Bosch Rexroth.

Automation & Electrification

Solutions

CNC | MOTION CONTROL | PLC & IOT | PROCESS CONTROL | DRIVES | SERVICES

DC-AE/MKT | 10/16/2017

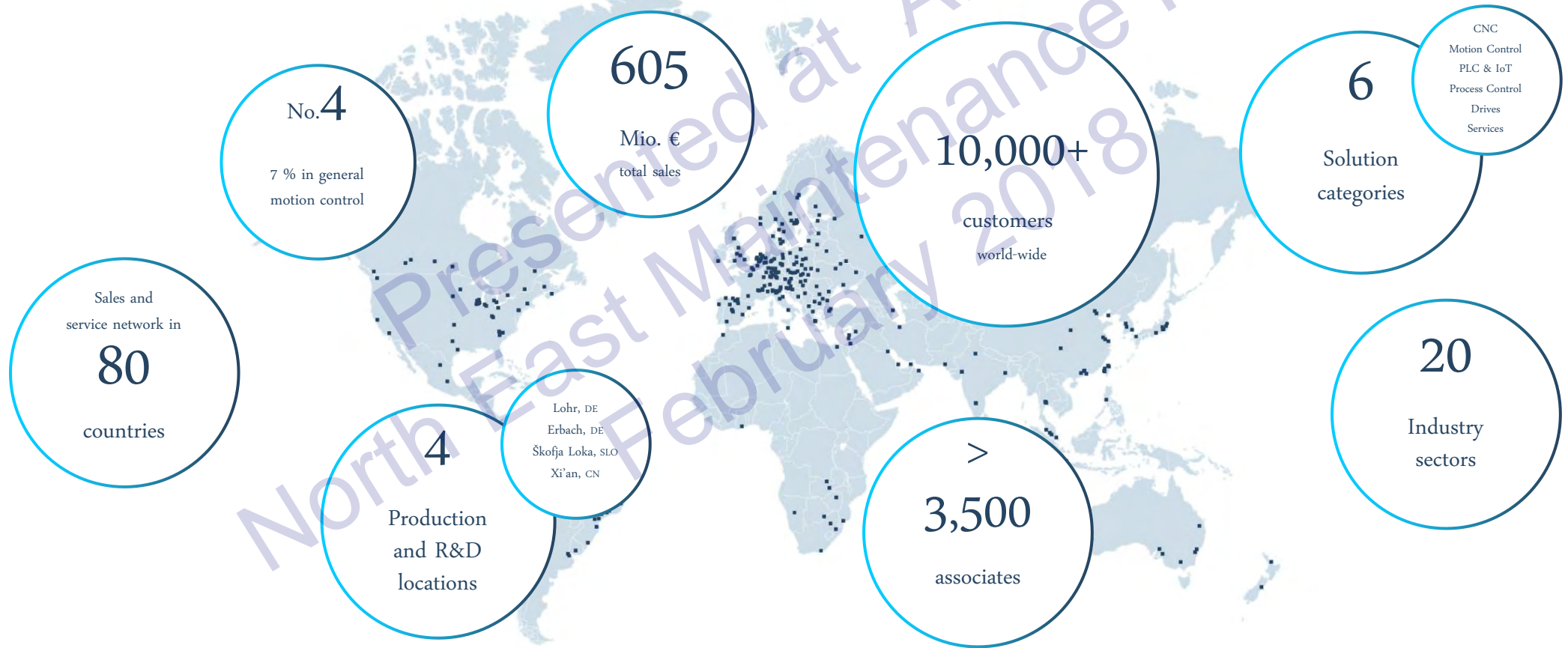**Rexroth**
Bosch Group

Bosch Rexroth. The Drive & Control Company

How can Innovations in drives and control technology improve OEE?

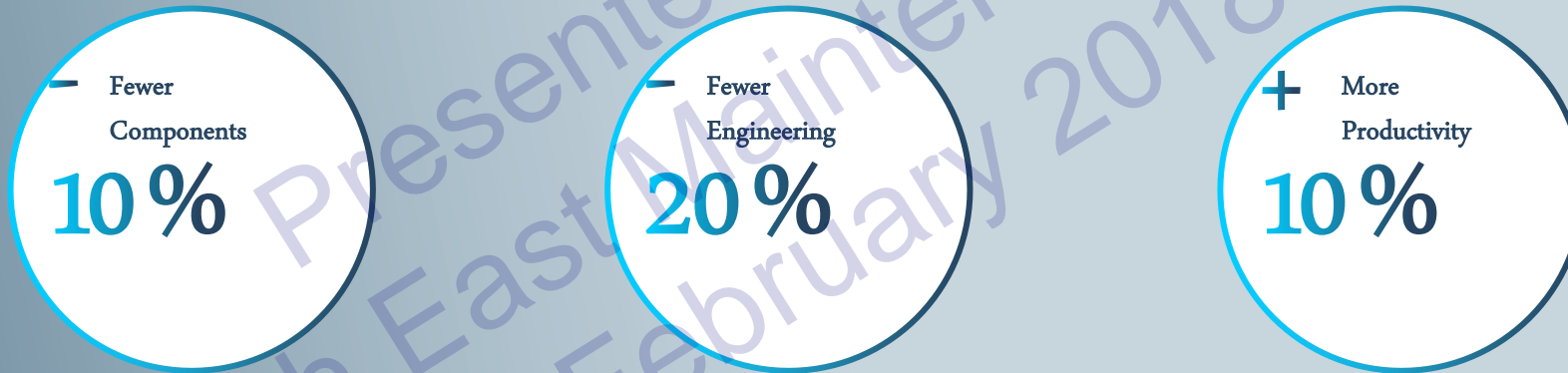Paul Streatfield - Strategic Product Manager

amap
automotive & manufacturing advanced practice

North East Maintenance Forum

University of Sunderland

eef The manufacturers' organisation

IET The Institution of Engineering and Technology

FEB 07

North East Maintenance Forum Meeting - 7th February 2018

by AMAP - University of Sunderland

Free

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Leading in automation technology

No.**4**

7 % in general motion control

605

Mio. €

total sales

10,000+

customers

world-wide

6

Solution categories

CNC
Motion Control
PLC & IoT
Process Control
Drives
Services

Sales and service network in

80

countries

4

Production and R&D locations

Lohr, DE
Erbach, DE
Škofja Loka, SLO
Xi'an, CN

>
3,500

associates

20

Industry sectors

All figures of 2016

DC-AE/MKT | 10/16/2017

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Our philosophy

− Fewer
Components
10 %

− Fewer
Engineering
20 %

+ More
Productivity
10 %

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Innovations for industrial applications 1979–2013

