safety functions



Safe Master Communication

Activation via Safe Zone Module

CIP Safety on Sercos

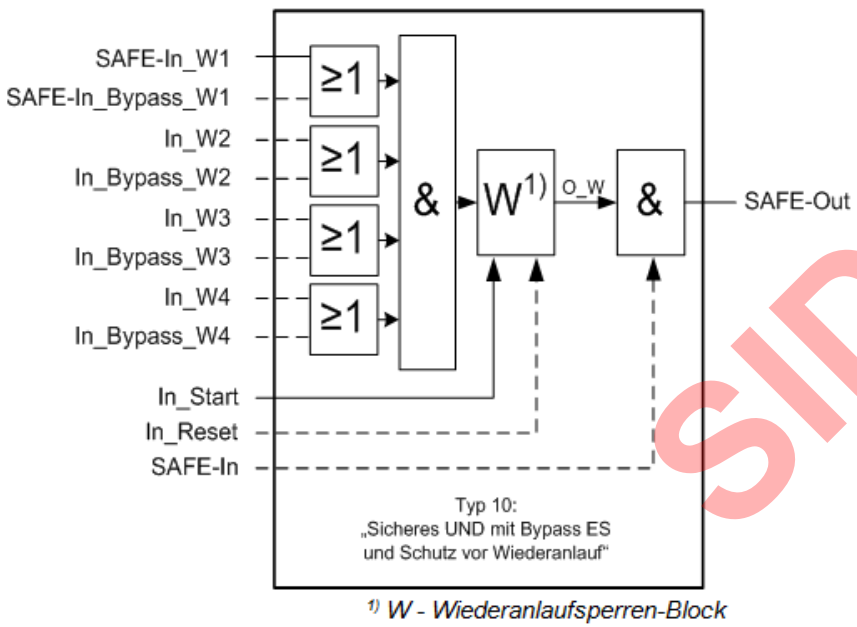


Safe Cross Communication

- 35 Axes per Safety Zone
- Alternatively
  - 8 Inputs Cat. 4, PL e, SIL3
  - 16 Inputs Cat. 3, PL d, SIL2
- Safe Door Locking
- Safe Zone Status

Safe Zone Module

Intelligent due to drive-integrated safety functions



- Safe **AND** with muting and protection of restart for Emergency Stop Function
- Safe **Door Locking** with request for door opening
- Safe **OR**
- Safe **Inverting**
- Safe **Decoder** ”Binary-to-Bit“

IndraControl V – Overview portfolio

Compact operator panels

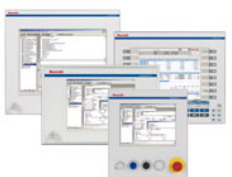
IndraControl VCP, VR21

Compact hand-held operator pan

IndraControl VCH, VH2110

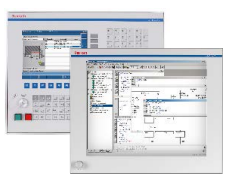
Embedded-PCs

IndraControl VEP



Panel- & Box-PCs + separate display

IndraControl VPP/VPB und VDP



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IndraControl V multi-touch

- **For new operation concepts**
  including widescreen
- **Projected capacitive touchscreen (PCT)**
  with protected, durable and resistant sensor technology
- **10 finger multi-touch**
  (IndraControl VDP, VEP, VPP)
  (2 finger multi-touch with VR21, VH21)
- **Non-reflecting glass surface**
  with tempered glass and IP65 front
- Mounting can be **vertical** or **horizontal**

WinStudio – Creating multi-touch visualizations

- **Multi-touch functionality**
  - In conjunction with IndraControl VEP/VPx and multi-touch displays VPD
- **Configurable multi-touch functions**
  - Zoom of screen objects
  - Move of screen objects
  - Rotation of screen objects
- **Programing interface** (VBscript)
  - Two-hand or multi-touch operation
  - Generating of individual gestures
- **Improved multi-touch functions**
  - Screen navigation through flick gesture
  - Border Dragging Tabs

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IndraDrive – Overview portfolio

IndraDrive Cs HCS01	IndraDrive C HCS02	IndraDrive C HCS03	IndraDrive C HCS04	IndraDrive Mi KSM
				
Feeding converter integrated control unit up to 14 kW	Feeding converter up to 11 kW	Feeding converter up to 75 kW	Feeding converter up to 630 kW	Motor-integrated inverter in IP65 up to 1,2 kW

IndraDrive M HMV01 -E	IndraDrive M HMV01/02 -R	IndraDrive M HMS01/02	IndraDrive M HMD01	IndraDrive Mi KMS
				
Feeding supply unit up to 120 kW	Regenerating supply unit up to 120 kW	Single-axis inverter up to 132 kW	Double-axis inverter up to 7,5 kW	Decentral inverter IP65 up to 2,2 kW

Agenda

- Fact Sheet
- Key Message
- Function principle and product description
  - Intelligent system components
  - High level efficiency in engineering
  - Seamless integration in Industry 4.0 environments
- Summary and highlights

Note: This presentation covers functional range of IndraMotion MLC 14VRS

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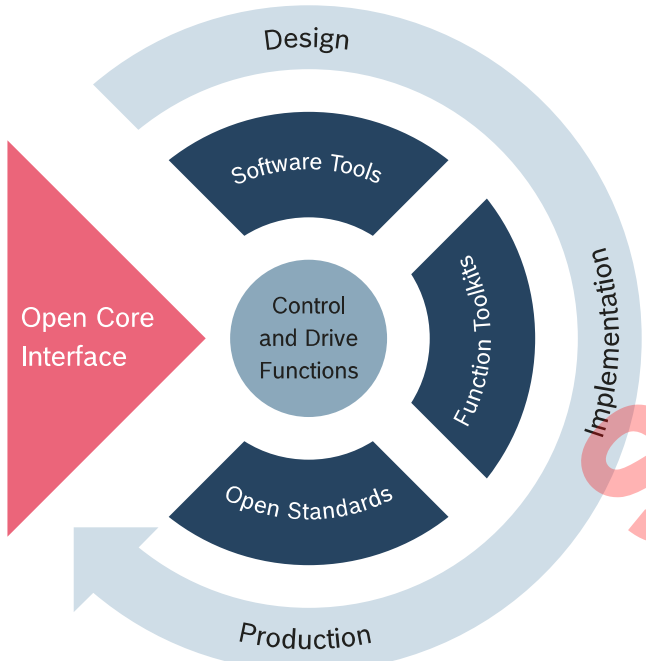
High-level efficiency in engineering

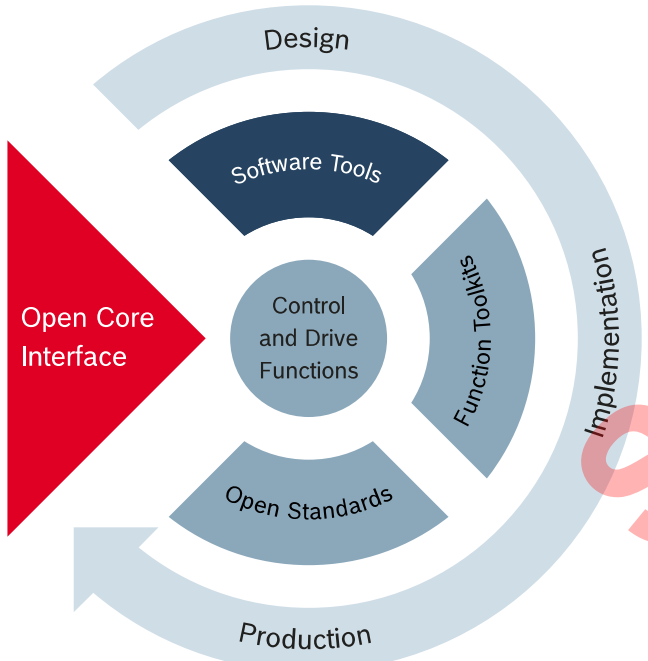


Bringing together the previously separate worlds of the PLC and IT automation as broad portfolio of

- Software Tools
- Function Toolkits
- Open Standards
- and **Open Core Interface**

as enabler for new degrees of freedom in machine automation.

Software Tools



Software Tools

The toolkit covers all phases of a software-based engineering workflow

The software solution in electric engineering integrates all necessary tools on the basis of open standards

The support of open interfaces allows optimum integration into the engineering environment of OEMs

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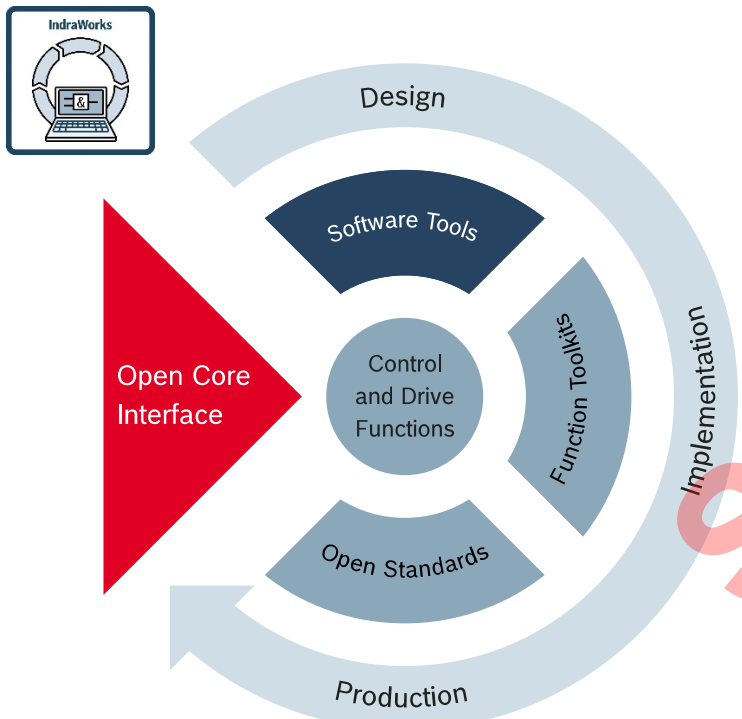
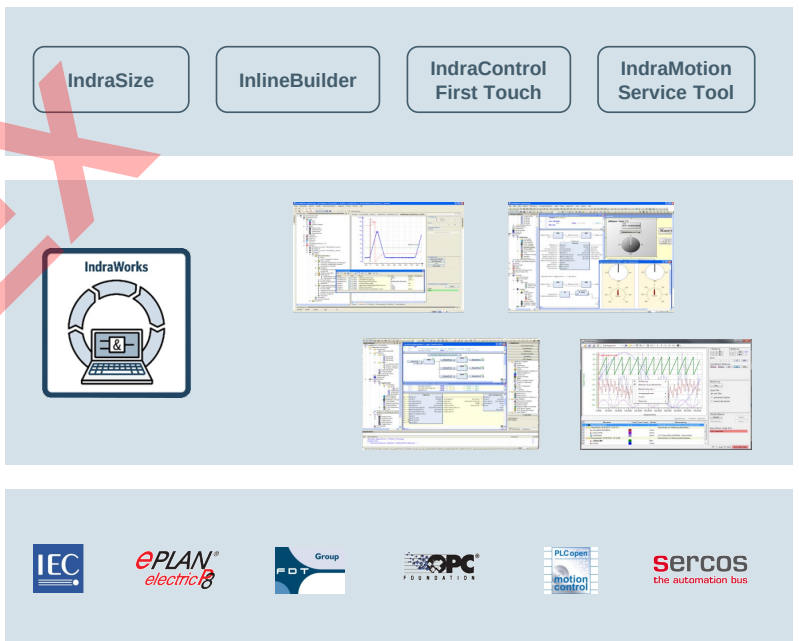
IndraWorks as central engineering tool





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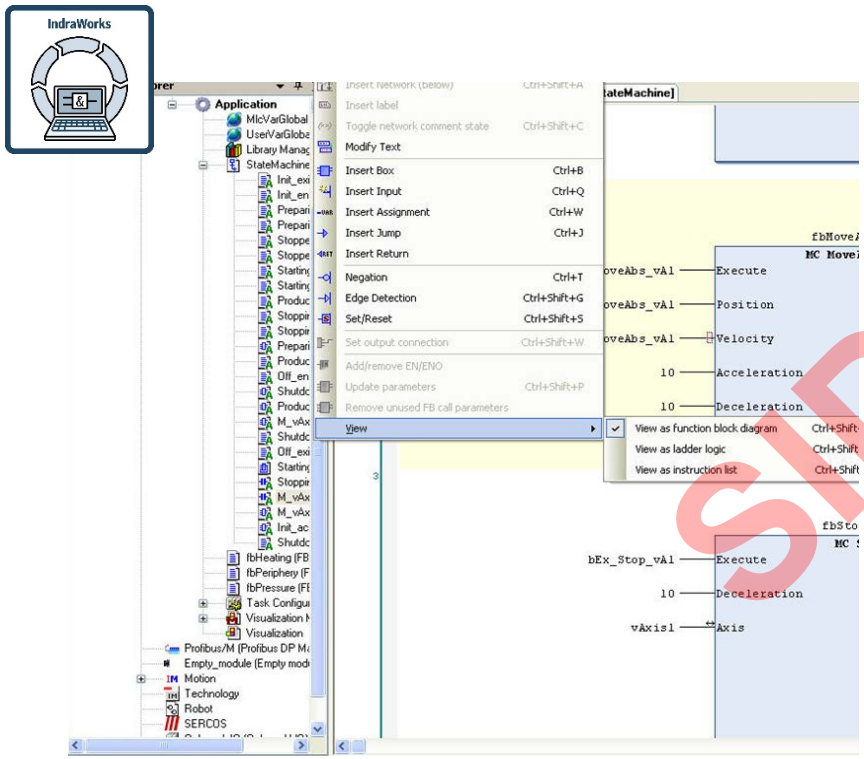
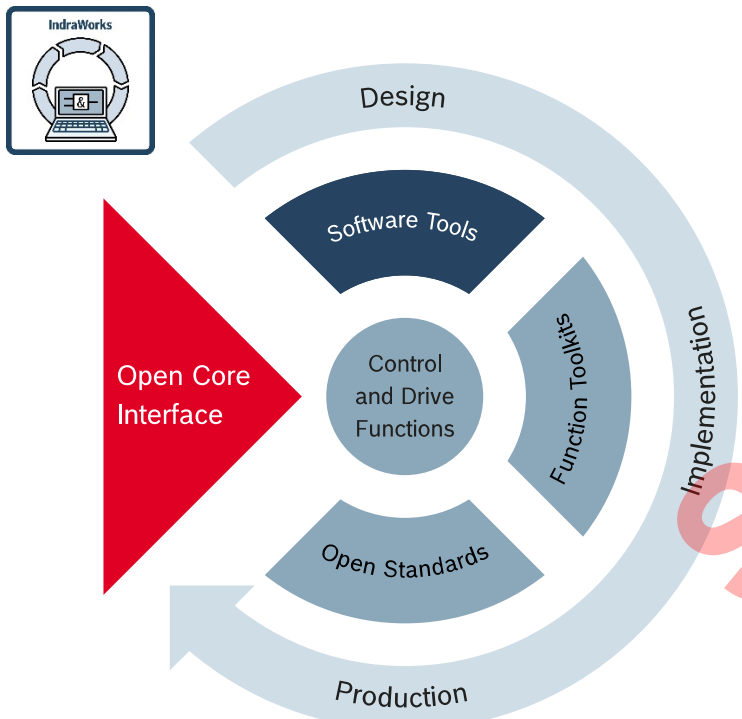
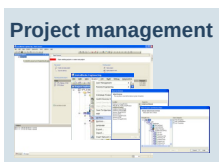
IndraWorks – The engineering framework

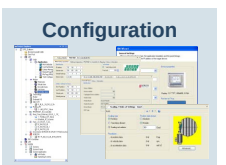


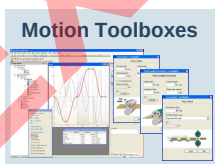
- **Single point of engineering**
  - design, setup, programming, diagnostics and visualization in one environment
- **Intelligent systems engineering**
  - with complete tools integration and open FDT/DTM interface
- **Centralized project data management**
  - using XML-based device interfaces
- **Uniform Motion logic programming**
  - with comprehensive library functions
- **Wizard supported device engineering**
  - clear parameter setup of motion and control

