



Technologies for our future



# Advanced Mechatronics System for higher-level Performance & Flexibility

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# Advanced Mechatronics: Independent Movers System

- Passive movers move along an active travel path consisting of motor modules.
- Movers are freely movable on the path and can be controlled independently of one another
  - Brake / Accelerate
  - Gearing
  - Electronic Cams
  - exert a constant force at a standstill and in motion.
- Modular System: Geometry and length of the travel path as well as the number of movers can be adapted to suit the application ( > 100m , 200 movers)



# Advanced Mechatronics: Planar System

- A passive mover containing permanent magnets levitates above XPlanar tiles that generate a magnetic field to control and to generate the movement
- The movers are independent of each other
- Six degree of freedom:
  - Positioning in X/Y up to 2m/s
  - Lifting, Lowering, weighing variable in height by up to 5mm
  - Tilting by 5°



# Control System Architecture

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The system must satisfy the following fundamental characteristics:

- Modularity
- Independence and controllability of movers at any point in the path/space
- Fast engineering: short time-to market
- Flexible operation through software & simple configuration

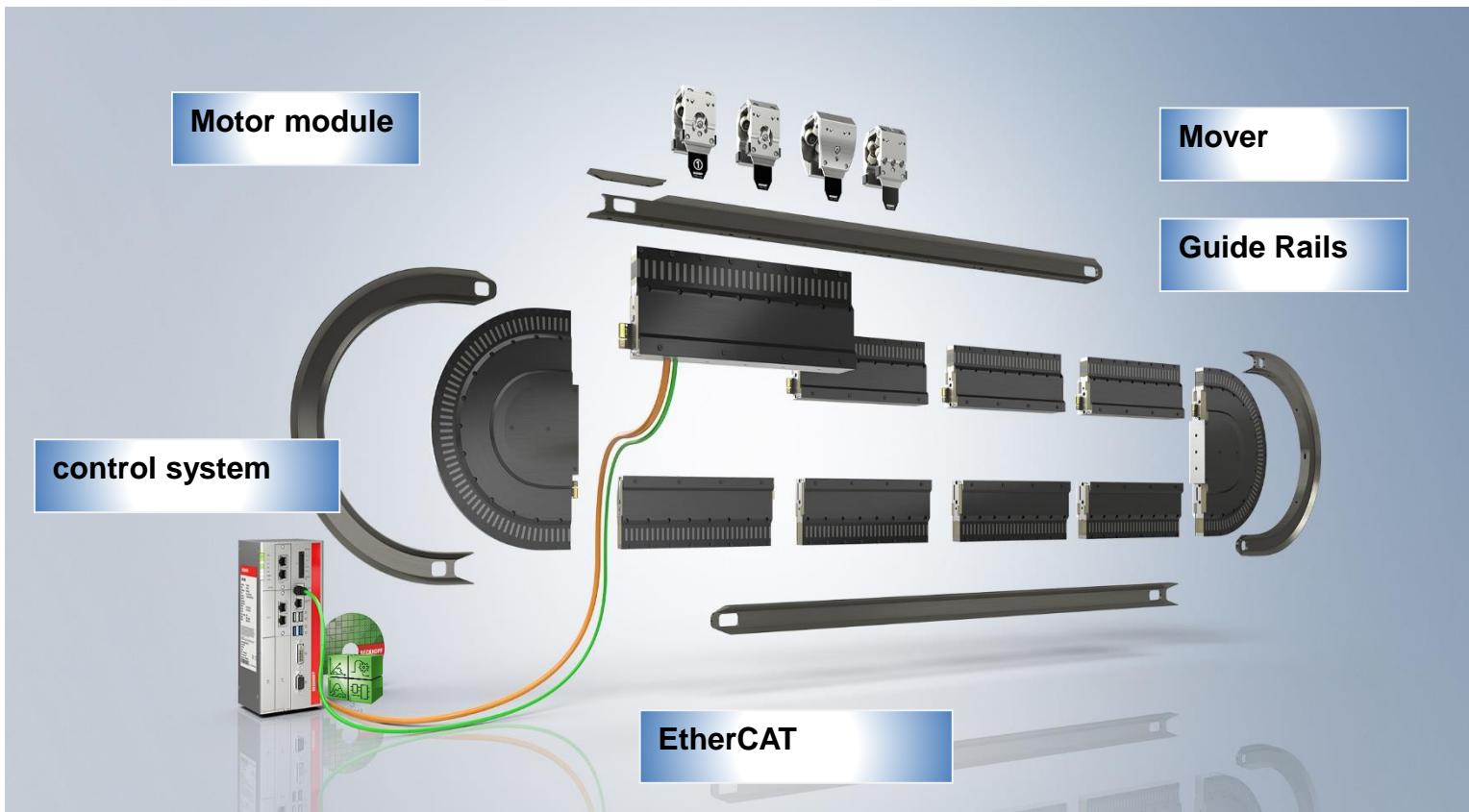


The optimal solution is centralized control where all the control algorithms and feedback ones reside in the controller itself