MAC	TRANS 01	MT-CNC	DIAX/ECODRIVE	SYNAX 200
Maintenance-free servo drives	CNC system for decentralized application	Multi-axis / multi-process control	Digital, intelligent AC drives	Automation system for the printing industry

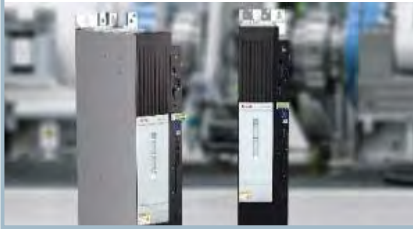| LSF	ServoDyn	MTX	MLC	Open Core Engineering
Linear direct drives with synchronous motors	First servo drive with integrated safety system	CNC system	Motion logic system	Freedom and efficiency redefined
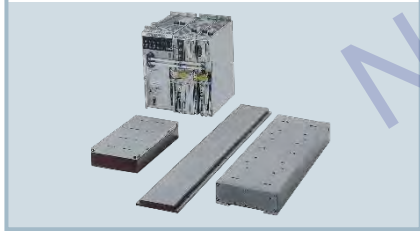
Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Innovations for industrial applications 2014–2018

IndraDrive ML

Powerful, flexible drives

IndraDrive Mi

Cabinet-free drive technology

Industry 4.0

Networked multi product line (Homburg/Saar)

XM

Control platform with more intelligence

MS2N

Synchronous servo motor

PRC7300

Medium-frequency welding control system

FM

Cabinet-free control technology

IoT Gateway

Industry 4.0-connectivity of machines

DR/PR/VR

Industrial PCs for highest efficiency

Rexroth
Bosch Group

IndraDyn S - MS2N

New motor generation

intelligent | powerful | flexible

Rexroth
Bosch Group

IndraDyn S - MS2N

Powerful

Less space and more power

Higher productivity and process quality
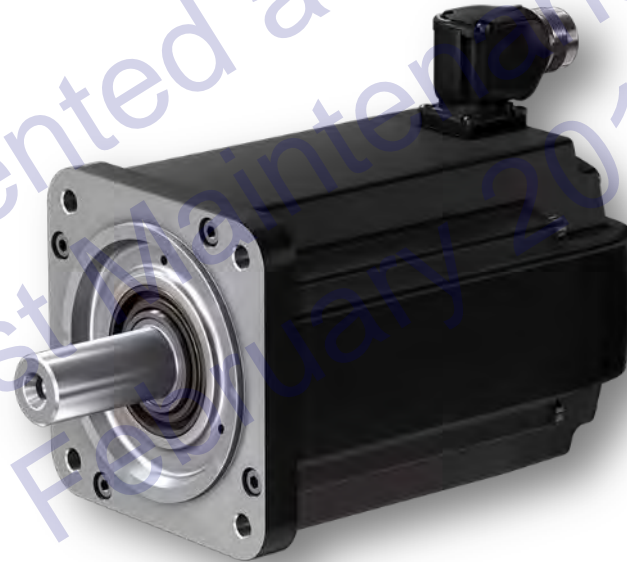
Reduced operating costs

Single-cable connection

Saves space, weight, installation costs and time

Flexibly configurable

Cost-optimal motor equipment

Tailored for your application

System intelligence

MS2N as data source for Industry 4.0

Secure utilization up to operational limits

Rexroth
Bosch Group

IndraDyn S - MS2N
Encoder options

Performance	Signal periods	Accuracy [arcsec]	Design	Revolutions absolute	Type code	Safe Motion	Single-cable	Interface
BASIC	16	±360"	Singleturn	1	AS	•	•	HIPERFACE® by SICK
			Multiturn	4096	AM			
STANDARD	128	±120"	Singleturn	1	BS	SIL2 PLd	•	HIPERFACE® by SICK
			Multiturn	4096	BM			
ADVANCED	2048 (20bit)	±50"	Singleturn	1	CS	SIL2 PLd	Yes	ACURO link
			Multiturn	4096	CM			
HIGH [1]	2048 (24bit)	±20"	Singleturn	1	DS	SIL3 PLe New	Yes	ACURO link
			Multiturn	4096	DM			

HIGH-performance encoder only available for MS2N sizes 06/07/10

Additional encoder option with SIL3 Ple for size 03/04/05 in preparation

[1] Release in September 2017
DC-AE/MKT | 10/16/2017

Rexroth
Bosch Group

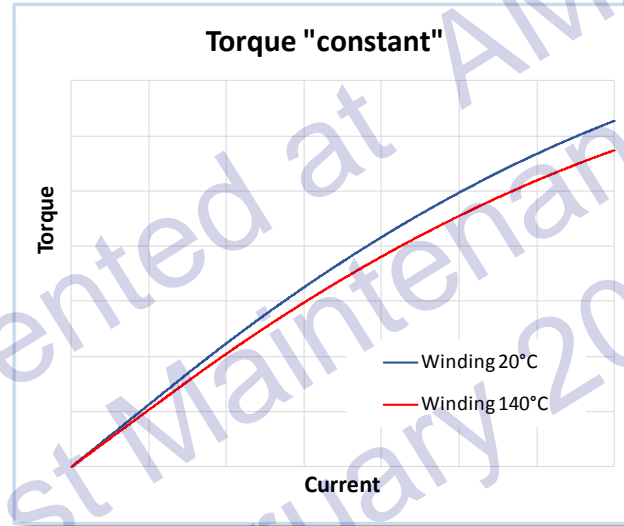# IndraDyn S - MS2N

System intelligence – MS2N as data source

Production tolerance ±5%
- magnet material
- mechanical tolerances

Saturation effects -10...+20%
at higher currents

Temperature effects 0...10%
Lower magnetization at higher temperatures

Torque "constant"

Torque / Current
— Winding 20°C
— Winding 140°C

Torque calculation
- Computing model for torque constant
- Consideration of saturation and temperature effects
- 100% motor test, individual parameters stored in encoder feedback

Worst-case error
+5 ... -35%

Improved torque model MS2N

Overall torque error
± 5%

Applications:
- Force and pressure control in robotics and production machines
- Condition Monitoring, e.g. detection of production faults or bad parts

Rexroth
Bosch Group

MEMS Sensors

Bosch Connected Devices and Solutions

BUILT-IN SENSORS

Accelero-meter · Temperature sensor · Humidity sensor · Digital light sensor · Gyroscope · Magneto-meter · Pressure sensor · Acoustic sensor