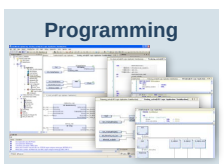
Toolbox for all engineering tasks

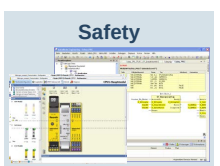


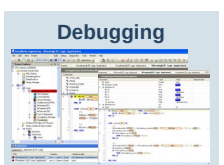


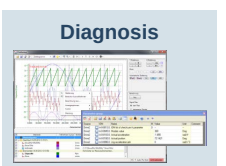


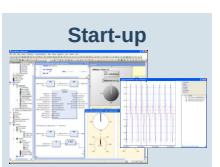


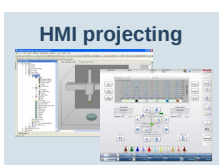


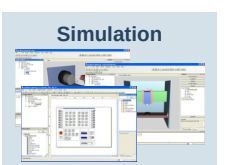




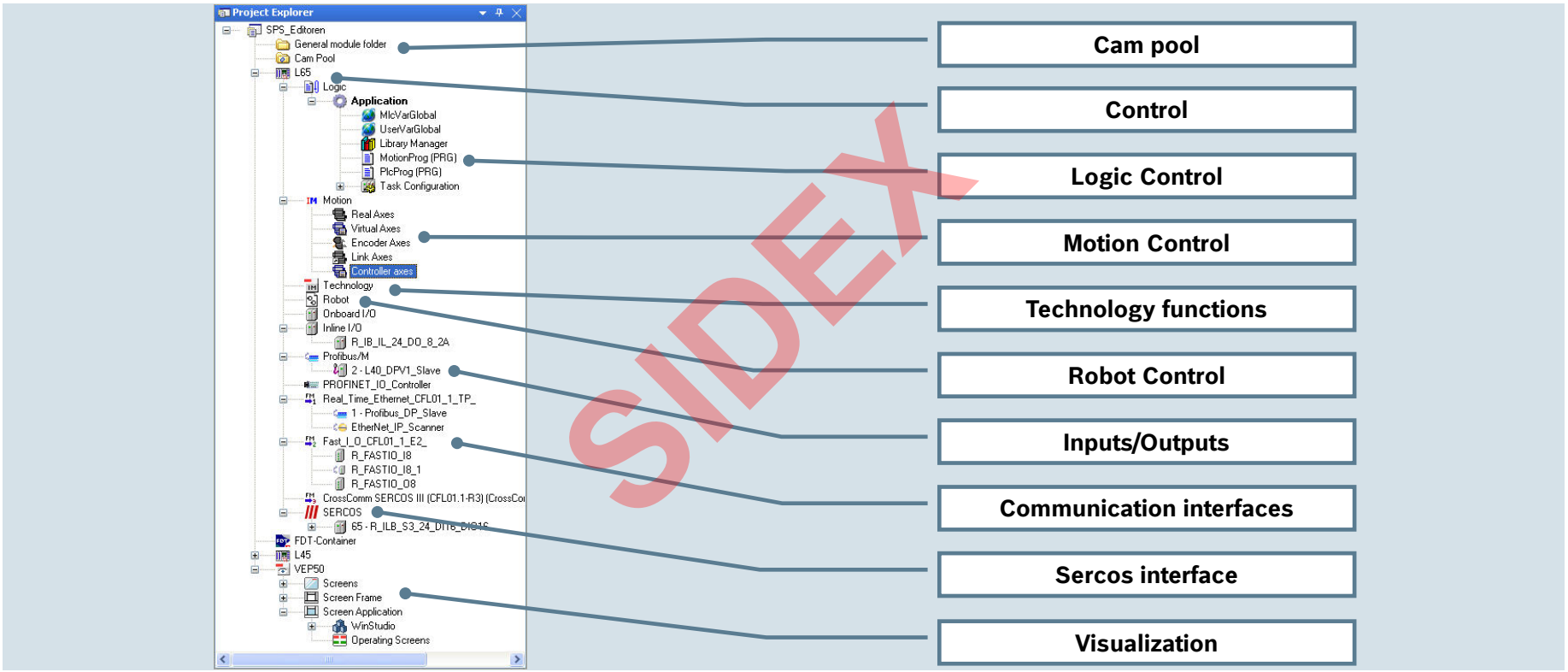




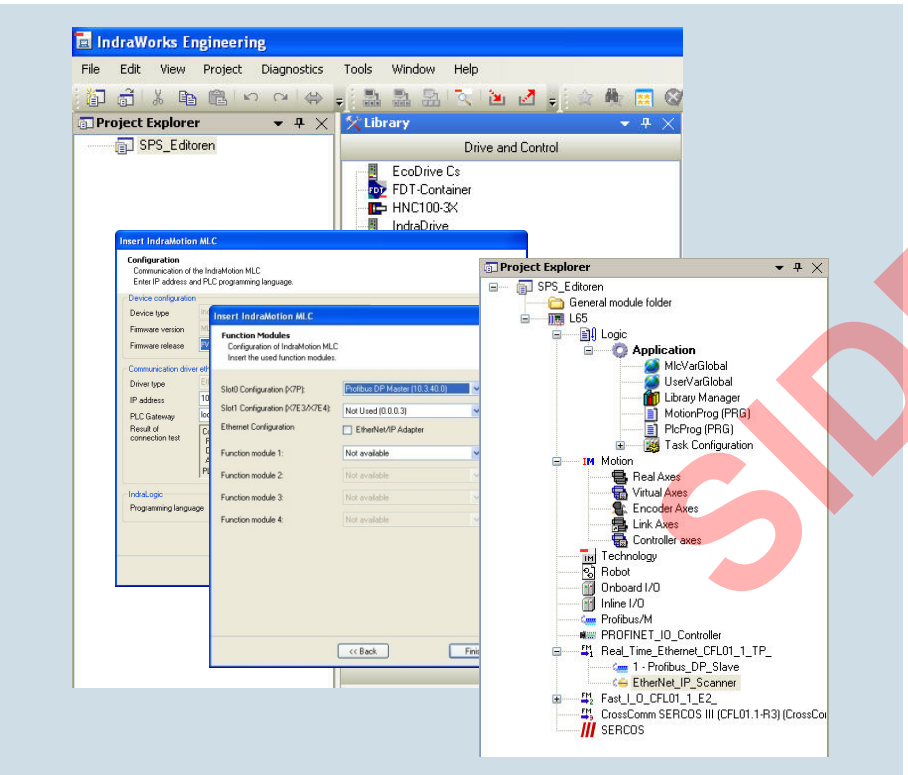




One explorer for the whole project



Easy control system configuration



- Adding control from device library to project via **Drag & Drop**
- **Wizard-aided control-configuration** for firmware, IP-address and function modules
- **Configurable on-board interfaces** for connectivity
- **Automatically generated** functional device node in project tree
- **Change of target system** for existing project

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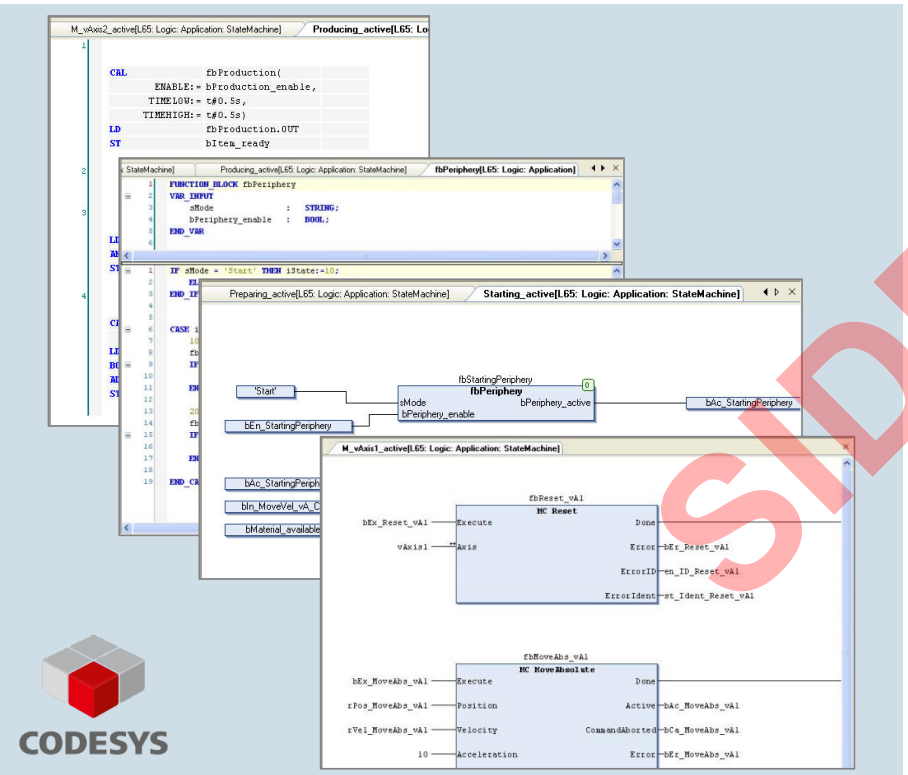
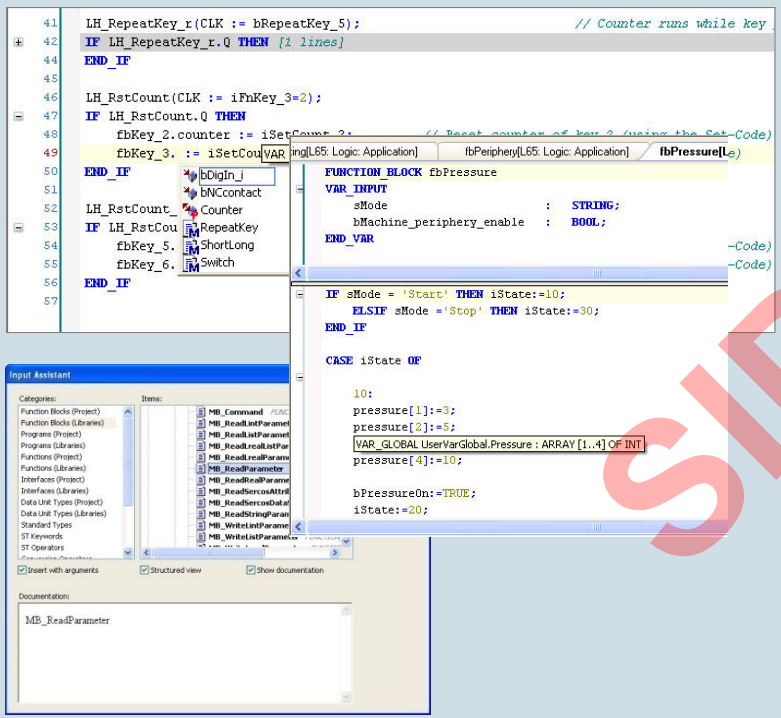
Open standard PLC programming



- Seamless **CoDeSys V3 integration** in IndraWorks for sequence programming in accordance with **IEC61131-3 3rd Edition**
- **Textual editors**
  - Instruction list (IL)
  - Structured text (ST)
- **Graphical editors**
  - Ladder diagram (LD)
  - Function block diagram (FBD)
  - Sequential function chart (SFC)
  - Continuous function chart (CFC)
- **Object-oriented language extension**

User-friendly editing



- **Autodeclare** with type detection
- **Semantic coloring**
- **Bookmark**
- **Cool Intellisense®** (structures, functions, FBs)
- **AutoIndent** – text block completion (e.g. END_IF)
- **Indenting** – automatic
- **Bracket highlighting**
- **Highlighting of related keywords**
- **PreCompile** – continuous syntax check
- **Folding** (indenting)
- **Search/Replace** with regular expressions
- **Single line comments (//)**
- **Tooltip help**
- **Conditional compiling**
- **and much more**

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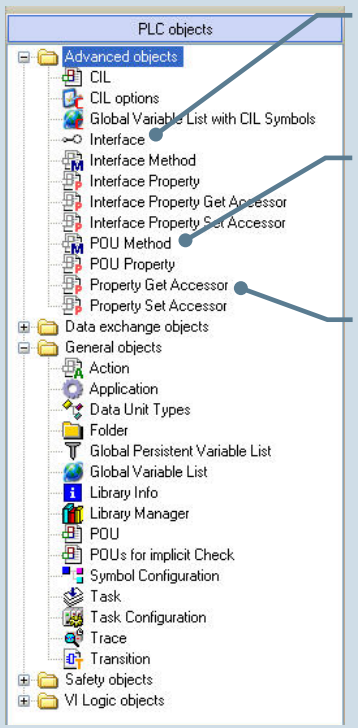
Object-oriented language extensions



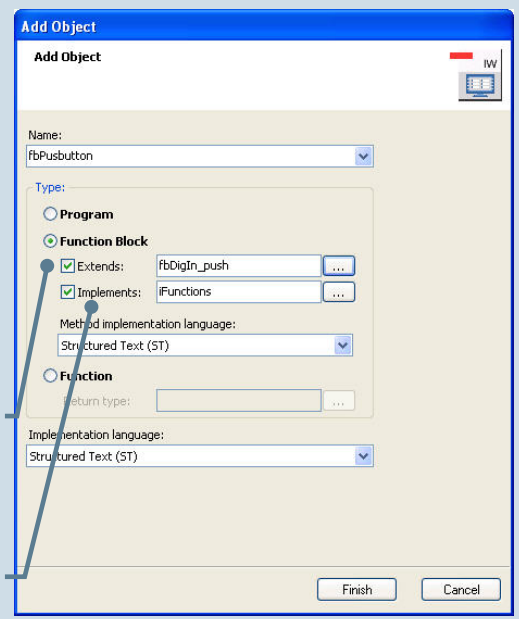
Interfaces
defined for a set of methods

Methods
a sequence of instructions assigned to a function block

Properties
GET/SET for read/write access to variables

EXTENDS
inheritance of properties from one FB to another function block

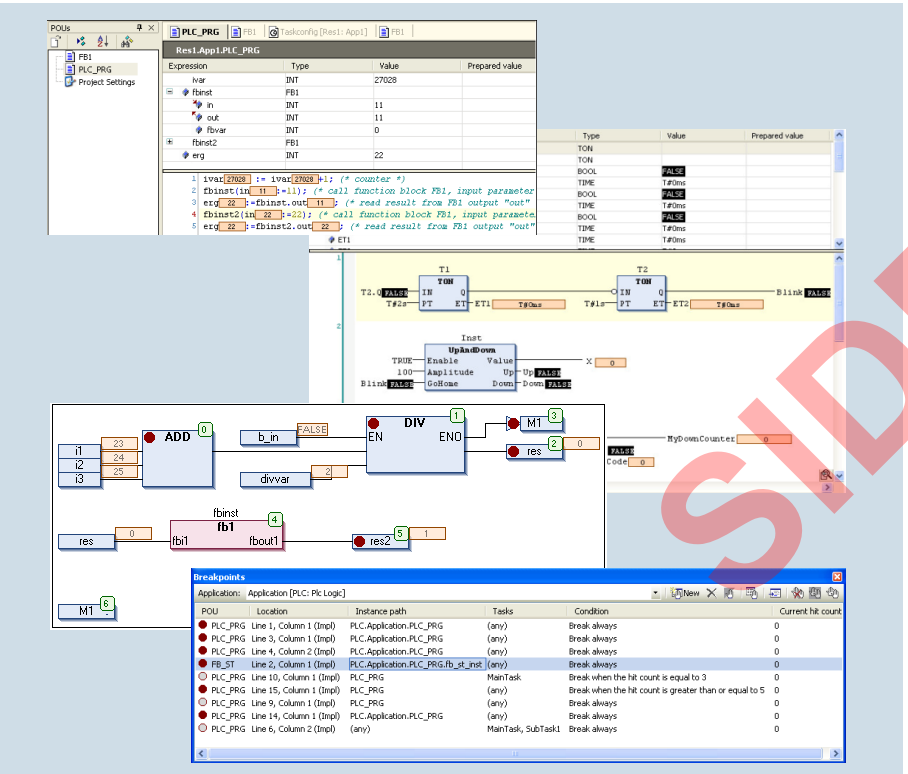
IMPLEMENTS
keyword for implementation of a function module



Drive diagnostics – Oscilloscope function

- **User-configurable signal** capture incl. multi-axis measurements
- **Import/Export** of configurations
- Manual or automatic **trigger**
- Triggering for **binary signals**
- Automatic, manual and fixed **scaling**
- Display **- interpolated or real waveforms**
- **Zoom** in levels and line cursor
- **Mathematical combination** and display of calculated signals
- **Import/Export of measurement data**
- **Offline mode** for visualization of measurement data

Online monitoring and debugging



- **View of online-values** in declaration window and program code
- **Uniform usage** in all languages
- **Watch list** with clearly arranged variables
- Dialog-aided **setting of breakpoints** in each network
- **Overview and editing** of breakpoints in separate window
- **View of breakpoints** within logic programs

NEW

Fit for Windows 10 operating system

Version	Targets	Release	Date
IndraWorks ML* 14VRS	IndraMotion MLC 14VRS IndraLogic XLC 14VRS	14V14	June 2016
IndraWorks ML* 13VRS	IndraMotion MLC 13VRS IndraLogic XLC 13VRS	13V16 Patch 7	May 2016
IndraWorks ML* 12VRS	IndraMotion MLC 12VRS IndraLogic XLC 12VRS IndraLogic L/V 04VRS	12V14 (planned)	2016 (planned)
IndraWorks ML* SafeLogic 14VRS (certified)	IndraMotion MLC 14VRS IndraLogic XLC 14VRS SafeLogic	14V16 (planned)	October 2016 (planned)

IndraWorks Engineering is still a 32-Bit software

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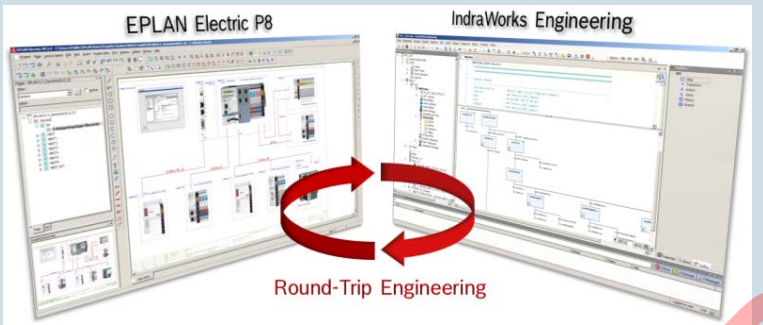
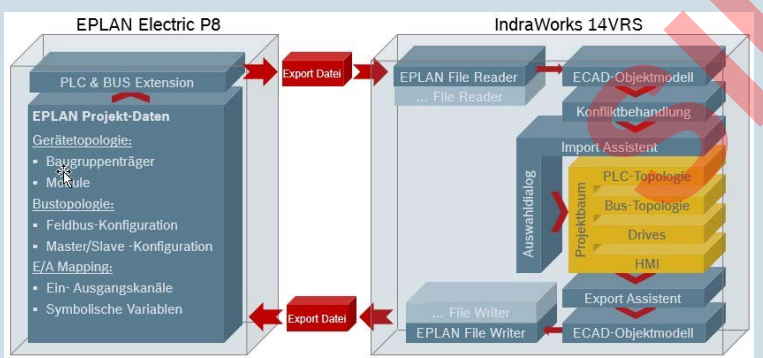
Bi-directional project data exchange



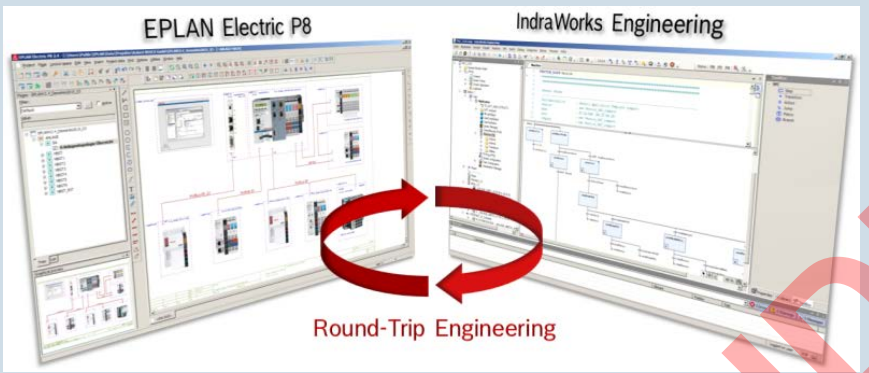


The ECAD-Data-Interface in IndraWorks builds the bridge between IndraWorks Engineering and EPLAN electric P8.