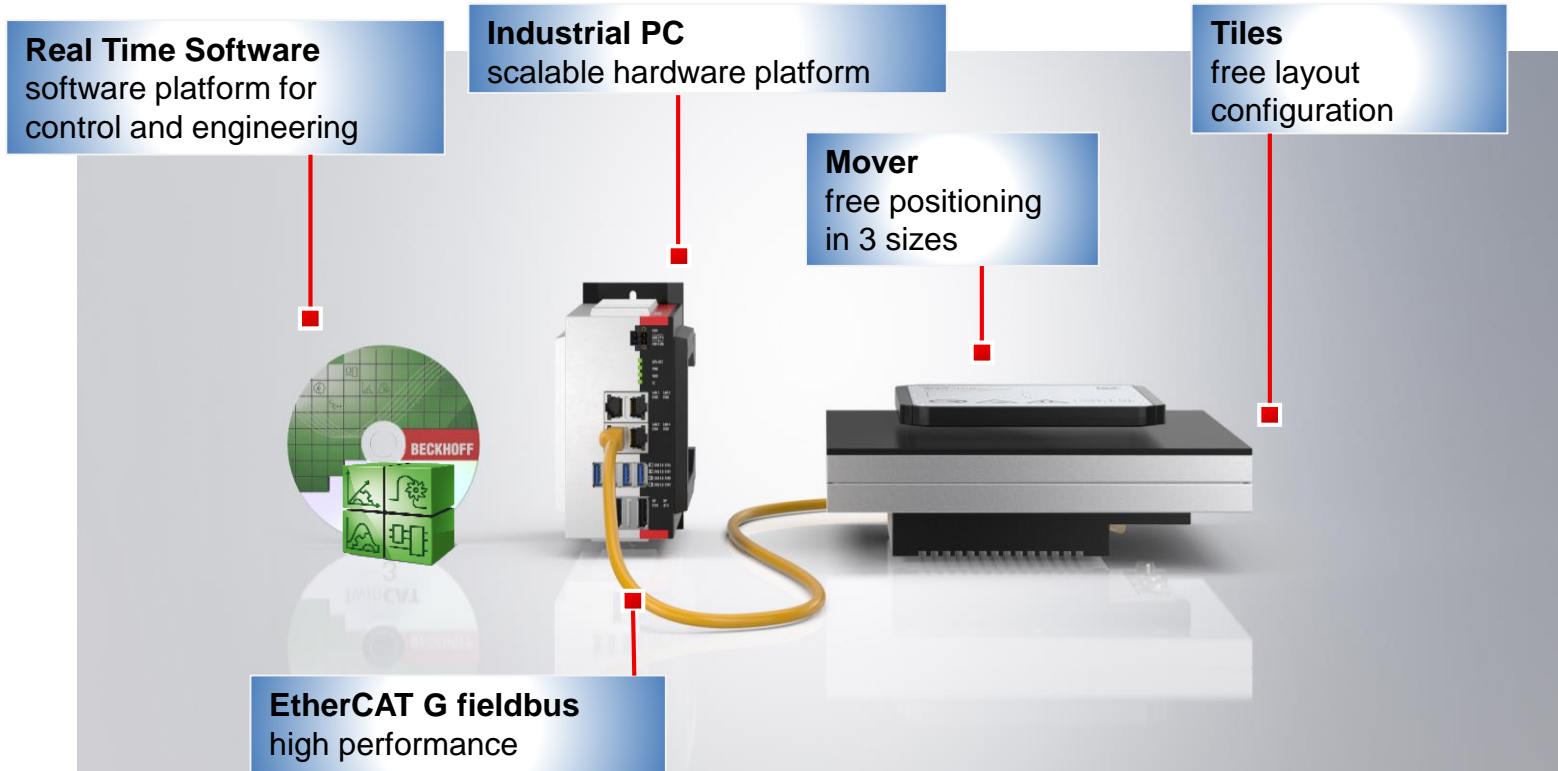


No drive is present in the control cabinet → Compact system for smaller machines

# Control System Architecture



# Control System Architecture



# Control System

- All typical servo-drive control loops moved within IPC →  $T_{cyc} < 250\mu s$

Settings | Online | Priorities | C++ Debugger

Router Memory  
Configured Size [MB]: 32  
Allocated / Available: [ ]

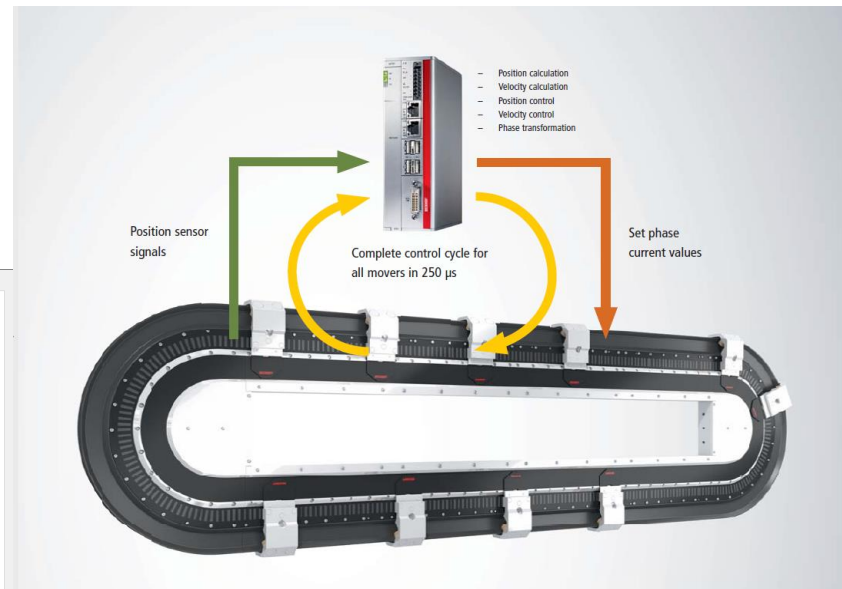
Global Task Config  
Maximal Stack Size [KB]: 64KB

Available cores (Shared/Isolated): 2 / 6

Core	RT-Core	Base Time	Core Limit	Latency Warning
0 (Shared)				
1 (Shared)				
2 (isolated)	✓ Default	1 ms	100 %	(none)
3 (isolated)	✓	250 $\mu s$	100 %	(none)
4 (isolated)	✓	250 $\mu s$	100 %	(none)
5 (isolated)	✓	250 $\mu s$	100 %	(none)
6 (isolated)	✓	250 $\mu s$	100 %	(none)
7 (isolated)	✓	250 $\mu s$	100 %	(none)

Object	RT-Core	Base Time (ms)	Cycle Time (ms)	Cycle Ticks	Priority
Task XPlanar	Core 3	250 $\mu s$	0.250 ms	1	1
Task Mover1	Core 4	250 $\mu s$	0.250 ms	1	2
Task Mover2	Core 5	250 $\mu s$	0.250 ms	1	3
Task Mover3	Core 6	250 $\mu s$	0.250 ms	1	4
Task Mover4	Core 7	250 $\mu s$	0.250 ms	1	5
NC-Task SAF	Core 2	1 ms	2 ms	2	6
I/O Idle Task	Default (2)	1 ms	1 ms	1	11
PicTask	Core 2	1 ms	2 ms	2	20
PicAuxTask	Default (2)	1 ms	(none)	0	50



Realtime extension of the OS can manage in parallel multiple cores →  
Using multicore CPUs to increase number of movers and system length/area