USE CASES

Condition Monitoring

Machine Doctor · Predictive Maintenance · Digital Twin

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Drives

Millions of drives working in machines and applications

We are the benchmark

in servo drives
and motors

Power range from 100 W up to 4 MW available

Integrated and most extensive Safety-on-Board functions

Full
IoT connectivity

Unrivaled communication variety

Fastest
engineering

100 % cabinet-free solutions feasible

Rexroth
Bosch Group

IndraDrive Mi

Out of the cabinet, on the motor, in the machine

- Eliminates the power and control electronics from the cabinet
- Reduces the cabinet volume by up to 100 %
- Eliminates the power losses in the cabinet up to 100 %
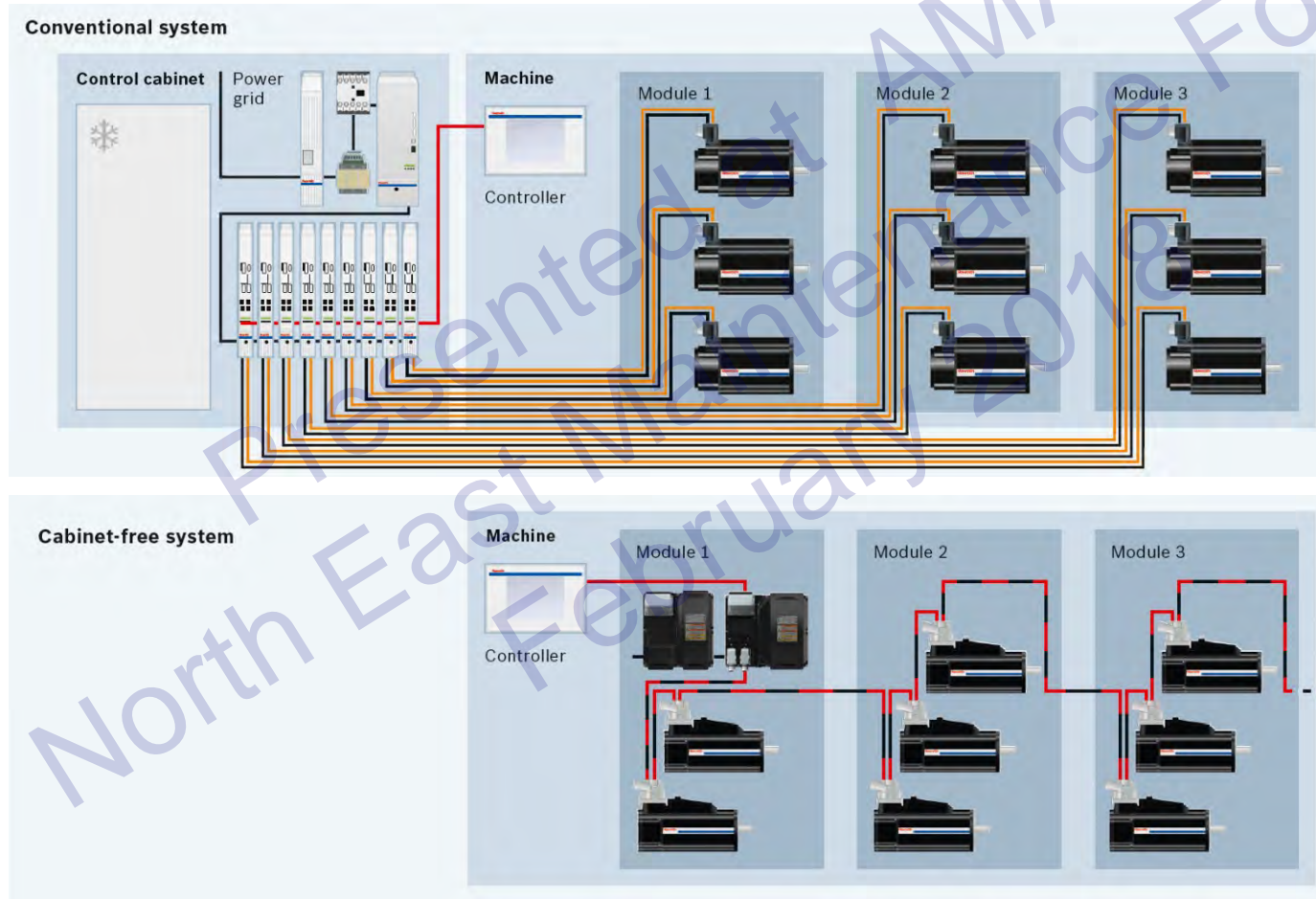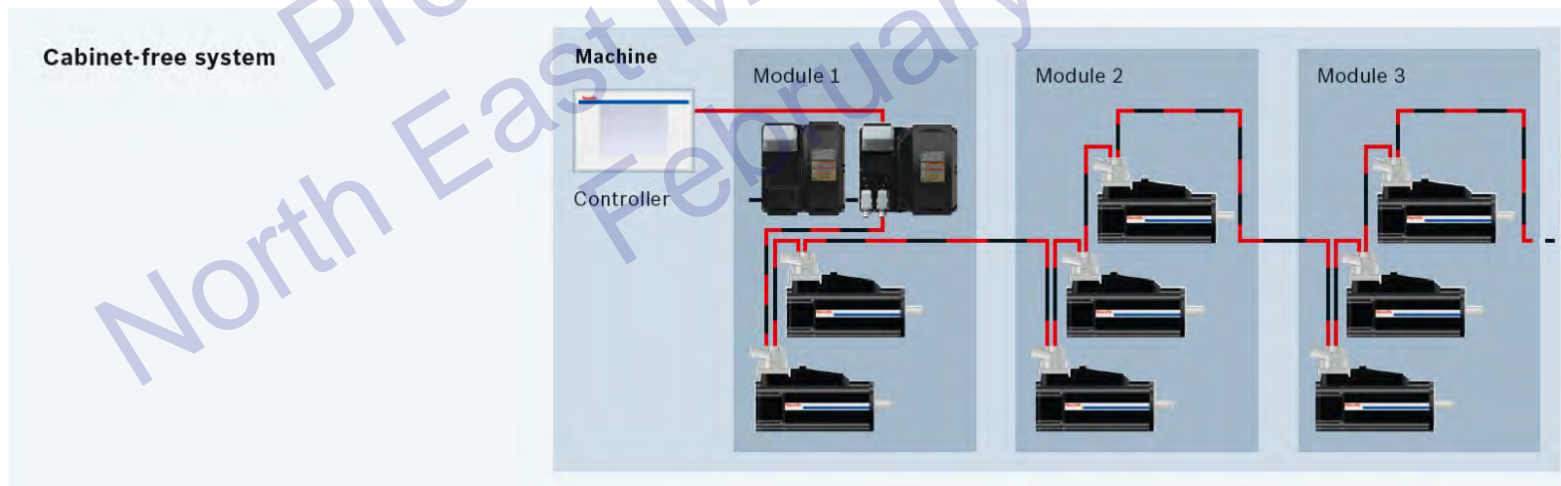- Decreases the cabling effort up to 90 %

IndraDrive Mi

+ =

Rexroth
Bosch Group

IndraDrive Mi

Out of the cabinet, on the motor, in the machine

IndraDrive Mi

Out of the cabinet, on the motor, in the machine

90% less wiring

100% less cooling output

100% less cabinet volume

Benefit more from less!