- Further use of existing project data
- Automatic generation of the IndraWorks project tree:
  PLC configuration, bus topology, I/O components
- Significant reduction of engineering effort
- Secured data consistency and increased software quality
- Support of EPLAN electric P8

NEW

Customer benefits



EPLAN
Electric P8

- Less project planning effort
- Data synchronization by means of Round-Trip Engineering
- Reduction of configuration errors
- More project planning comfort due to:
  - Import of the EPLAN export file in IndraWorks
  - Identification of the hardware-, bus- and I/O-topology
  - Transfer of the I/O symbol configuration or allocation list
  - Clear dialogs for import, export and comparison
  - Automatic hardware matching by means of EPLAN BMK and IndraWorks GUID

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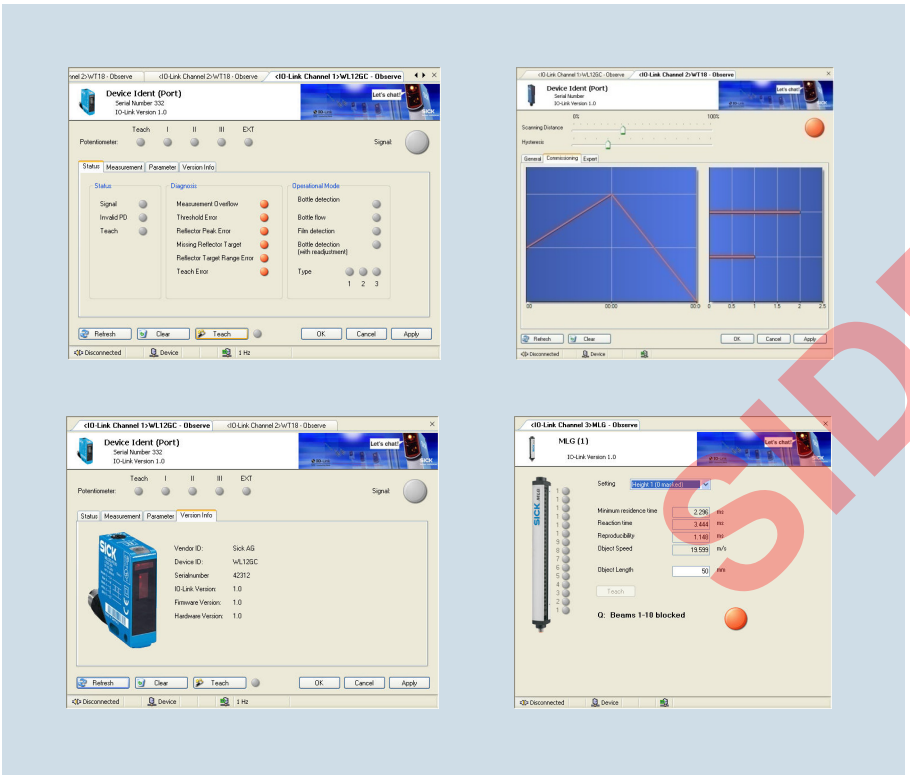
Seamless integration of 3rd party tools



- FDT Container (Field Device Tool) integrated into IndraWorks is based on the current FDT Group specification (V1.2.1)
- DTMs (Device Type Manager) as linkable 3rd party software tools contain all device rules and provide dialog-based configuration and diagnostics
- DTMs are installed by the user and are available in the IndraWorks DTM catalogue for configuration and parameterization of the complete system

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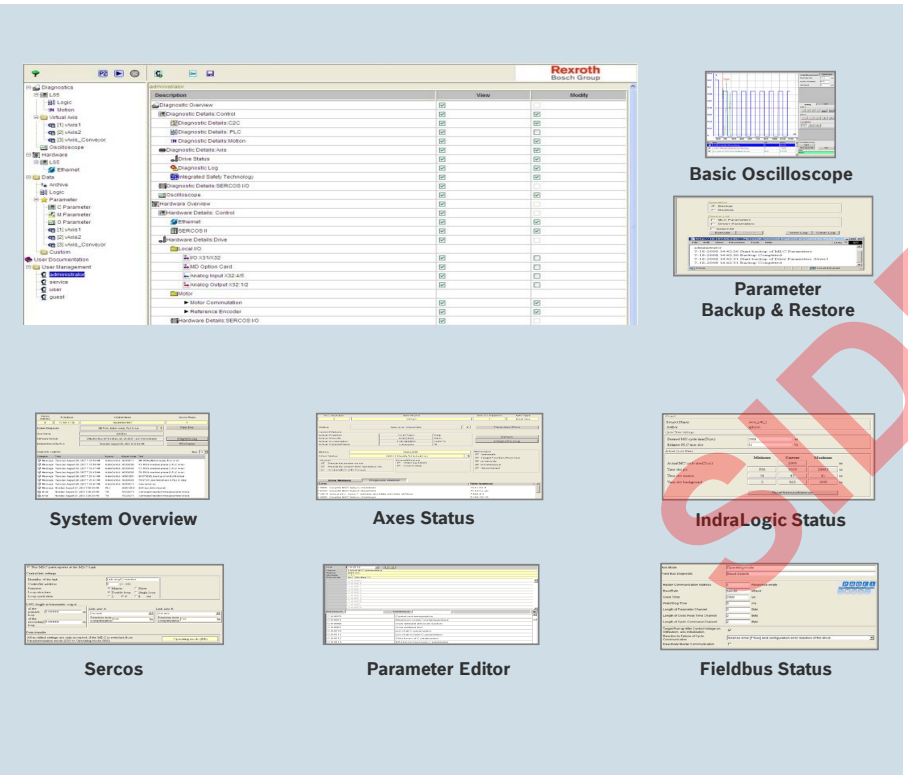
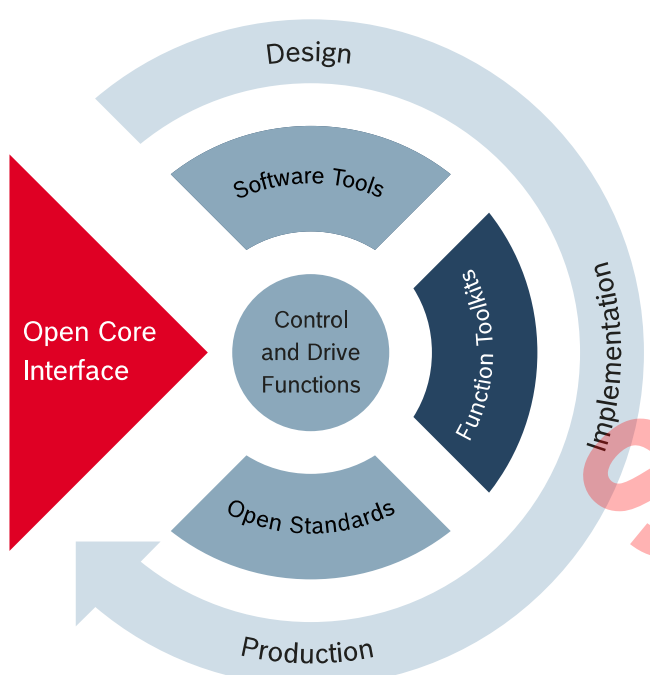
Web-server-based diagnosis and optimization



Web-based tool in for service issues

- **System status and diagnostics** of controller hardware, drives and communication
- **Parameter Editor**
- Access to PLC variables
- **User-specific lists**
- **Electronic nameplate** (hardware, firmware, serial numbers)
- **Simple oscilloscope function**

Function Toolkits



Function Toolkits

- **Extension of IndraWorks standard functionality** with technology-oriented solution packages
- **Accelerated implementing of machine processes** to reduce complexity
- **Improving of project workflows** with extended engineering interfaces
- **Enhanced productivity** via integration of machine functions, e.g. safety, energy and monitoring management

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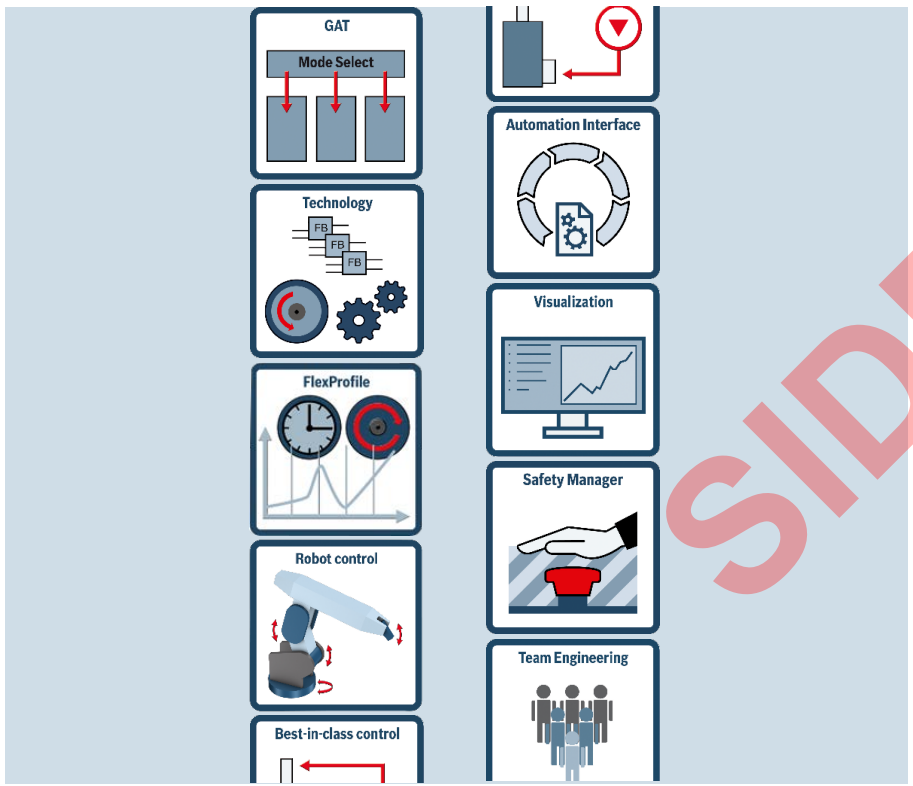
For all engineering tasks



Generic Application Template (GAT)

Technology

FlexProfile

Robot-Control

Best-in-Class-Control (Hydraulics)

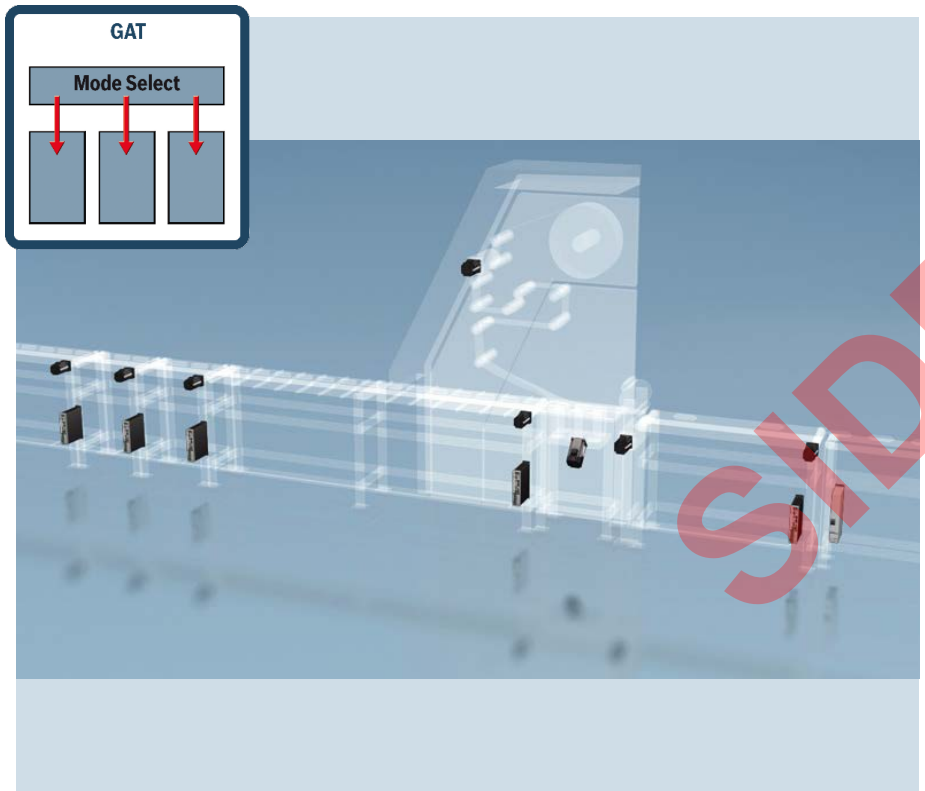
Automation Interface

Visualization

Safety Manager

Team Engineering

Automatic creation of modular machine programs



- **Pre-defined modular program and project structure** for development of re-usable applications
- **Simple to use** as library, modification using dialog boxes
- **Status machines, operating modes, data interfaces** and typical sequences fully integrated
- **Open IEC 61131-3 architecture and wizards** for simple extensibility and adaptation to specific applications
- **Reduced overall engineering effort** for series production and special machines combined with enhanced software quality

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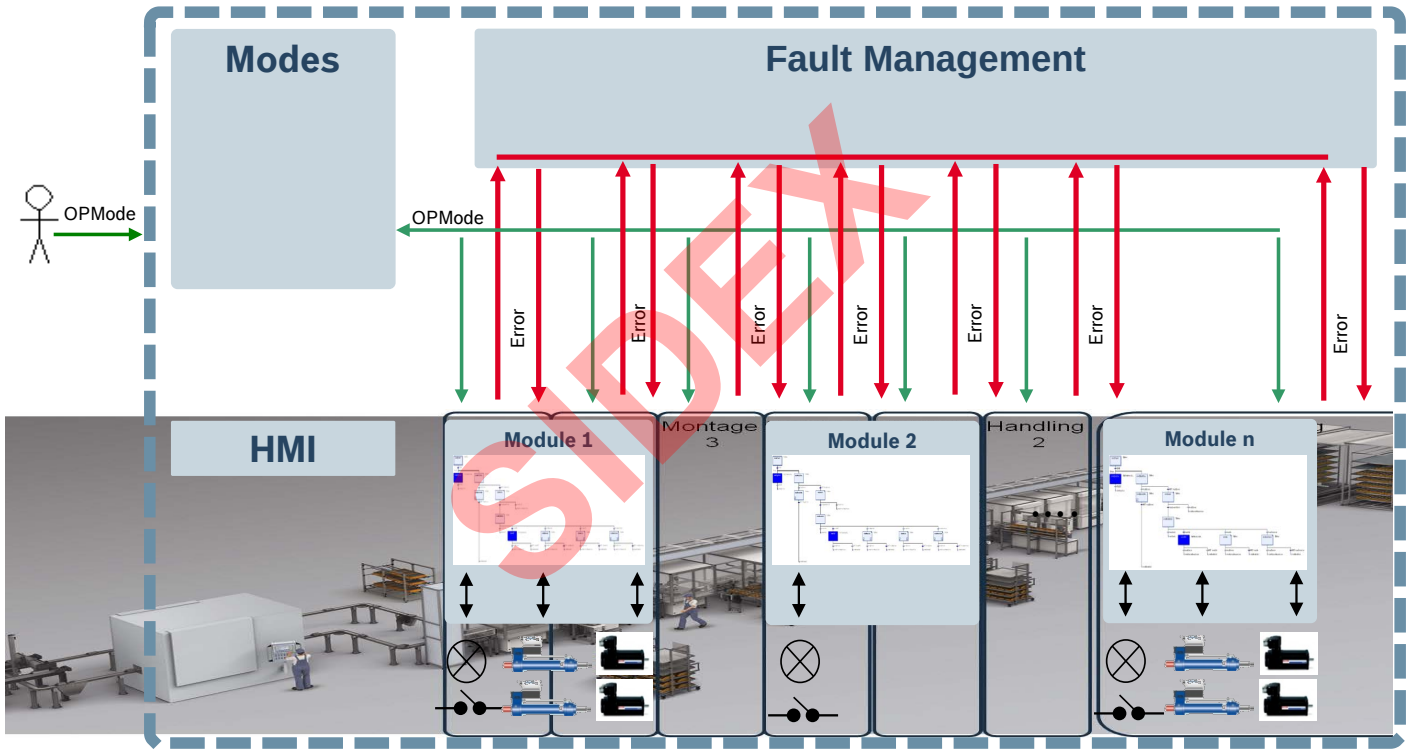
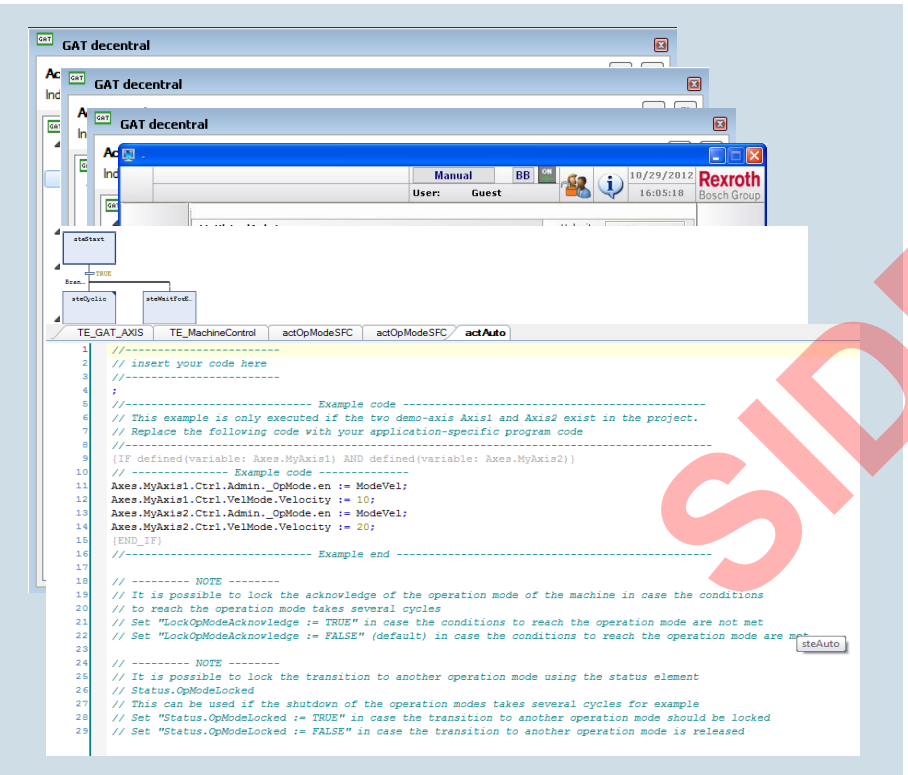
Concentrate on the essentials? – On your process