## CONTROL CABINET INDUSTRIAL PC

- Intel® Core™ i7-9700E, 9<sup>th</sup> generation, 2.6 GHz, **8 cores**



## EMBEDDED PC

- Intel® Xeon® D-1548, **8 cores**, 2.0 GHz
- Intel® Xeon® D-1567, **12 cores**, 2.1 GHz



## CONTROL CABINET INDUSTRIAL SERVER

- **Two** Intel® Xeon® Scalable processors with **8, 12, 16 or 20 cores each** on one motherboard
- 64 GB DDR4 RAM EEC, expandable to 1024 GB
- graphic card, 1 DVI-I and 1 DVI-D connector

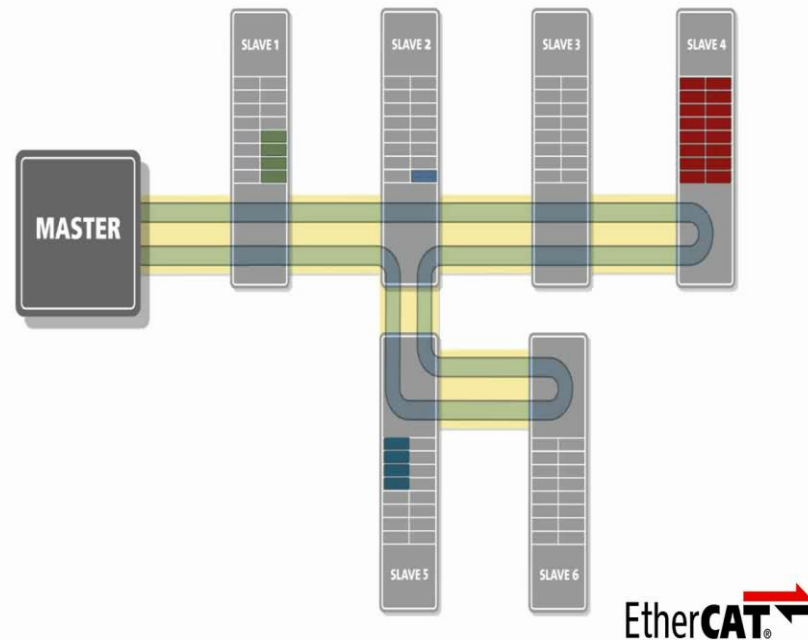


EtherCAT (*Ethernet for Control Automation Technology*) is an Ethernet-based 100Mb/s fieldbus system

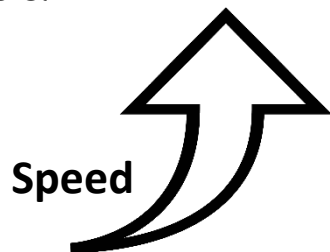
High performance through on the fly data elaboration

### Performance:

- 1000 digital distributed I/O in 30 $\mu$ s
- 100 servo-axes in 100 $\mu$ s
- EtherCAT integrated in I/O Slice, no Sub-Bus
- No extra Hardware is necessary: Optimal use of standard Ethernet port
- Accurate Synchronization ( $\ll 1 \mu$ s) thanks to Distributed Clocks Technology



- Based on EtherCAT protocol
- Ethernet based on 1Gbit/s & 10Gbit/s



- 2,000 digital inputs/outputs every 15  $\mu$ s
- 100 servo axes every 30  $\mu$ s

Speed	Protocol	Min. telegram length (0...46 byte user data)*	Max. telegram length (1,500 byte user data)*	Key Features
100 Mbit/s	EtherCAT	6.08 $\mu$ s	122.40 $\mu$ s	<ul style="list-style-type: none"> <li>100BASE-TX</li> <li>Vast choice of components</li> </ul>
1 Gbit/s	EtherCAT G	0.58 $\mu$ s	12.24 $\mu$ s	<ul style="list-style-type: none"> <li>1000BASE-T</li> <li>Integration of data-intensive devices</li> <li>Very high bandwidth</li> </ul>
10 Gbit/s	EtherCAT G10	0.06 $\mu$ s	1.22 $\mu$ s	<ul style="list-style-type: none"> <li>10GBASE-T</li> <li>Integration of EtherCAT G segments</li> <li>Ultimate bandwidth</li> </ul>

\*incl. Preamble and VLAN-Tag





**Thank you for your attention**

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