Cabinet-free system

Machine

Controller

Module 1   Module 2   Module 3

DC-AE/MKT | 10/16/2017

Rexroth
Bosch Group

IndraDrive Mi

DC-AE/MKT | 10/16/2017

Rexroth
Bosch Group

IndraDrive

Interconnectivity and Interoperability

IndraDrive Software – Open Core Interface for drives

Real-time Ethernet and Open Core Interface

Open Core Interface for drives be used in parallel to following real-time Ethernet systems:

- Sercos

  (connection via device-plug, Sercos switch or control)

- EtherCAT CoE* with EoE* (Beckhoff control)

  (Connection via control or Switchport Terminal)

- PROFINET

  (Connection via switch or control)

- EtherNet/IP

  (Connection via switch or control)

- Ethernet POWERLINK (B&R control)

  (Connection via control, but not yet tested)

-

Rexroth
Bosch Group

IndraDrive Software – Open Core Interface for drives
Enabling Connected Industry

Tools & Platforms
Languages & Interfaces
Operating Systems
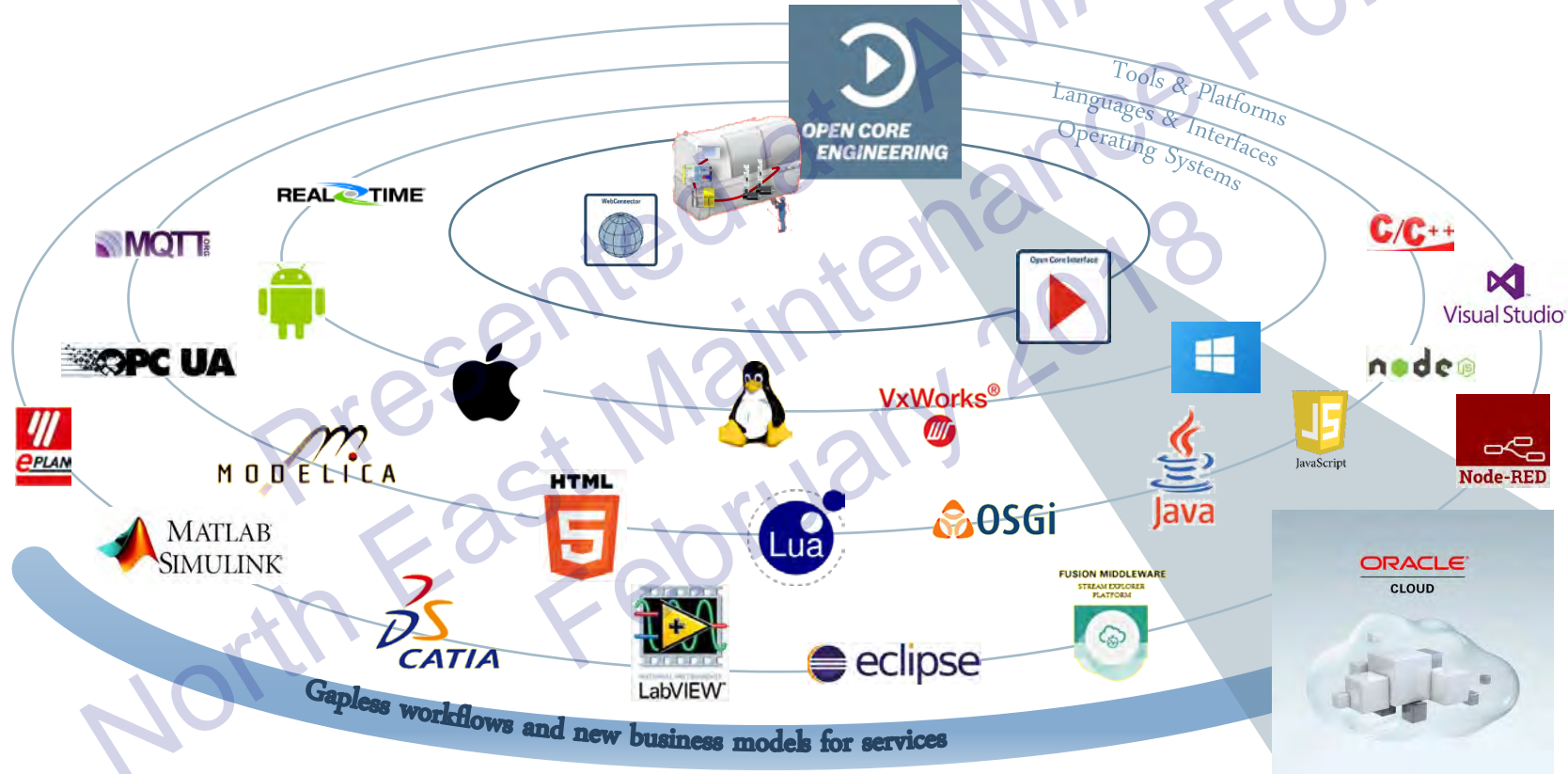
Example: Cloud based services with Java

Gapless workflows and new business models for services

Rexroth
Bosch Group

Sequential Motion Control SMC V14 for IndraMotion MLD

System overview

Sercos, EtherNet/IP, CANopen, PROFINET, Profibus, EtherCAT, Powerlink, Parallel/Analog