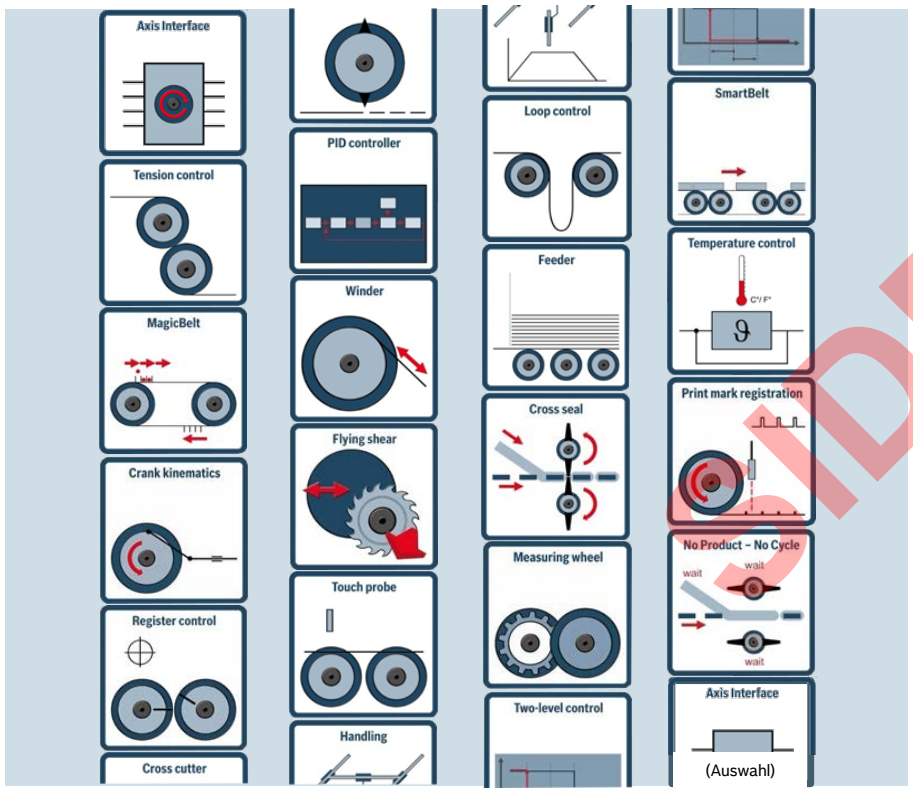


Programming with wizards make it possible



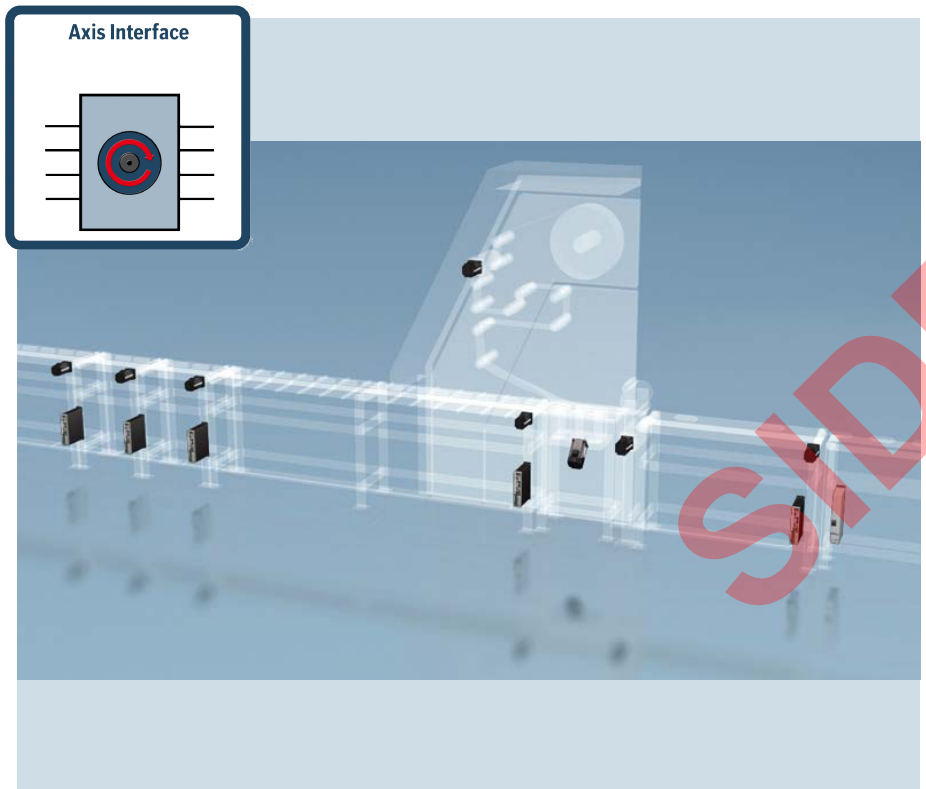
1. Mode Handling
2. Fault Management
3. Modules
4. Axes and Kinematics
5. HMI
6. Automatic Code Generation

Ready made PLC function blocks



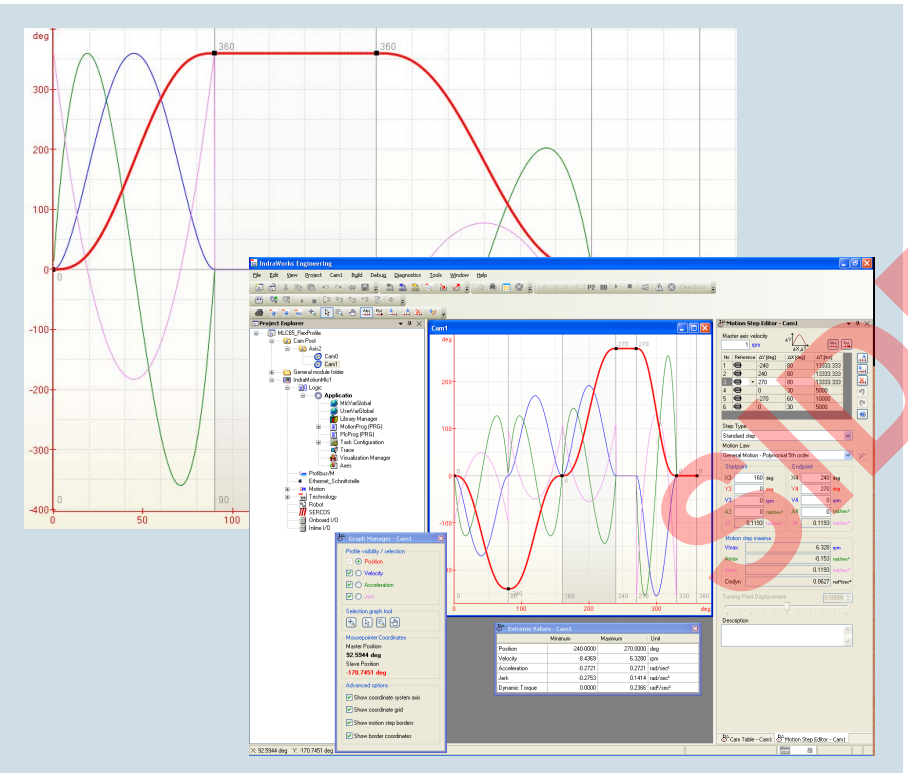
- Simplified implementation of complex machine functionality with ready-made technology function blocks
- Large selection of standard libraries as toolbox solutions for the most diverse applications in factory automation
- Basis for modularized machine software with increased quality, efficiency and easy maintenance
- Accelerated engineering of machine variants with comprehensive set of customizing options
- Openness and transparency for customer or manufacturer-specific solutions
- Easy usage within IndraWorks Engineering with dialog-supported parameterization and setup

Axis Interface



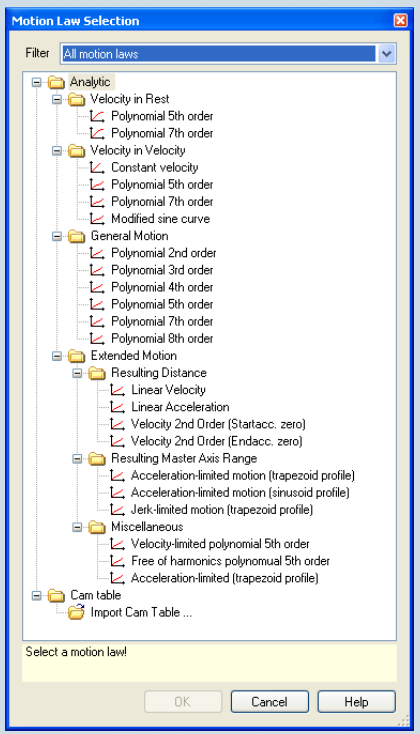
- **Simple, comprehensive drive motion command**
- **Axis Interface combines PLCopen motion functionality** creating a data interface that is easy to use
- **Bi-directional data transfer** using transparent control and status words
- **Faster implementation of applications** using powerful instructions and less code
- **Ease of use** enhanced by IntelliSense functionality
- **Pre-defined visualization template** simplifies commissioning

CamBuilder – Cam editor overview

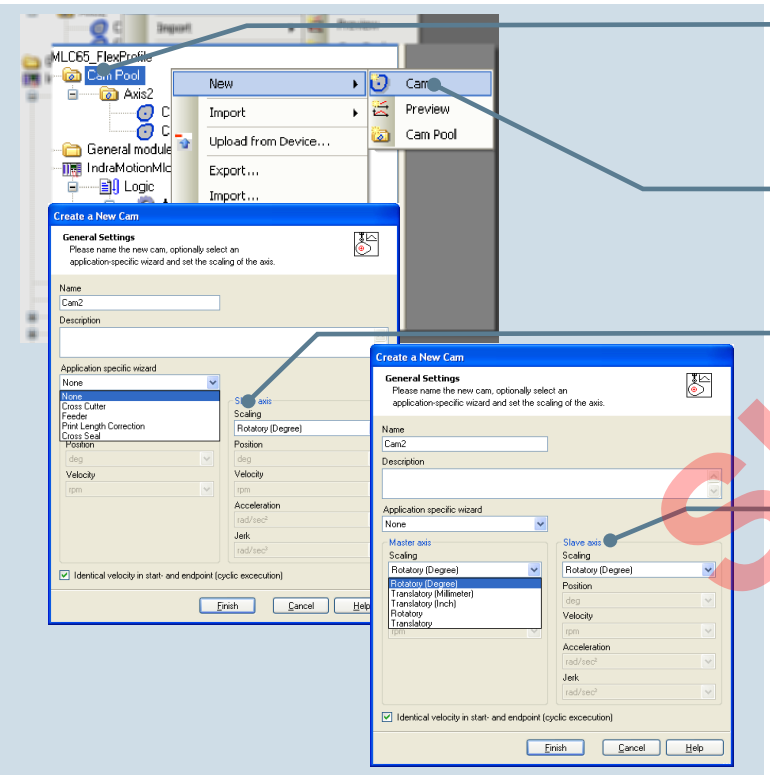


- **Simple generation of cams and segmented motion profiles** with the aid of graphic objects
- Uses **VDI 2143 compliant motion laws**
- **Automatic display** of position, acceleration, speed and jerk
- **Application-specific wizards**
- **Point table import** for cam segments
- **Automatic detection and calculation** of cam **boundary conditions**
- Switch between **standardized and evaluated view**
- **Export/Import functionality** in various formats
- Formula editor for defining cam points using **PLC variable**

CamBuilder – Supported motion laws



CamBuilder – Creating cams



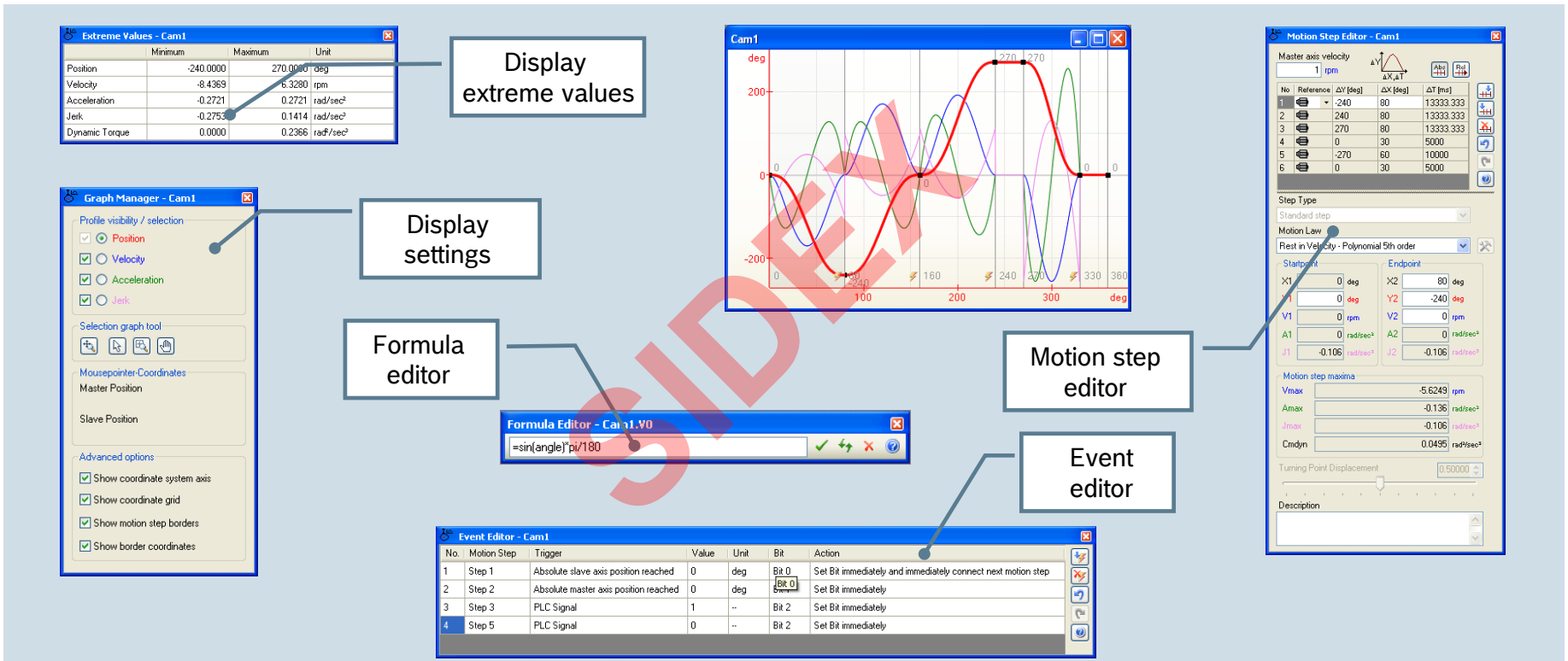
Management of cams in a folder “Cam pool”

Generation of **cams using standard values**

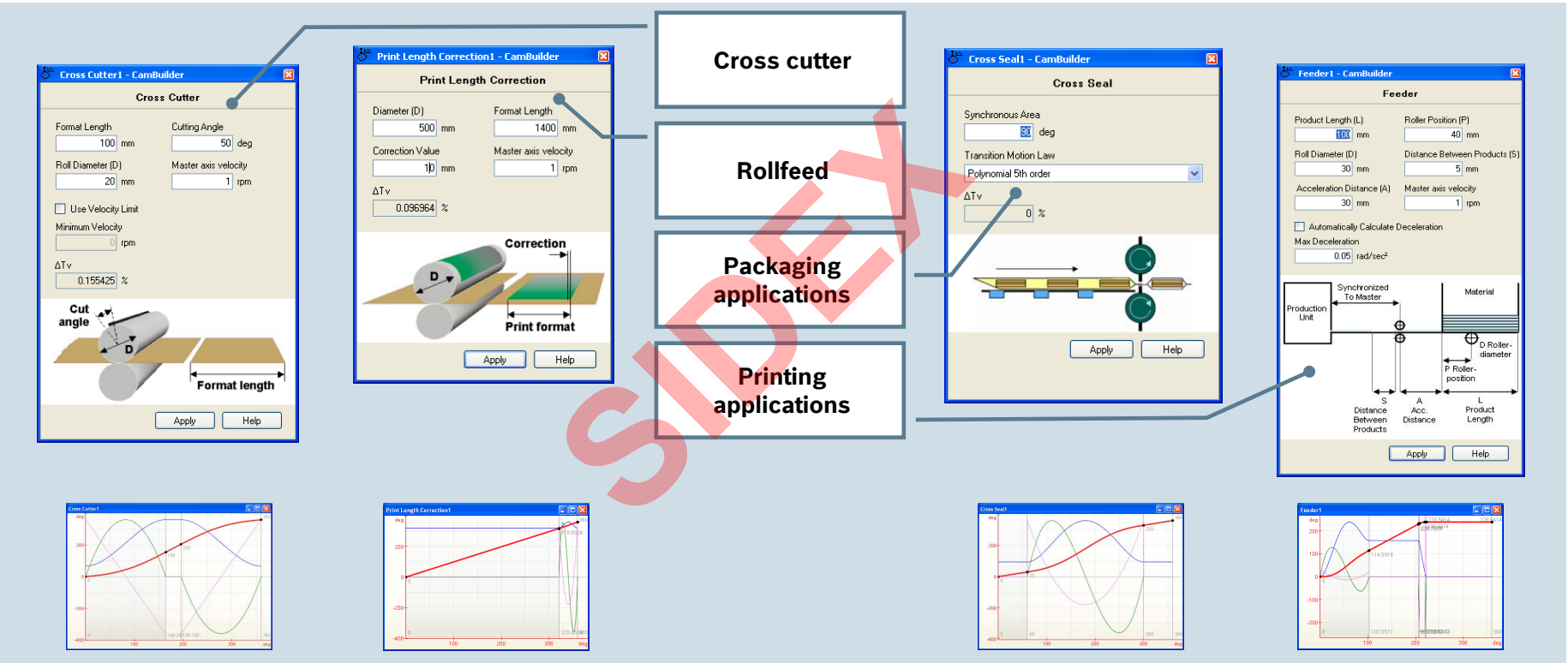
Wizard-based cam generation

Wizard-based cam generation for **specific applications**

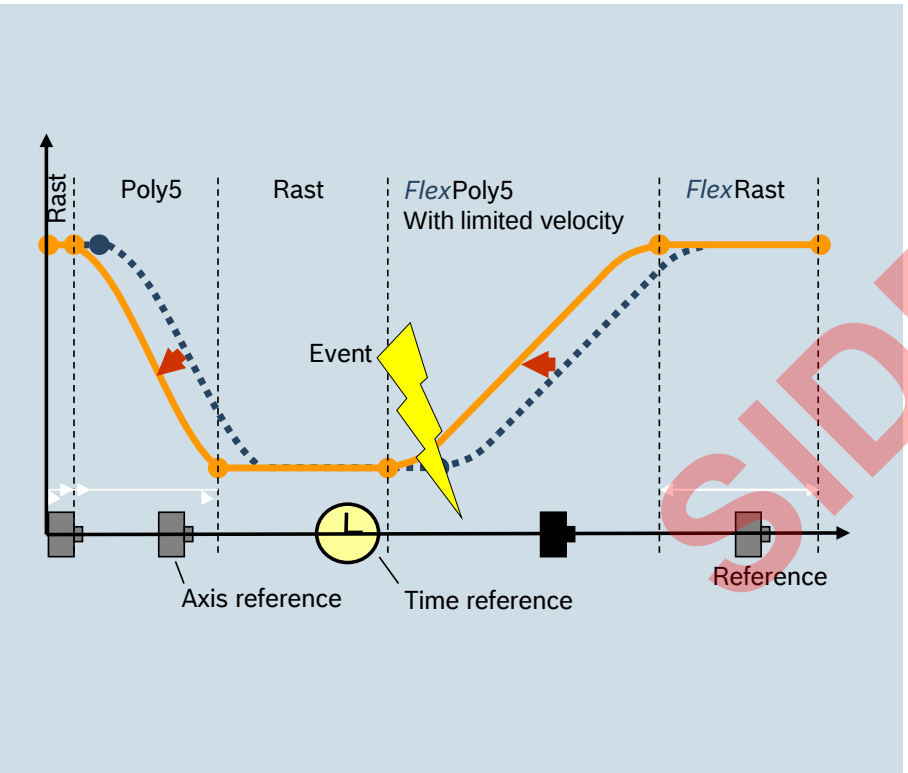
CamBuilder – Toolkit



CamBuilder – Application wizards



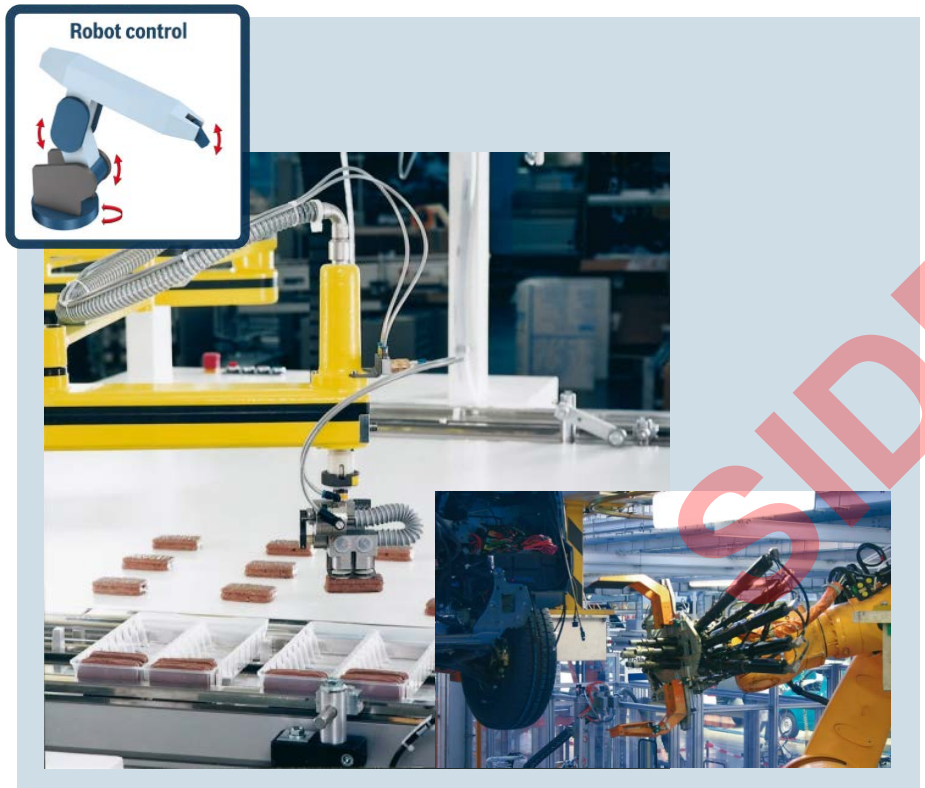
CamBuilder – FlexProfile



Synchronous motion functions with time-dependent segments:

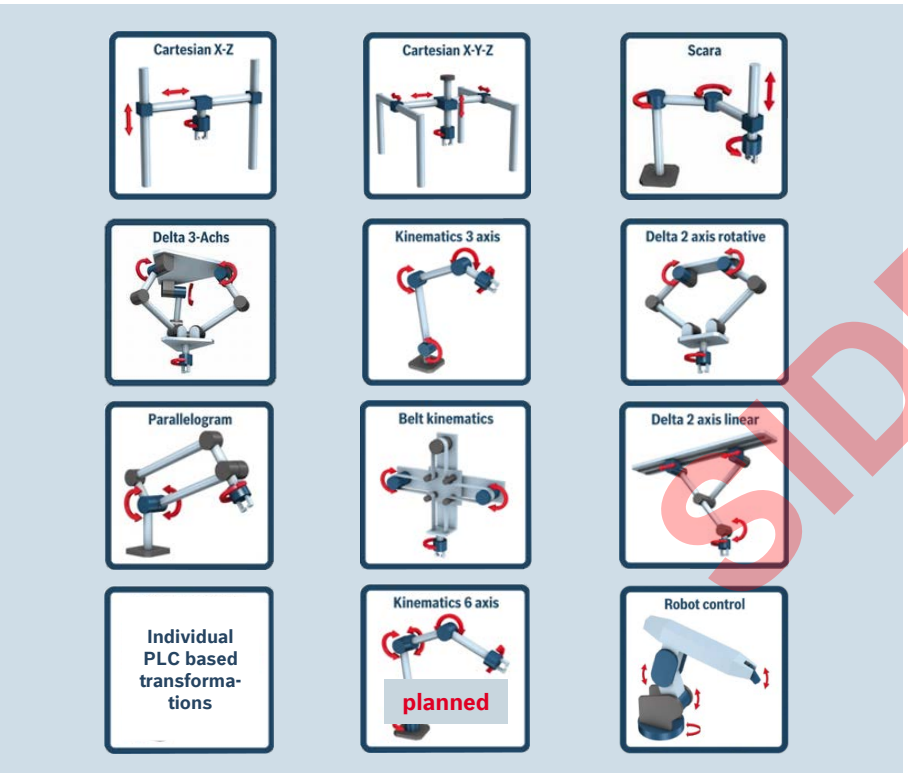
- **Segmented representation** of the motion sequence
  - Motion description based on motion law or checkpoint table
  - Master axis or time reference
- **Flex Segment**
  - Following segment can be adapted to prevailing conditions
- **Event-dependent motion** using Event Editor
- **Event triggering** to control other process segments
- Cam editing **using absolute or relative reference** (relative = without altering other reference points)

3D-Motion programming



- **User-friendly creating of motion control applications** with interpolation in three-dimensional space
- **Large number of ready-to-use transformations** for standard applications in robotics, extendable by user-defined kinematics
- **Dialog-aided configuration and parameterization**
- **PLCopen compliant programming- and data interface**
- **Kinematic Interface** – in 3 steps to executable kinematic
- **Open Core Interface** – completely programmable in high-level-language

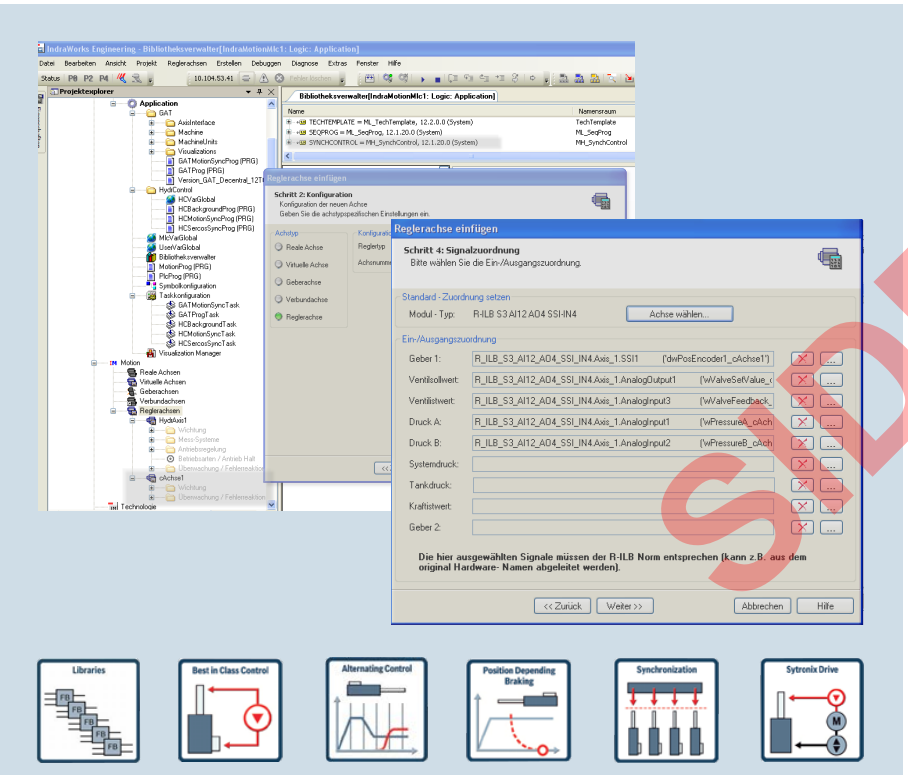
Types of kinematics



IndraMotion MLC	XM21 XM22	L25	L45	L65 L75	VPx
No. of axes	40	16	32	64	99
No. of axes per kinematics	16	16	16	16	16
No. of kinematics	4	4	16	16	16

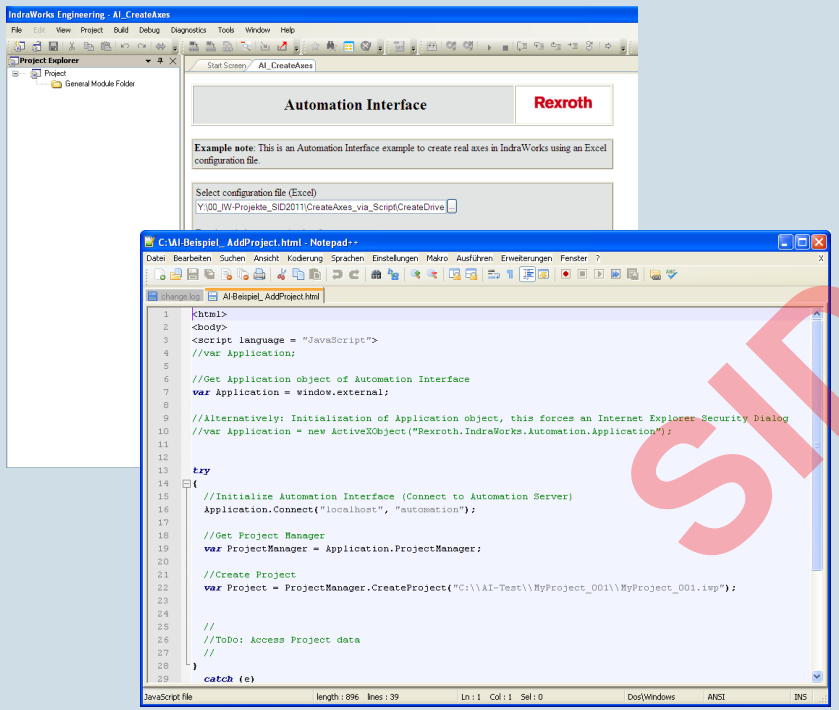
- Support of various types of kinematics
- Mixing of different kinematics in a single project
- Extendable with individual PLC-based transformations

Seamless integration of electro hydraulic axes



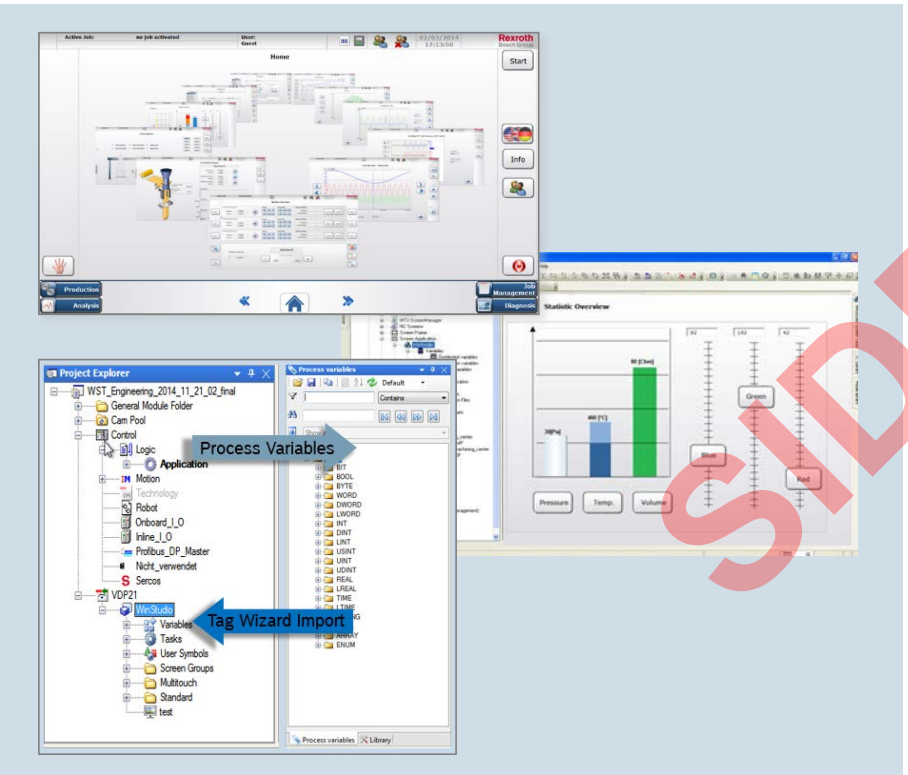
- **Axis type control axis**
  - Freely programmable controller
  - Central hydraulic controller
  - Hydraulic synchronization controller
  - Central Sytronix controller
- **Hydraulic libraries**
  - MH_TechHydrBase
    - Base function blocks for use of hydraulic functionality
  - MH_TechHydrMotion
    - Basic modules for moving hydraulic axes
    - Initialization, alternating control etc.
    - incl. integration of 4-axes-modul
- **Dialogs for hydraulic Best-of-Controller**

Control IndraWorks remotely



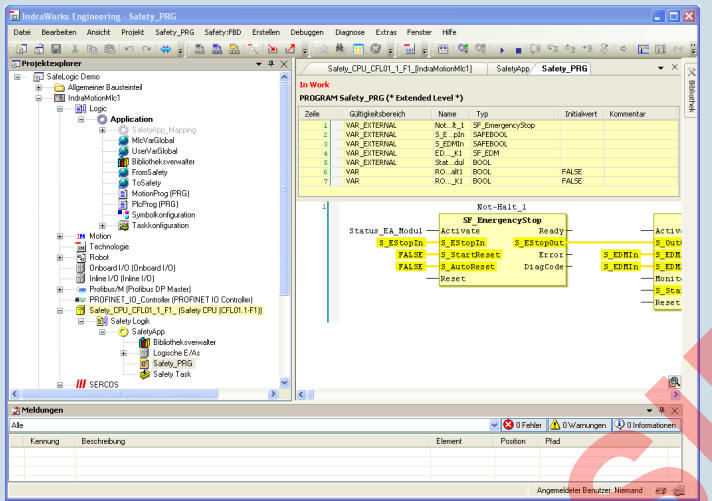
- Script interface for IndraWorks project data access
- Application spectrum
  - Create **customer specific reports**
  - **Automate regularly recurring modifications** to IndraWorks projects
  - **Generate IndraWorks projects automatically** using script-based processing of parts lists
  - Generate **simple customer-specific GUIs** on the IndraWorks Engineering Desktop
- Script Clients, e.g. JavaScript, VBScript

WinStudio: Implementation of machine operation



- One Visu-Tool for all device classes
- Completely integrated in IndraWorks
- Variable import via TagWizard
  - Control variables are automatically available
  - Takeover via mouse click
- Comprehensive toolkit to create HMIs
  - VBScript editor
  - User management
  - Integration of controls
  - Creation of project in accordance with FDA 21 CFR Part 11
  - And much more …

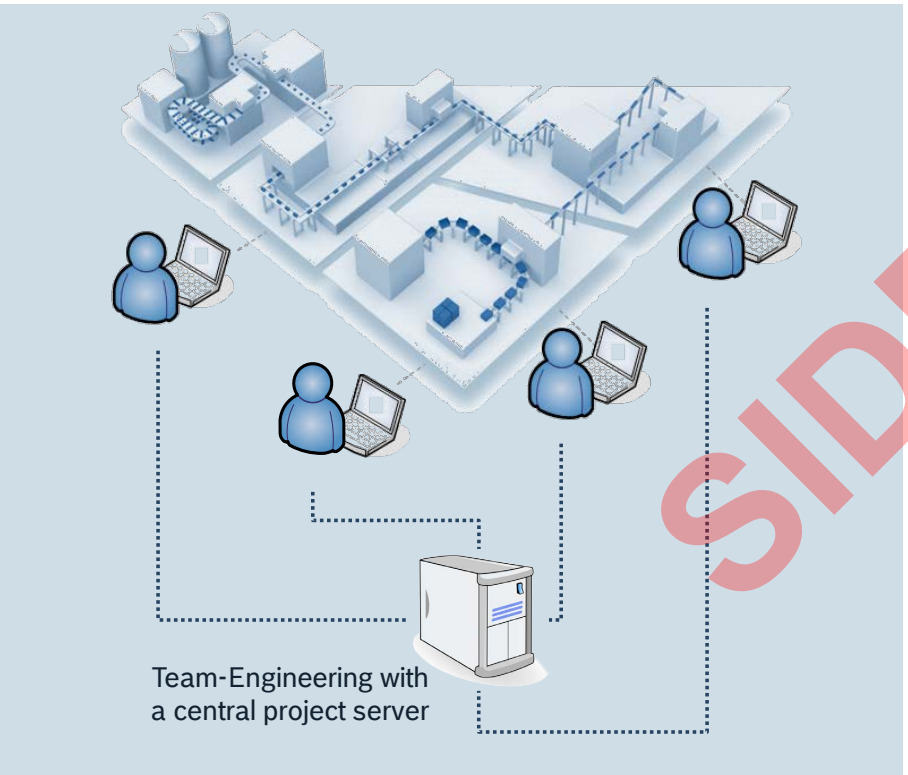
SafeLogic – Programming safety



- Safety manager contains everything to
  - Project
  - Parameterize
  - Program the safety project
- Full, seamless integration with the standard tool
  - Same look and feel
  - Comprehensive diagnostics
- Systematic safety integrity features built into the tool
  - User management
  - PLCopen safety compliance
  - Certified libraries