Ethernet TCP/IP
Modbus

IndraMotion MLD

SMC
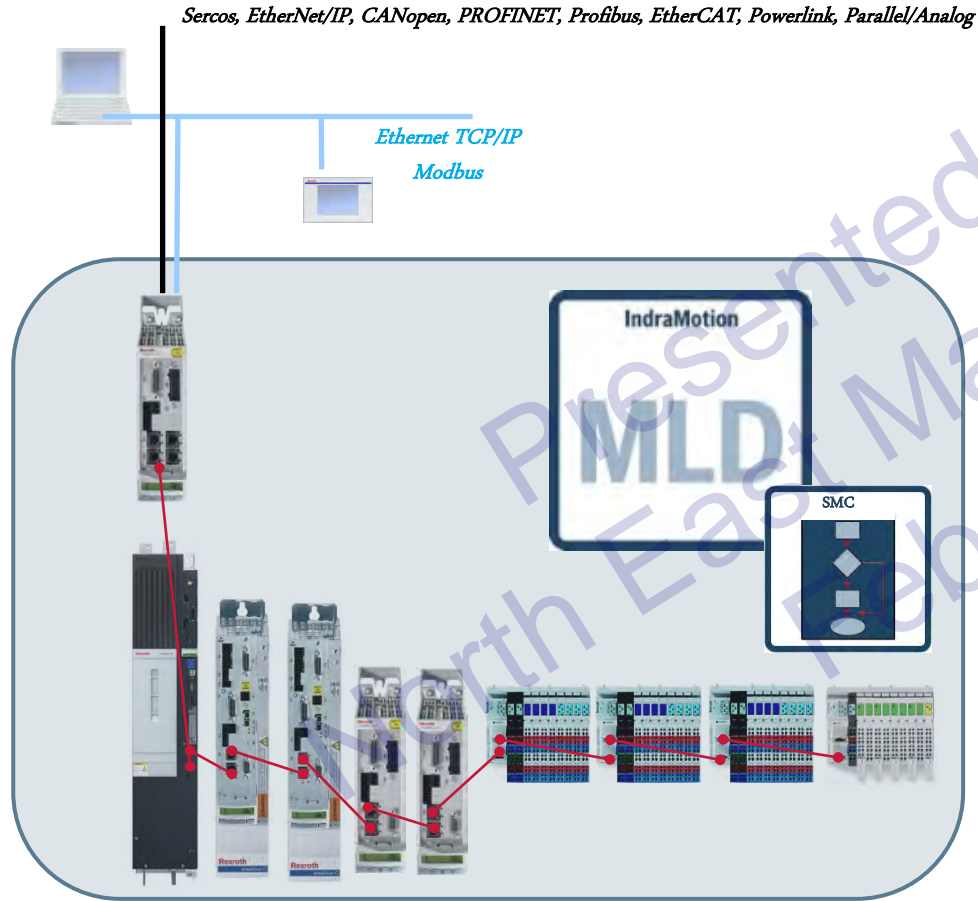
- **Engineering:**
  - IndraWorks basis project with PLC/Motion-Interface
  - Parameter box for offline/online machine configuration
  - Easy to learn programming language for offline/online sequential programming
- **Control IndraMotion MLD:**
  - IndraDrive Cs Advanced Sercos Master
  - IndraDrive C/M/ML Advanced Sercos Master
- **Slave axes:**
  - IndraDrive Cs Economy, Basic, Advanced
  - IndraDrive C / M Economy, Basic, Advanced
  - IndraDrive M double axes
  - IndraDrive ML Basic, Advanced
- **I/O-device:**
  - Inline block I/O digital and analog

Rexroth
Bosch Group

Intelligent Energy Management

Overview and Basics - Introduction

Why Energy Management?

- buffering against mains failure
- increase efficiency
- peak power reduction
- increase mains quality
- increase productivity
- reactive power control

Werk Homburg
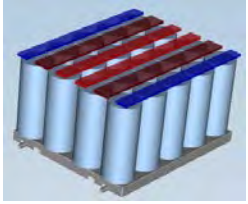3.5 MW
Momentane Leistung

Rexroth
Bosch Group

Intelligent Energy Management
Overview and Basics – Storage Solutions

Energy Storage System with external partners

Customer specific solutions

Capacitor modules   Kinetic buffer systems   Koch Bremsenergie

75 mF / 7,5 kJ

300 mF / 30 kJ

z.B. kinetic buffer motor

450 kJ / 500 kW

external electric buffer (Elko, Supercaps..) connected to DC-Bus

different sizes up to 18 kW / 2 kJ

compatible zu IndraDrive M

Source: https://www.bremsenergie.de/de/

Rexroth
Bosch Group

Intelligent Energy Management
Smart Energy Mode SEM

- Operation mode of regulated DC- bus

Voltage control with **Smart Energy Mode** → **SEM and SEM+**

SEM	SEM+
Use energy buffer	use energy buffer
reduce mains load – limit mains current and mains power	reduce mains load – limit mains current and mains power
bipolar, fix value 1,1-times nominal current	bipolar and unipolar current limits / power setting
nominal DC-bus voltage @ 750 V	adjustable DC- bus voltage
	dynamic adaption of current limits at over – and lower DC bus voltage

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company
PLC & IoT

Future-proof IoT connectivity for new and legacy machines

Fastest engineering

We lift the PLC to the

Internet of Things

Free choice of programming tools and languages

Bosch Group is lead user and lead supplier of PLC and IoT solutions

Bosch IT Security standards included

Rugged hardware components for tough industrial applications

Rexroth
Bosch Group

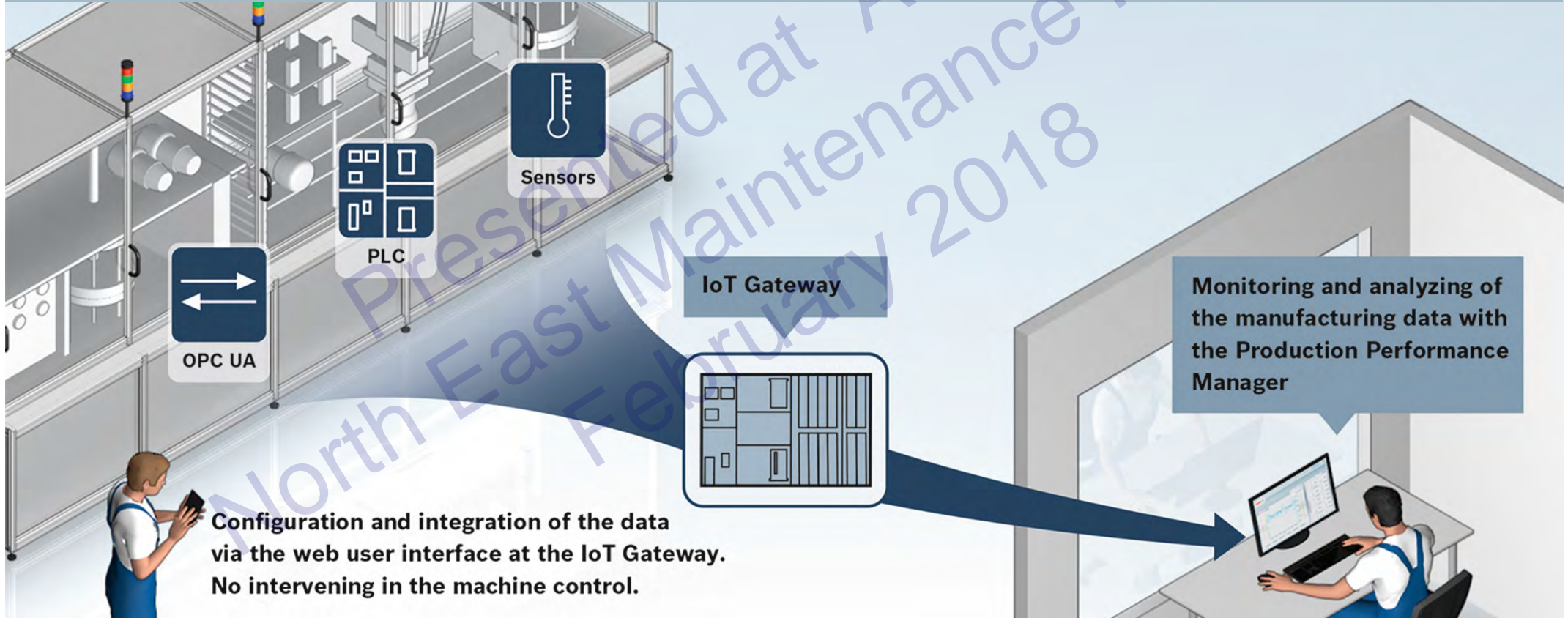# Bosch Rexroth

IoT Gateway Get ready for Industry 4.0!