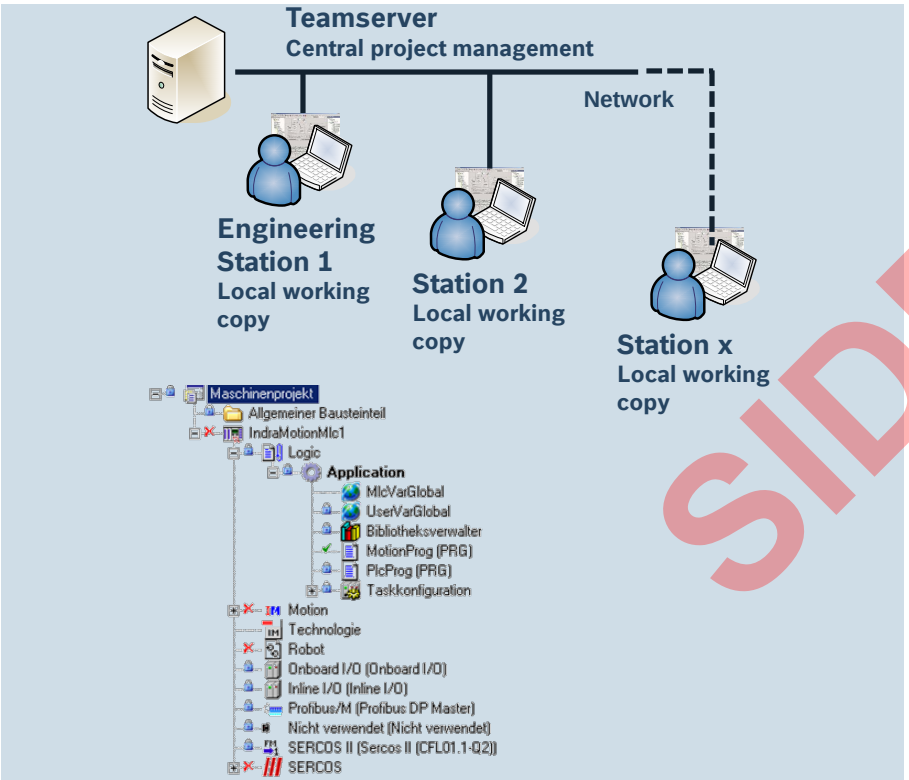
→ **Safety on Board**

Perfect engineering with version control



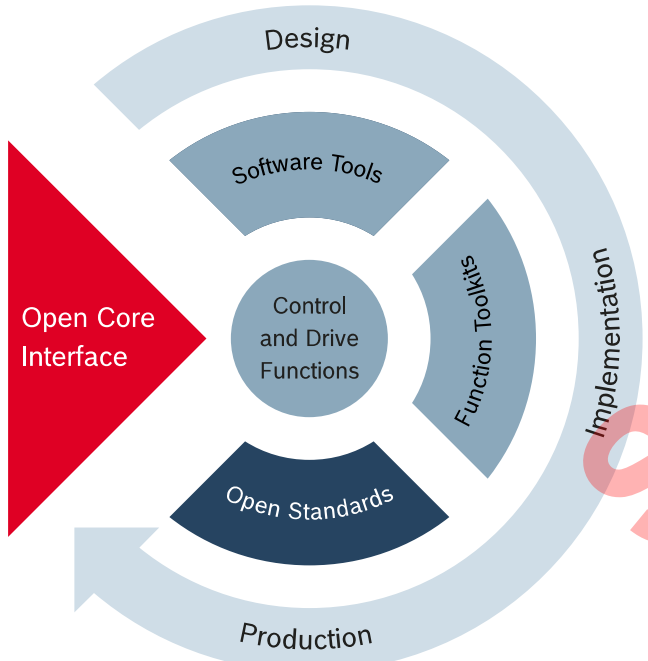
- Support for engineering workflows with **integrated version control system**
- **Simple traceability of versioned project status** based on integrated project data for individual users or teams
- Extensive **project administration and data management functions**
- **Creation of versioned library projects** for efficient generation of machine versions, etc.
- **IndraWorks data server** for integration of Visual Source Safe and Subversion
- **Enhanced efficiency of in-house engineering workflows** or during commissioning in the field

Functional overview



- **Central management** of IndraWorks projects
- **Version comparison**
- **Update preview**
- **Label different versions** of a project
- **Version history** for each object
- **Access management** for project elements
- **Commenting** of changes
- **Analyze differences** between versions of PLC elements
- **Object hijacking** (e.g. for offline engineering)
- Search function **for modified PLC objects**

Open Standards



Open Standards

- Required for flexible integration of software based solutions into different OEM engineering environments
- Basis for flexible integration of software-based solutions in different engineering and system environments
- Basis for migration of new technologies in existing machine automation
- Guaranteed future for high investments in software solutions

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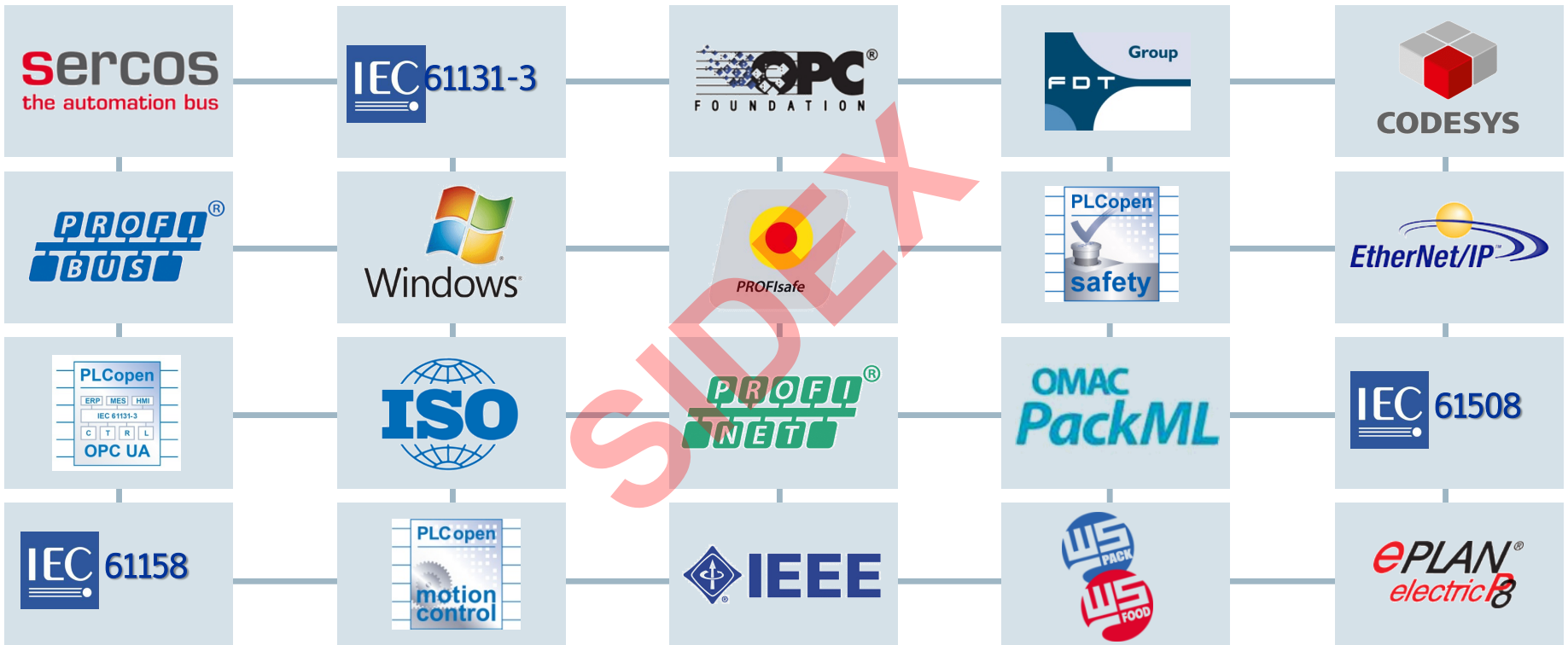
Open Standards for open automation solutions



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Agenda

- Fact Sheet
- Key Message
- Function principle and product description
  - Intelligent system components
  - High level efficiency in engineering
  - Seamless integration in Industry 4.0 environments
- Summary and highlights

Note: This presentation covers functional range of IndraMotion MLC 14VRS

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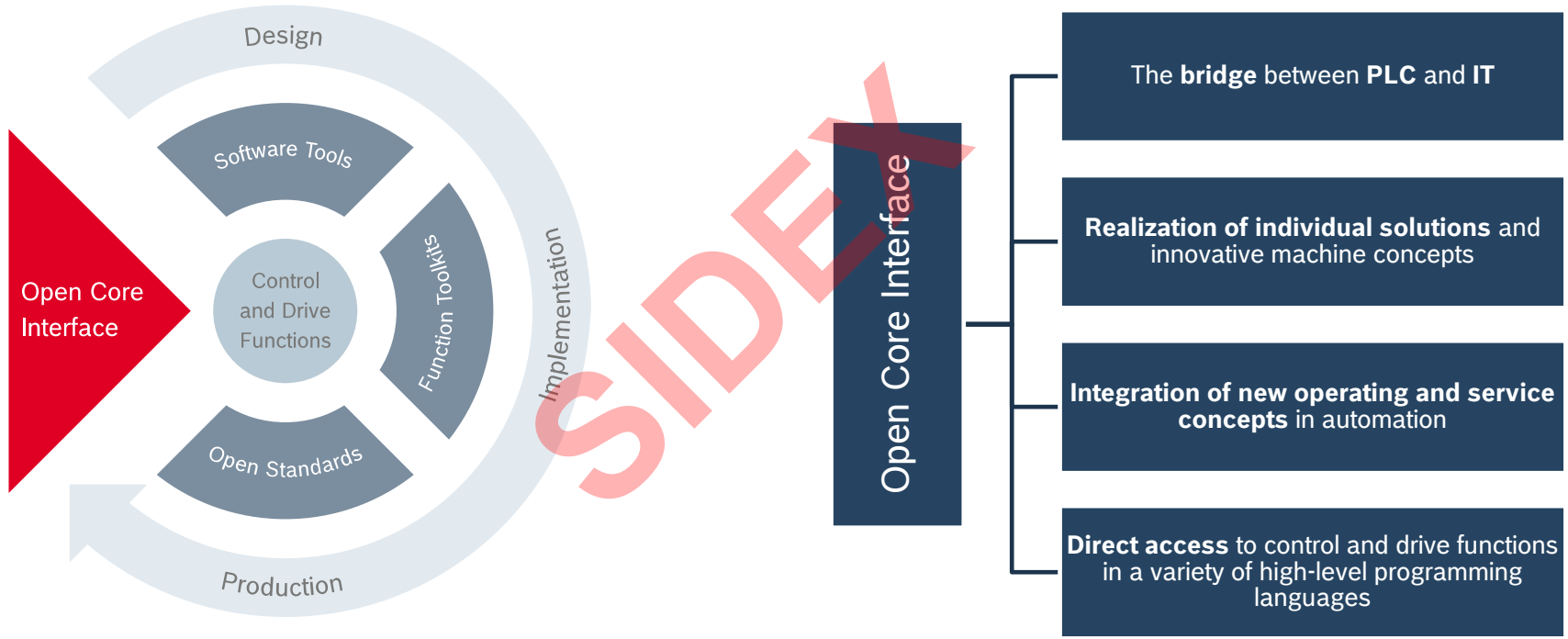
Optimal integration for Industry 4.0

i 4.0 CONNECTED INDUSTRY



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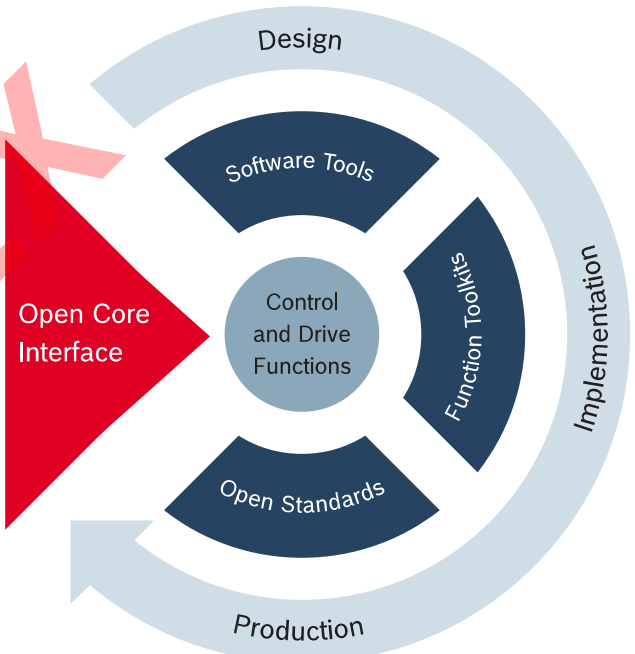
Catalyst for Connected Industry

i 4.0 CONNECTED INDUSTRY

- **Bridging applications** of PLC- and IT-oriented automation
- **Direct access to core functions** of controls and drives via high-level languages and tools
- **Increasing competitiveness** and **enabling new business models** for Connected Industry



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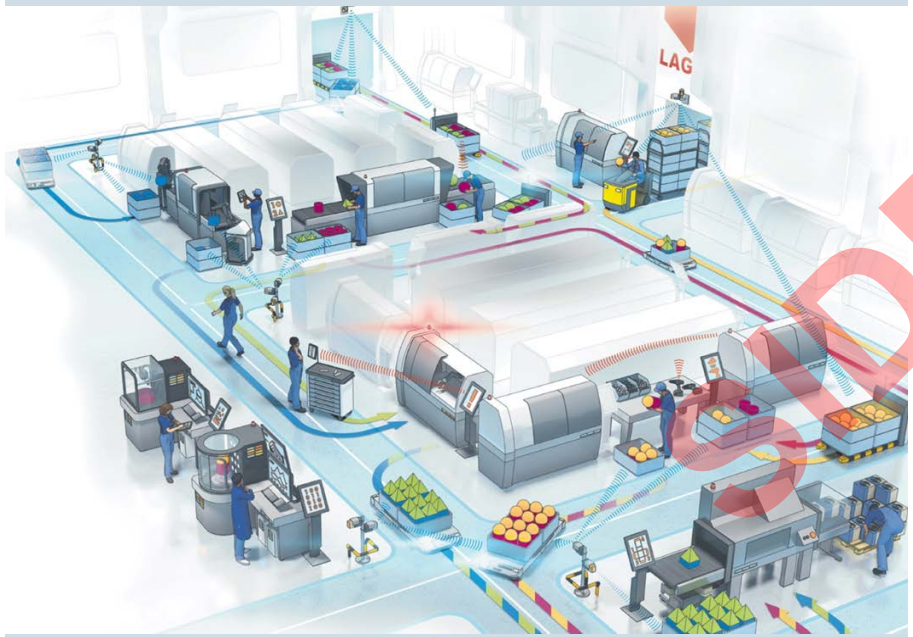
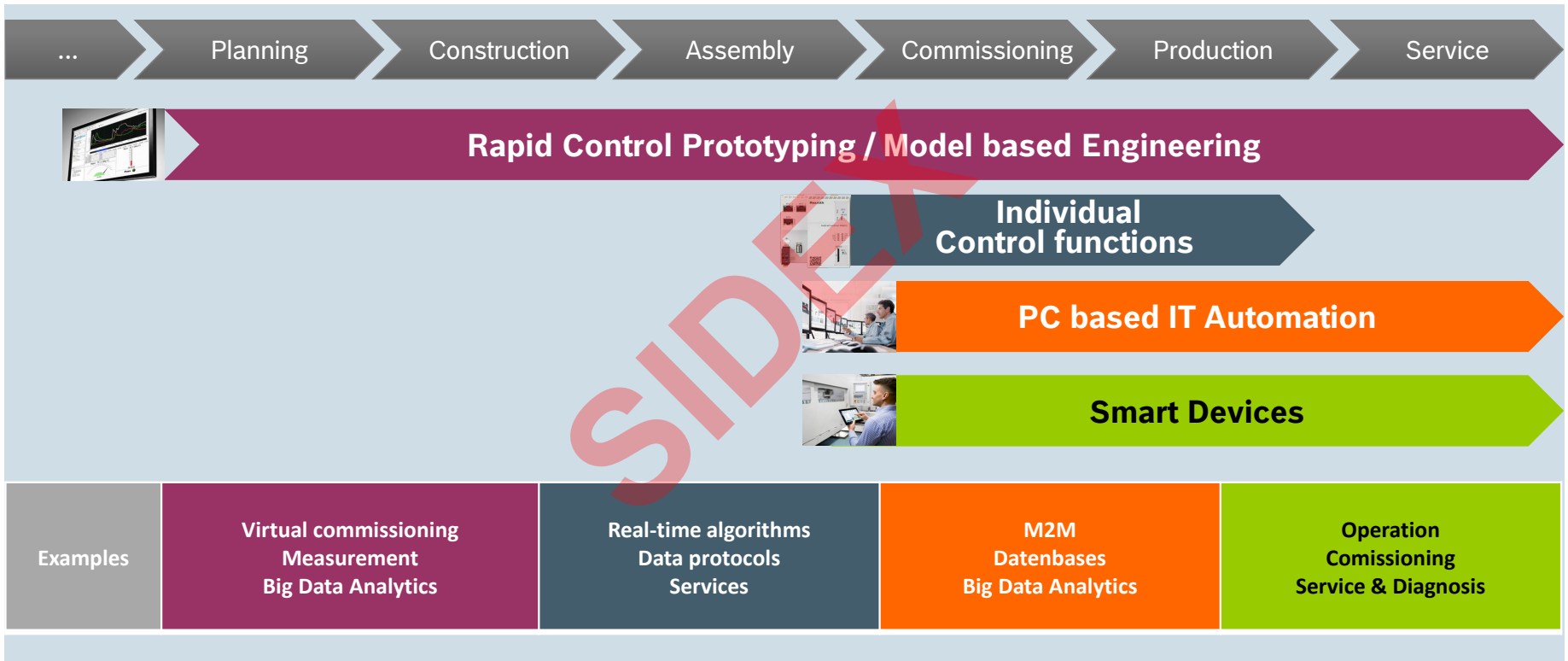
Factory automation requirements



- **Manufacture flexibly and autonomously**
  - Modular machine set-ups
  - Versatile and flexible products
  - Easy machine networking
- **Enhance usability**
  - Cyber-physical systems
  - Simple and error-free engineering
- **Access to machine data at anytime**
  - Big data, cloud connection, web access
  - Open data interfaces, e.g. for model-based engineering, process optimization, service
  - Security
- **Enable new business models**
- **…**

Typical applications



Applications with IndraMotion MLC

Application	Individual Functions			Smart Device		IT Automation						Rapid Control Prototyping			
Device Platform	IndraControl			Smart Device		PC						PC			
Operating System	vxWorks			Google Android	Apple iOS	Windows				Linux	Mac OS	Windows			
	native	Java VM	Lua VM												
Development Environment	Wind River Workbench	NetBeans Eclipse ...	Any Editor Eclipse	Eclipse	Xcode	Visual Studio	NetBeans Eclipse ...	Any Editor Eclipse	Client dependant	NetBeans Eclipse ...	Xcode	LabVIEW	MATLAB	Simulink	SimulationX Dymola ...
High level language	C/C++	Java	Lua	C/C++ Java	Objective-C Swift	VB/C/C++ +C#...	Java	Lua	OPC UA Client dependent	C/C++ Java	Objective-C Swift	G	MATLAB	Simulink MATLAB	Modelica
Toolbox	Core	Java	Lua	Core Java	Core	Core COM	Core Java	Lua	OPC UA	Core Java	Core	LabVIEW	MATLAB Simulink		Modelica
XLC / MLC Support	+	+	+	+	+	+	+	+	+	+	+	+	+		+
32/64 Bit	+/-	+/-	+/-	+/-	+/-	+/+	+/+	+/+	+/+	+/+	+/-	+/+	+/+		+/+

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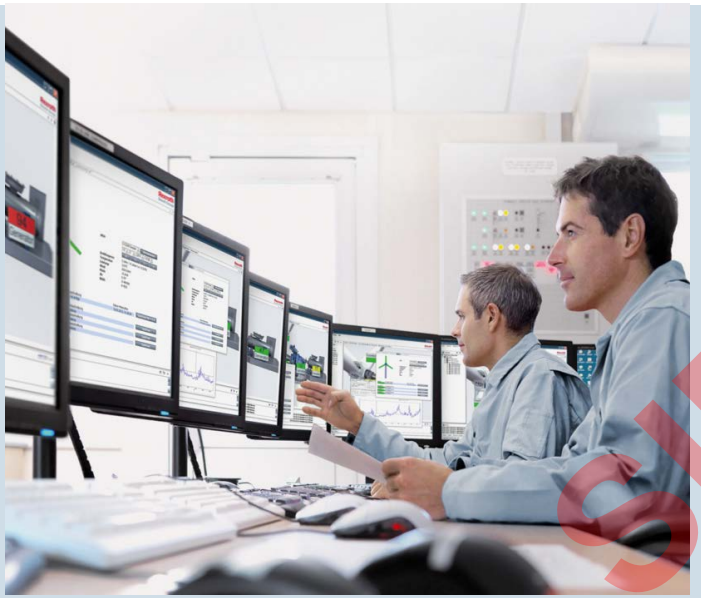
Connecting PC-based applications



- Seamless connecting of controls and drives to wide area of **PC-based applications**
  - Enhancements of OEM programs
  - Office tools, MES solutions, production systems
  - Big Data and cloud applications

- **Simplified M2M communication** for tracking of product and machine status, diagnoses or process data

Rapid Control Prototyping

MATLAB®
The Language of Technical Computing

SIMULINK

NATIONAL INSTRUMENTS
LabVIEW

MODELICA

OpenModelica

- Increase the **efficiency and consistency of engineering workflow**
- Design and implementation of **complex control algorithms**
- **Iterative development and optimization** of machine processes
- **Accelerated adaptation of machine programs** using simulation models
- **Virtual commissioning** with model-based engineering

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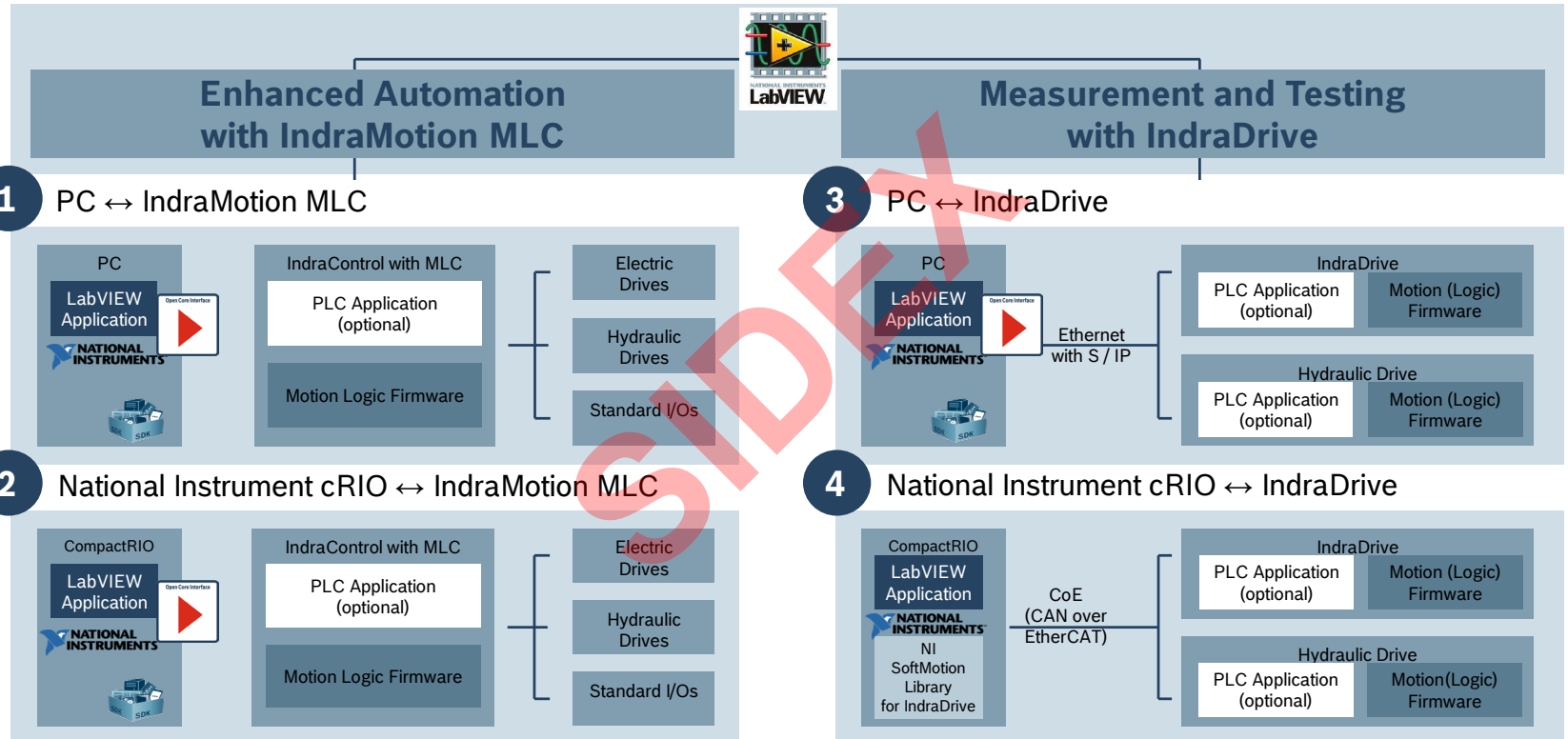
4 ways to get connected with LabVIEW



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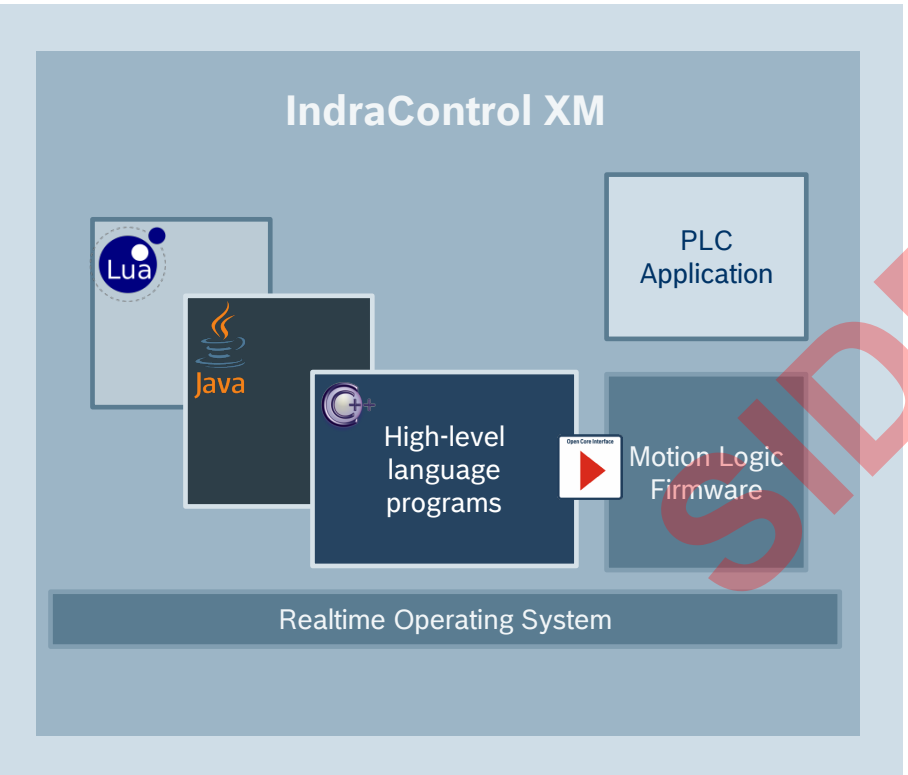
PLC- and IoT-enabled firmware

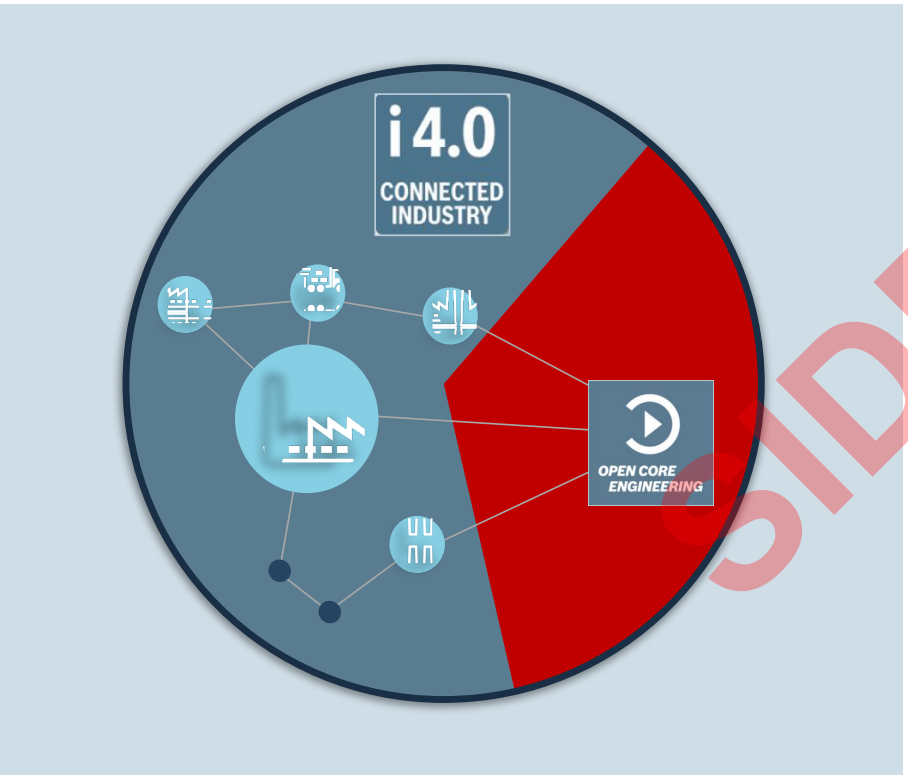


- **OEM-specific applications** direct on the control using Open Core Interface
- **PLC and high-level language applications** autonomous or in coexistence
- **C/C++ – Real-time-enabled programs** via most used IT programming language
- **Lua – Easy sequential programming** via script- and interpreter-based open source language
- **Java – Connecting to world's largest development ecosystem** as basis for new technologies such as IoT

New operating and service concepts

- Easy access to documentation and manuals locally, on-site
- Tailored provision of diagnostic and production information for higher clarity and ease of use
- Intuitive operating philosophy with gestures and symbols
- Use of mobile device-technologies such as WLAN, sensors, camera and GPS

Features and benefits



- ✓ **Efficient, safe and secured**
  Automation platform with easy adaption to machine requirements
- ✓ **Intelligent solutions**
  Scaled controls and software for decentralized production networks
- ✓ **Open connectivity**
  „Multi-Ethernet“ communication and standardized web & IT technologies
- ✓ **Enabling new services and business models**
  Seamless integration of IT and IoT tools and applications

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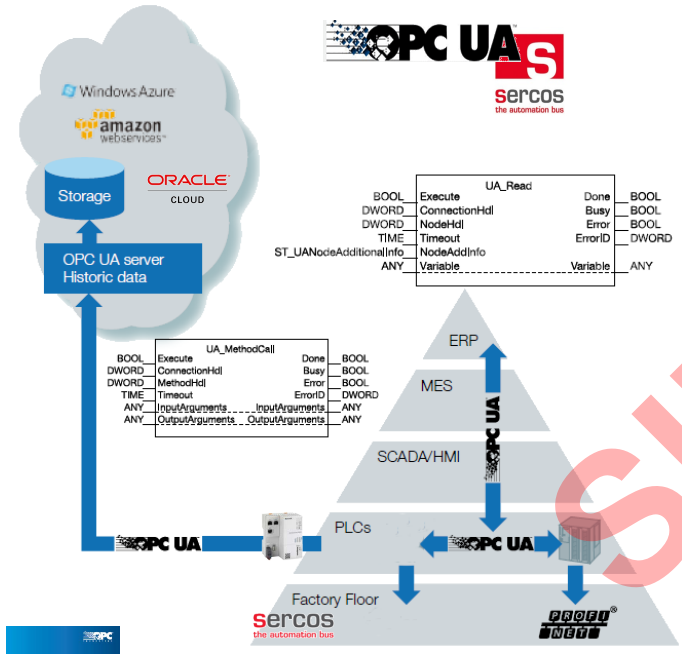
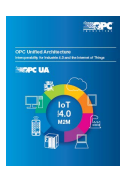
The open standard for Connected Industry





- Standardized **machine-to-machine (M2M) communication protocol**
- **Most comprehensive implementation of the OPC UA information model** via OPC UA server in Rexroth controls
- **Access to complete device data and functions via services** such as PLC, motion control and systems information
- **Enables future-oriented cloud or web based solutions**, especially in conjunction with Open Core Interface
- **Seamless integration in real-time networks** via mapping of Sercos on OPC UA information model (OPC UA companion specification)

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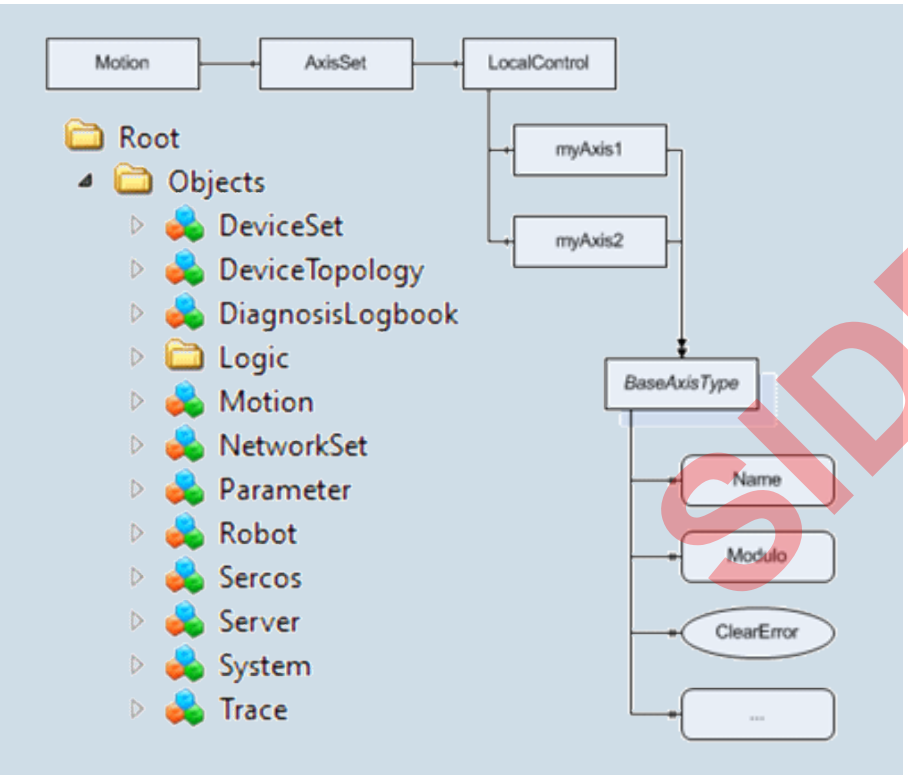
NEW

Information model implementation



- Base Information Model
  - Data Access - Browse, Read, Write, Subscribe
  - Alarms and Conditions
  - Historical access
- Technology-Specific Information Models
  - PLC Open Rel. 1.0 - Variables
  - Sercos Parameter (S, P)
- Rexroth specific
  - Device, Diagnosis Logbook
  - Motion / Robot / System
  - Parameter (A, C, K, N, M, O)

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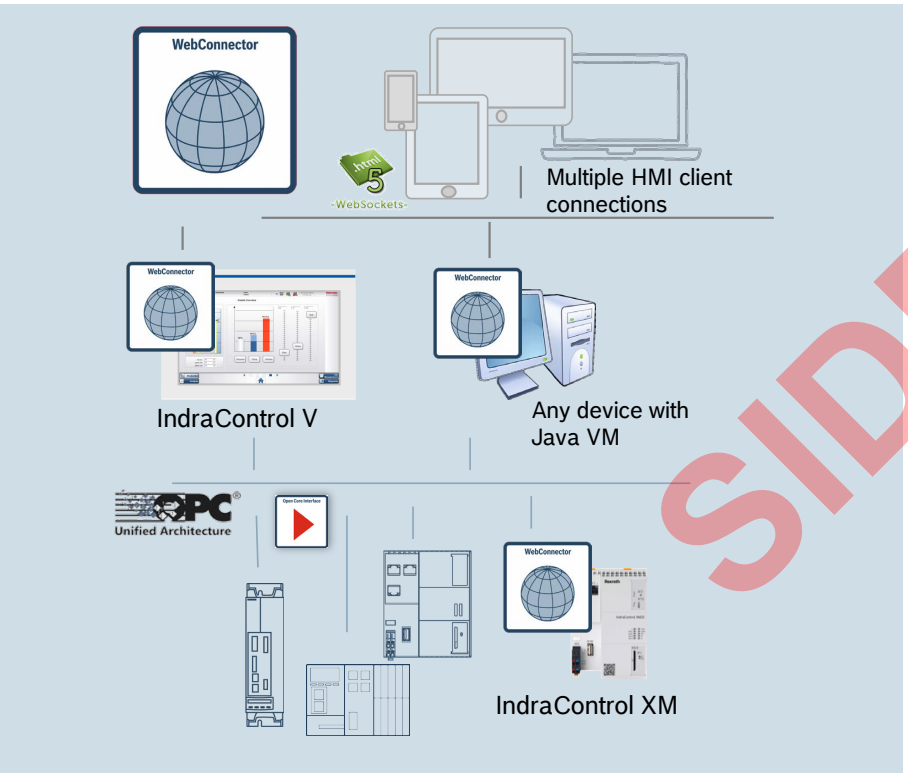
NEW

Simplified connecting with IT solutions



- **Translation of IT and web protocols** to machine communication (OPC UA, OCI)
- **Integrated web server with fast WebSockets communication** to provide OEM specific HTML5 pages
- **Establishing of automatic data access** via synchronous and asynchronous communication including security[1)]
- **Executable on every device with Java VM** for unlimited multi-client connection to devices, also through firewalls
- **Easy connecting to IoT applications** via open communication standards as MQTT, Node.js and JSON