Use the IoT Gateway for:

- Increased machine availability

- Enhanced process quality

- Significant energy saving

- Optimized product quality
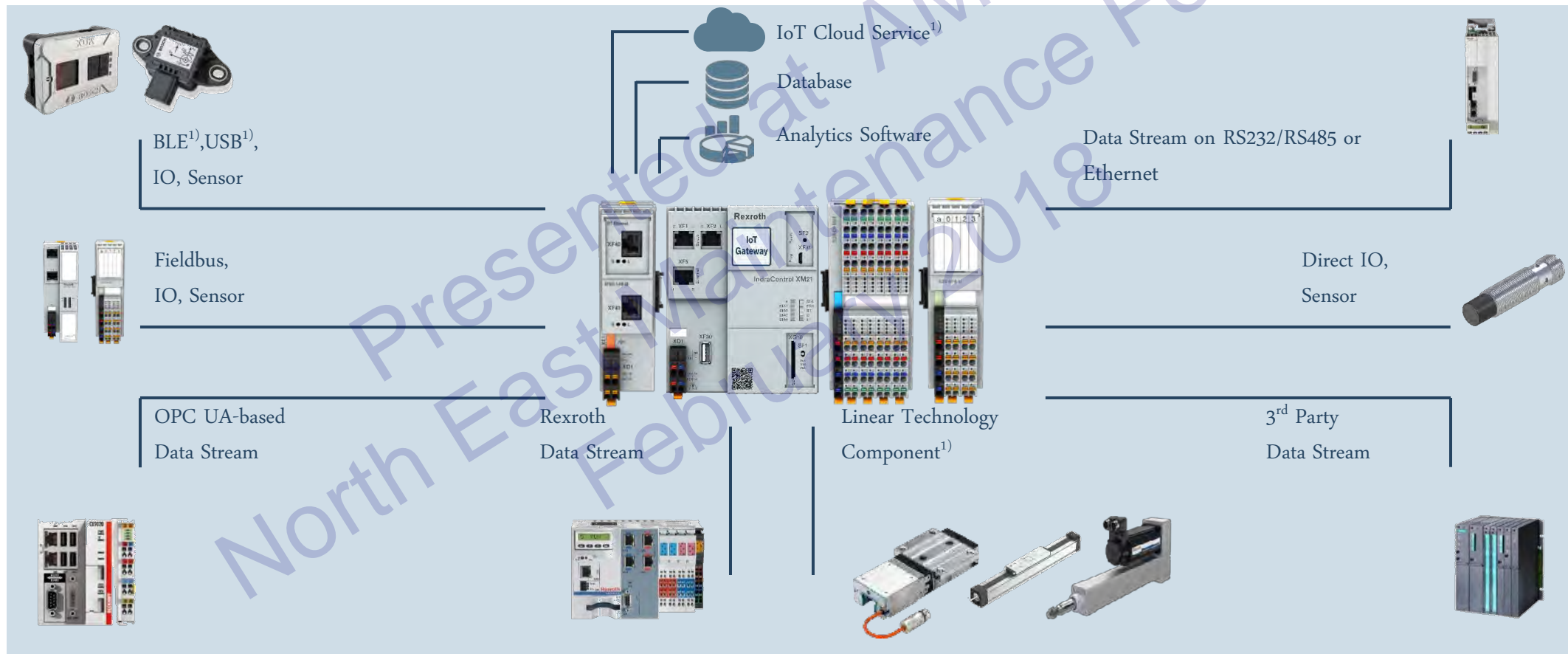
Rexroth
Bosch Group

IoT Gateway

Starter Kit: Production Performance Manager and IoT Gateway

For a fast way in to Industry 4.0, start by monitoring and analyzing your manufacturing data
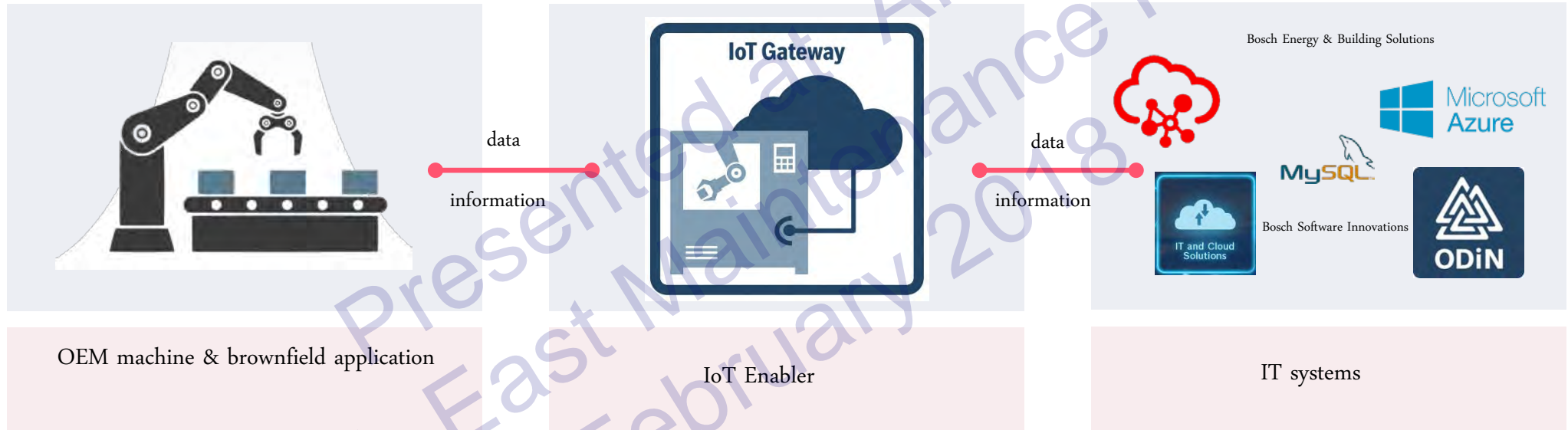

Sensors

PLC

OPC UA

IoT Gateway

Configuration and integration of the data
via the web user interface at the IoT Gateway.
No intervening in the machine control.