1) Using OPC UA with HTTPS andTLS encryption over certificates

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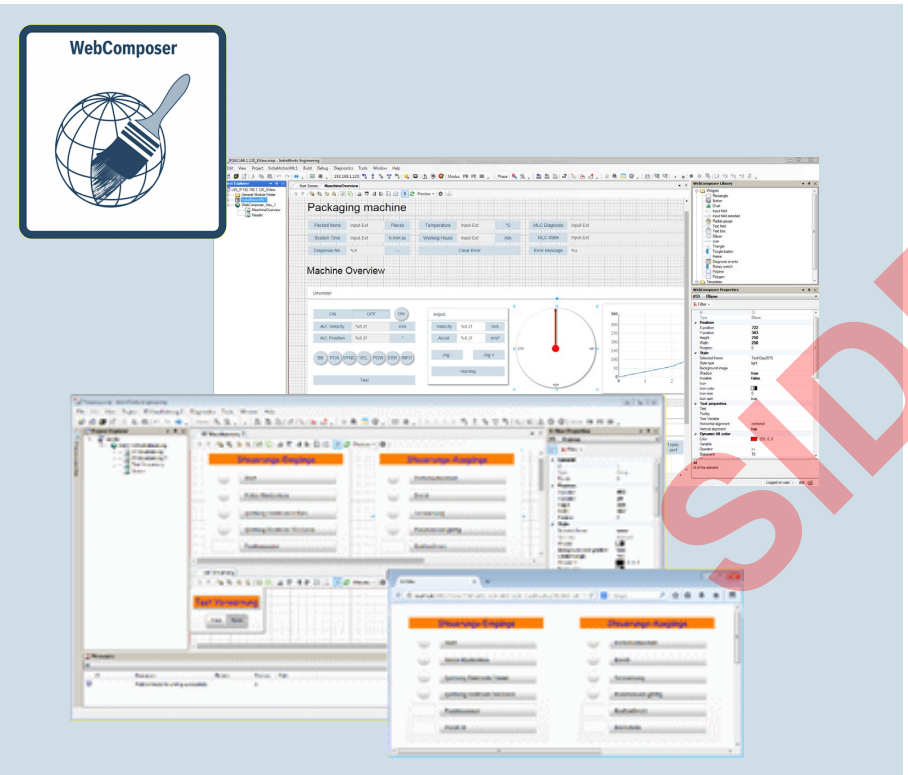
NEW

The easy way to smart HMI solutions



- **Fast implementation of smart web based HMI applications**
- **HTML5 Editor** inside of IndraWorks Engineering
- **Generates device-independent web pages** for any browser based on recommended architecture by BOSCH HMI CoC
- **No user knowledge of HTML5** or JavaScript necessary
- **JavaScript programming** with full access to all OPC-UA nodes
- **No knowledge of OPC UA** communication necessary

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NEW

Enabling higher machine availability

Invests in big data analytics will rise by 9.1 %/p.a. till 2021[1)]

- **Sustainable solution for monitoring of machine and process data** via OPC UA
- **Workflow system** to optimize processes or to solve problems in production
- **Storage of large amounts of data** via connected database
- Provision of **methods for web-based data analyzing and processing**
- **GDS Features**
  - RCM – Remote Condition Monitoring
  - RPM – Remote Process Monitoring
  - RDL – Remote Longterm Diagnosis Logbook
  - **Support for customer projects** via Rexroth Service

1) Source: Frost & Sullivan 2015 (market volume approx. 35 bill. US-$)

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The precondition for Connected Industry

- **Industrial Security is central precondition** and today's largest obstacle to spread Connected Industry solutions
- **13,000 incidents per month on process control systems** were affected with dangerous code in 2014[1)]
- Connected Industry requires **secure-by-design automation software**
- **Secure IT infrastructure for I4.0 value streams at BOSCH** will be enabled via SC-ITM[2)] (est. 2006) and I4.0 project ("I4.0sec")

Sources: 1) Kaspersky Lab, 2015
2) Steering Committee for IT in Manufacturing

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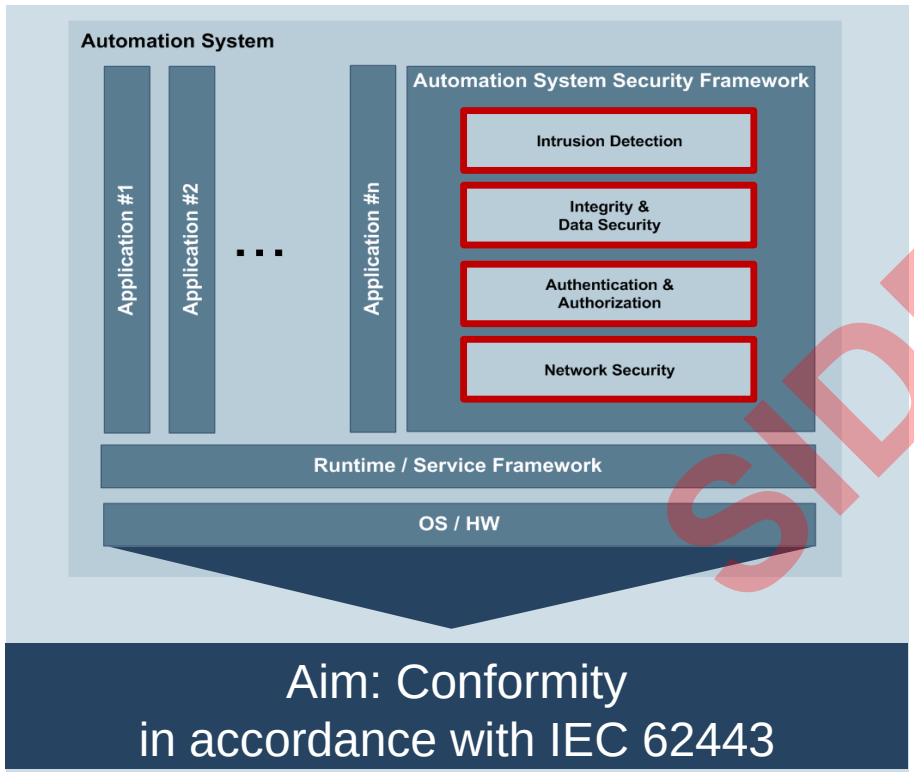
Security Framework for Industrial Security



- **Establishing SEP** (Security Engineering Process, 2016 mandatory in Product Engineering Process (PEP))
- Providing basic **security function blocks**
- **Cryptographic control functionality** via OpenSSL and TPM chip
- Firmware-integrated **user management**
- **Secured communication** via SSL/SSH

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The future of Big Data and IoT

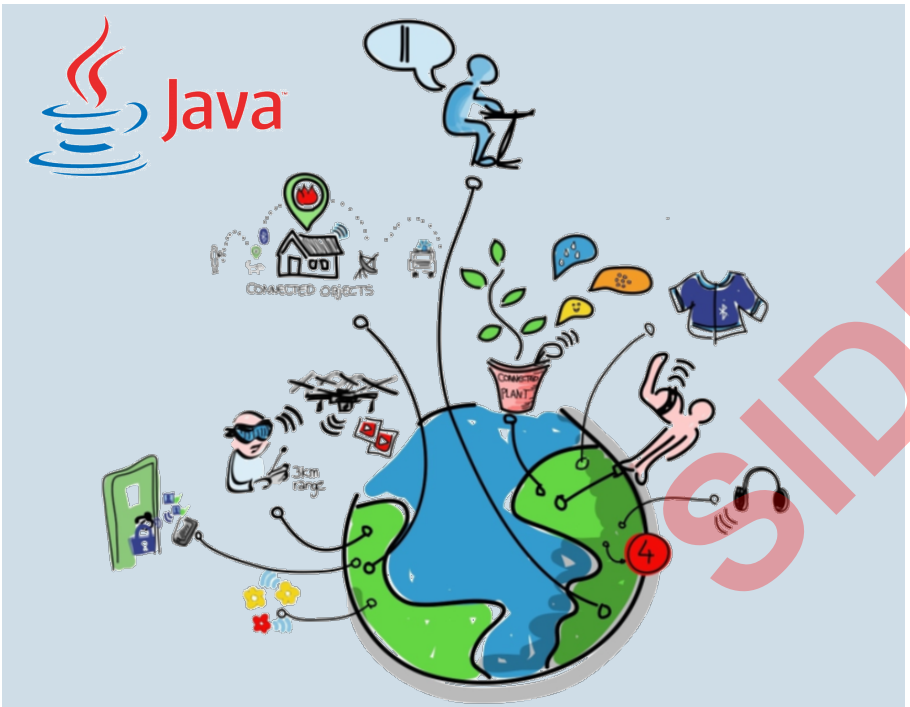

Image: Wikimedia.org
Introduction on Java by Oracle see Link

1. **Big companies using Java for their platforms**
   Bosch, Google, Amazon, SAP, Facebook, eBay, Netflix, LinkedIn, ...,Oracle

2. **Huge collection of open source libraries available**
   Already coded and tested software on vast expanse of information and knowledge by big companies available for use…9 million developers worldwide…

3. **Java is already everywhere**
   More than three billion devices being powered by Java technology

IndraMotion MLC – Implementing Java VM

- **Oracle's Embedded Java VM** implemented on IndraMotion MLC firmware for IndraControl XM / VPB
- **Java applications** can be developed and debugged on external devices
- **External applications** can be deployed on the control at a later time
- **Integrated OSGI service platform** running on Java VM enables integration of versioned service bundles on runtime
- Fully functional access via **Open Core Interface**

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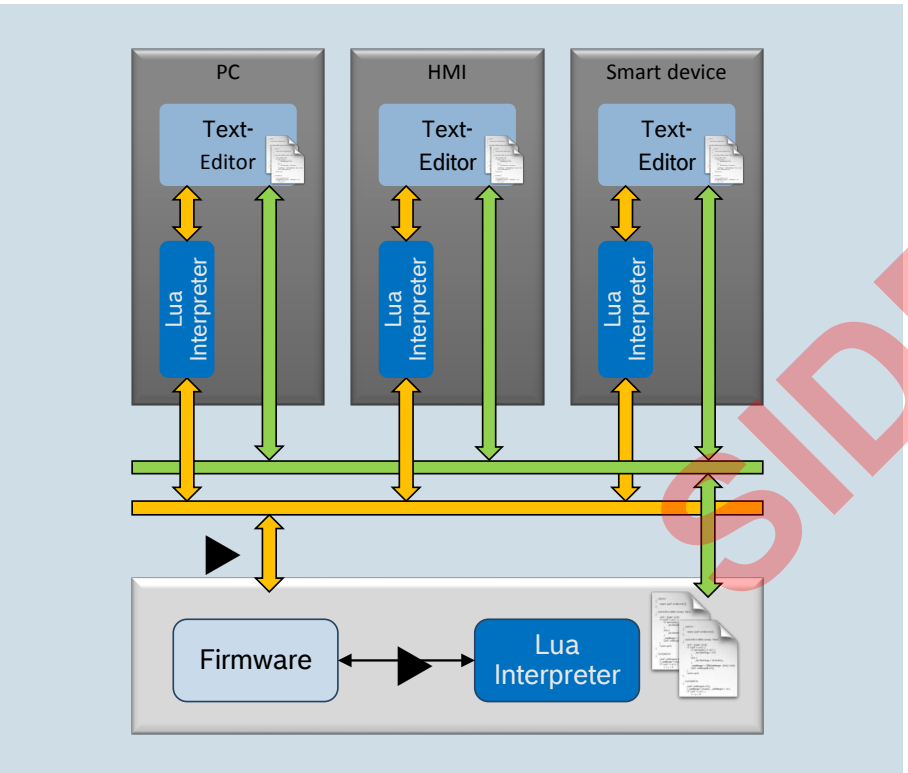
Covers all requirements and offers even more!

Lua is a **scripting language** which:

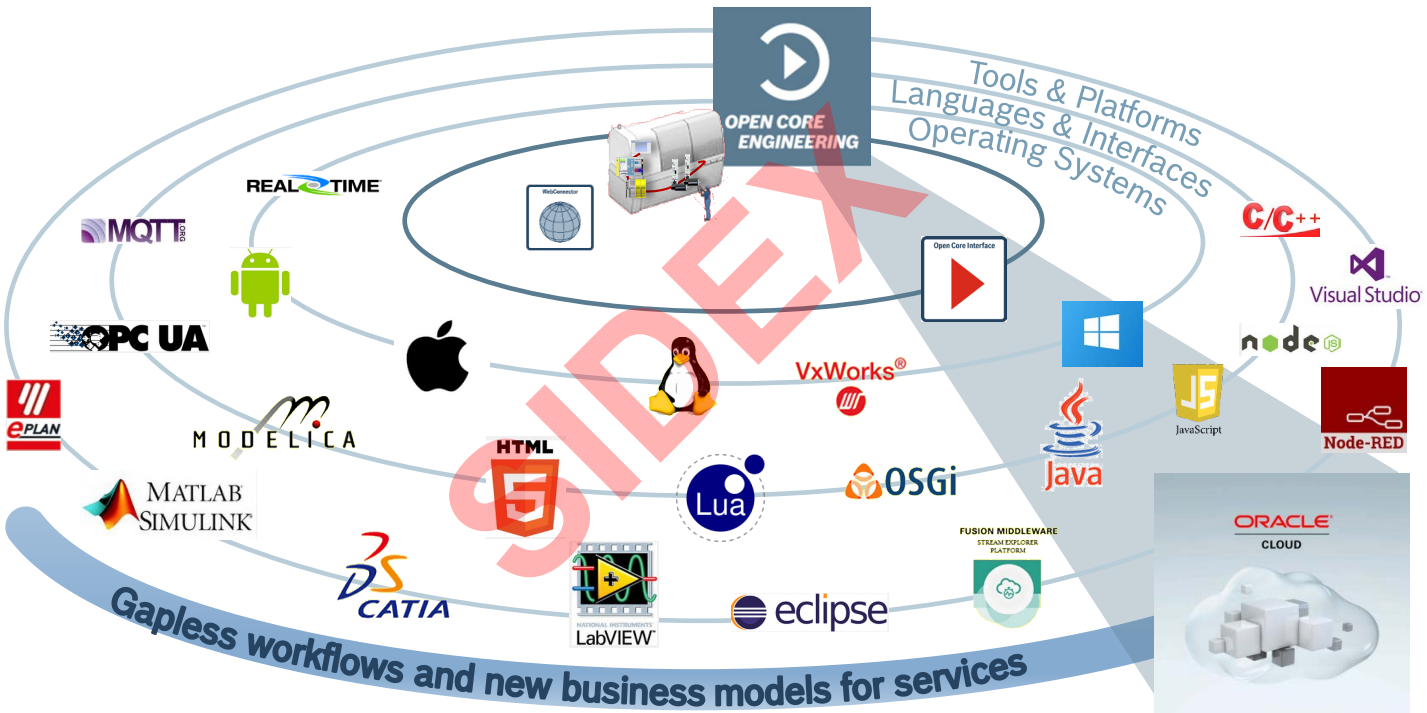
- Is **very small** – the Lua interpreter built with all standard Lua libraries takes ~200K
- Has been **used in many industrial applications** (e.g. Adobe's Photoshop Lightroom)
- Is the **fastest** interpreted scripting language
- Is **powerful** – it provides meta-mechanisms for implementing individual new features
- **Portable** – Lua builds out-of-the-box in all platforms that have a standard C compiler
- Is **open-source** software, distributed under MIT license

Lua for IndraMotion MLC



- Use a **Text-Editor** or tools like **Eclipse** with the **LDT** (Lua Development Tools) **plug-in** to create the Lua script
- The **default functionality** of Lua is **extended** with the Open Core Interface
- Lua scripts can run on
  - PCs
  - HMI-Devices
  - Smart devices
  - Controls
- **Develop** on a **PC**, **execute** on the **control**
  - Application area: programming of sequential motion sequences, e.g. in robot control environments

Enabling Connected Industry



Example: Cloud based services with Java

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Agenda

- Fact Sheet
- Key Message
- Function principle and product description
  - Intelligent system components
  - High level efficiency in engineering
  - Seamless integration in Industry 4.0 environments
- Summary and highlights

Note: This presentation covers functional range of IndraMotion MLC 14VRS

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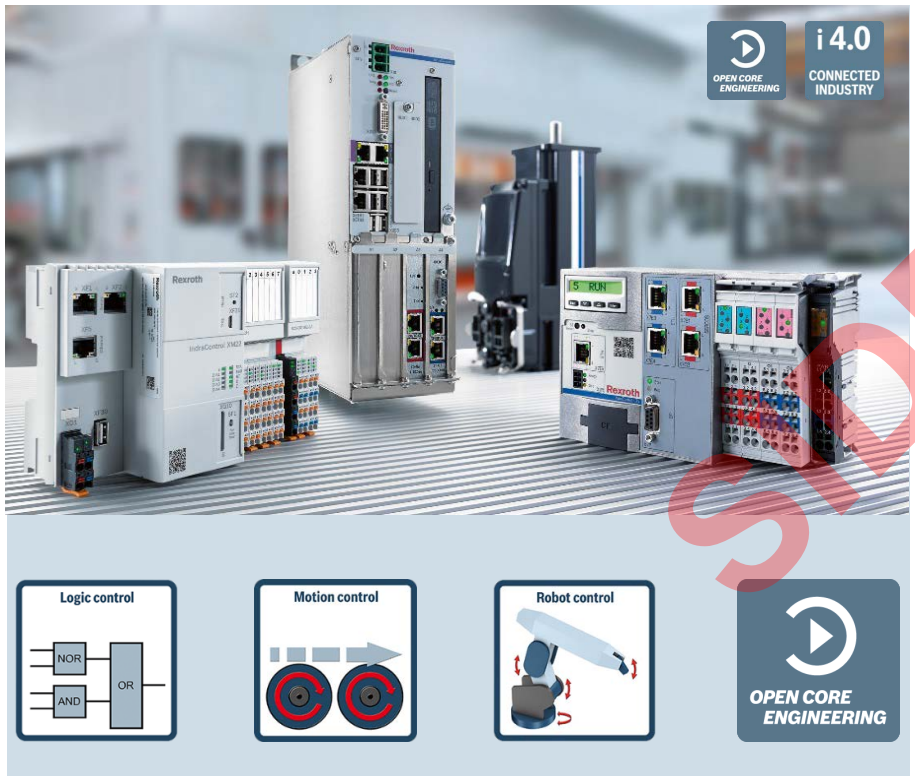
Benefits at a glance



- **Free choice of the hardware device** with a uniform design
- **Integrated runtime system** for motion, robot and logic control
- **Support of all drive technologies**
- **Optimal integration** – Open Standards, open interfaces and Open Core Interface
- **Uniform Engineering** due to the software framework IndraWorks with standardized programming in accordance with IEC 61131-3 and PLCopen Motion Control
- **Ready for use in Industry 4.0 environments**