Monitoring and analyzing of
the manufacturing data with
the Production Performance
Manager

Rexroth
Bosch Group

IoT Gateway

High connectivity for flexible topology

BLE[1],USB[1],
IO, Sensor

IoT Cloud Service[1]

Database

Analytics Software

Data Stream on RS232/RS485 or
Ethernet

Fieldbus,
IO, Sensor

Direct IO,
Sensor

OPC UA-based
Data Stream

Rexroth
Data Stream

Linear Technology
Component[1]

3rd Party
Data Stream

IoT Gateway

Basic Logic Behind the IoT Gateway Software

OEM machine & brownfield application

IoT Enabler

IT systems

Data is key

Industry goal: 100% connected machines

IoT Gateway as an enabler

Rexroth
Bosch Group

IoT Gateway

IoT Gateway Software – Three Main Blocks
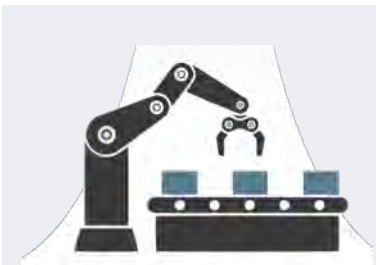
Machine data	The IoT Gateway Software Basic Apps			IT Systems

Device apps

Get access to your machine data

Examples:

Controls, sensors, OPC, etc.
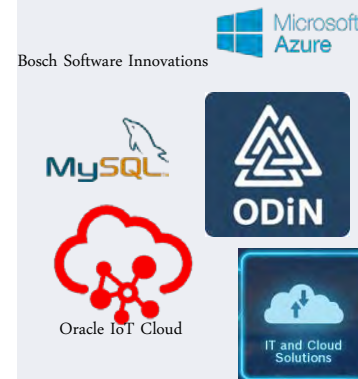
Internal apps

Play with your machine data

Examples:

Math calculations, formatter, dashboard, etc.

processing apps

Send data to your preferred system

Examples:

Microsoft Azure, Oracle IoT Cloud, MySQL, etc.

and many more...

Bosch Software Innovations

Microsoft Azure

MySQL

ODiN

Oracle IoT Cloud

IT and Cloud Solutions
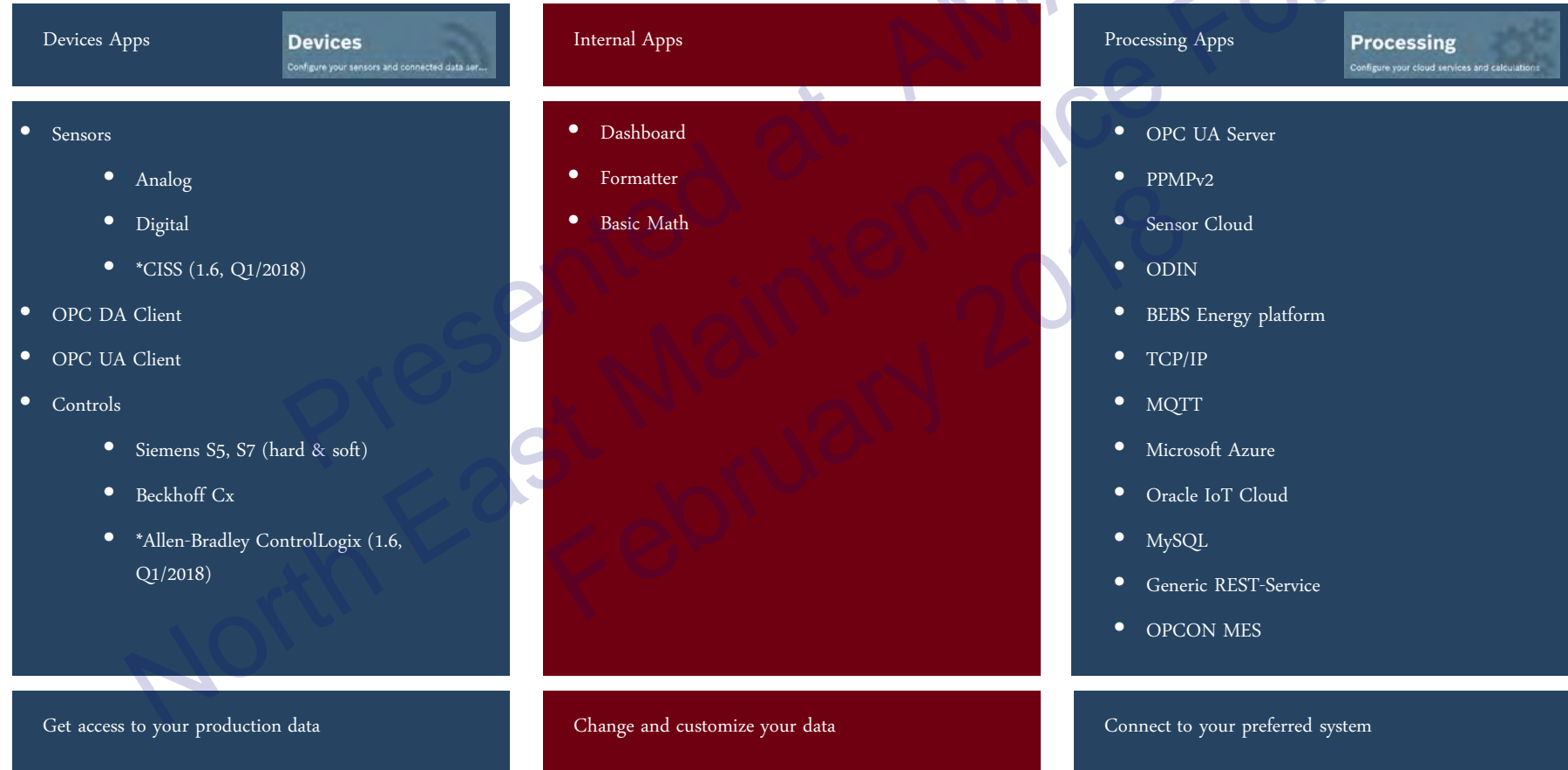
Bosch Energy & Building Solutions

and many more...

Java OSGi Framework as Platform

modular software; dynamically **extendable**; additional **security features**;

adaptable for specific solutions; **plug & play; browser-based**

Rexroth
Bosch Group

IoT Gateway

The Three Detailed IoT Gateway Software Blocks

Devices Apps	Internal Apps	Processing Apps
Devices — Configure your sensors and connected data ser...		**Processing** — Configure your cloud services and calculations

Devices Apps

- Sensors
  - Analog
  - Digital
  - *CISS (1.6, Q1/2018)
- OPC DA Client
- OPC UA Client
- Controls
  - Siemens S5, S7 (hard & soft)
  - Beckhoff Cx
  - *Allen-Bradley ControlLogix (1.6, Q1/2018)

Internal Apps

- Dashboard
- Formatter
- Basic Math

Processing Apps

- OPC UA Server
- PPMPv2
- Sensor Cloud
- ODIN
- BEBS Energy platform
- TCP/IP
- MQTT
- Microsoft Azure
- Oracle IoT Cloud
- MySQL
- Generic REST-Service
- OPCON MES

Get access to your production data	Change and customize your data	Connect to your preferred system

*coming in (version, date)

DC-AE/SMP41 | 10/16/2017

Rexroth
Bosch Group

IoT Gateway

Approved Hardware Configurations

IndraControl XM series

- Ideal for external sensor integration
- PLC built in
- XM21 (basis) & XM22 (high performance)

IndraControl PR21*

- Small & cost efficient
- Ideal for Ethernet based communication
- USB, wifi, HDMI

IndraControl IPC*

- Ideal for managing many devices, processings and calculations
- perfect for Ethernet based communication

*Q1/2018

Rexroth
Bosch Group

IoT Gateway
The Five Step Process

1.	2.	3.	4.	5.
Determining influencing variables	Selecting data sources	Connecting to the data sources with the "device" app	Work with the data and connect to your preferred secondary systems	Tapping into improvement potential
Temperature Pressure Time Etc.	Analog Digital Controls Etc.	With an installed IoT Gateway Software on the approved hardware setups With an easy to handle web-based configuration	Connect to popular systems such as Microsoft Azure, Oracle IoT Cloud, Production Performance Manager, etc.	Learn about your system and continuously improve it

Rexroth
Bosch Group

IoT Gateway

Success Story: Hydraulic Test Benches @ Bosch Homburg

Monitoring oil quality and filters and compliance with the ISO cleanliness level

Maintenance Support System

IO-Link

Bluetooth SMART

CERTIFIED USB

Rexroth

-25%
Maintenance costs

-20%
Complexity for manual testing

+5%
OEE

ROI < 1,5 years

| Existing test facility | + | IoT Gateway Software | + | Production Performance Manager (secondary system) |

Rexroth
Bosch Group
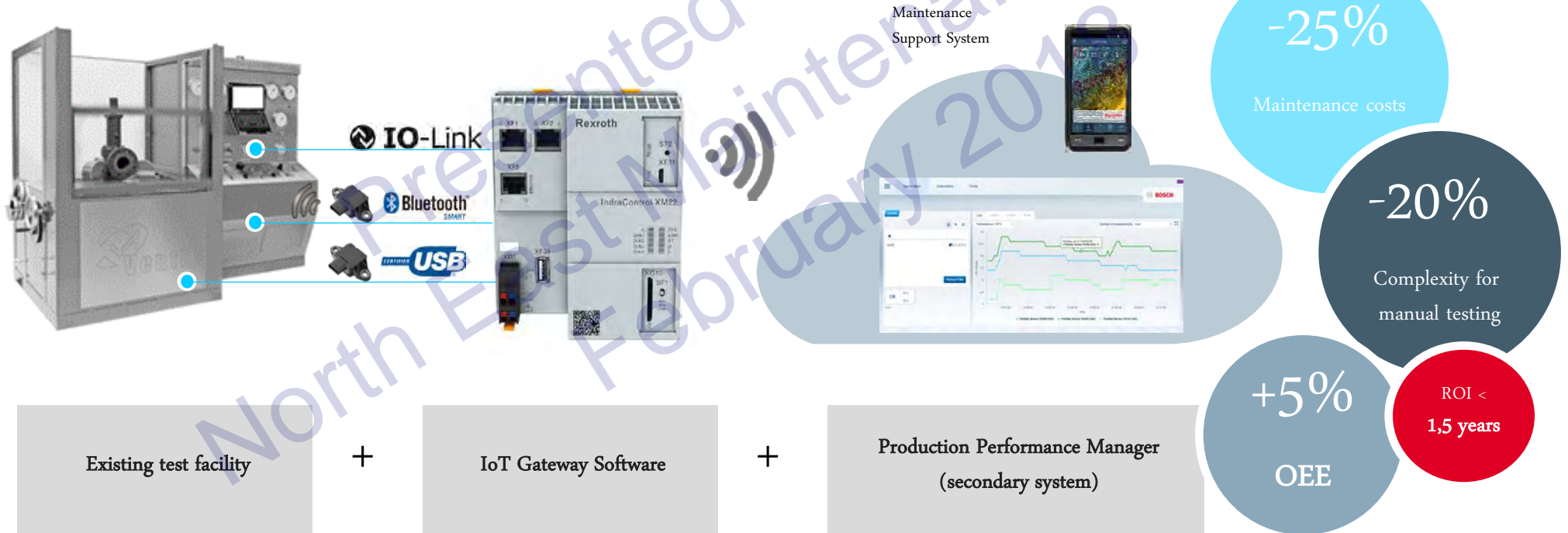
IoT Gateway

International Application Experts

Training & update of regional experts

Sales and service network in **80** countries

\> **3,500** associates

IoT application **expert** in every region

Strong **installation** support

All figures of 2016

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Services

<div>

We offer the best-in-class

Support and Service

</div>

360° consulting for I4.0 solutions, safety, energy efficiency, etc.

24/7/365 service availability — more than 200 service centers worldwide

Retrofit and modernization of machines and systems

Customized training and qualifications

Simulation, system integration, application support, and commissioning

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

The Drive & Control Academy

Product training and equipment

for all Rexroth Drive & Control Technologies

- Industry 4.0
- Electric drives and controls
- Resistance welding
- Hydraulics
- Linear technology

Customized training

- Individual training for specific industry sectors, products and solutions

Media platform

- eLearning with certifications

Training systems

for educational market

- Automation / Mechatronics
- Hydraulics
- Pneumatics
- Robotics
- Industry 4.0

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Summary

It's profitable for you to work with us!

- Fewer Components **10%**
- Fewer Engineering **20%**
+ More Productivity **10%**

| Perfect fusion of IT and Automation | Unique automation solutions and expertise | Tailored support and services |

Rexroth
Bosch Group

Bosch Rexroth. The Drive & Control Company

Product and solution portfolio

Solutions and Services

Standard System Solutions PC-, controller or drive based	**Service and Engineering** Training, simulation, commissioning, global spare parts and repairs, retrofit	**Consulting** e.g. for energy efficiency, safety, IT security etc. and extended services	**Factory of the Future** (Industry 4.0) Brownfield and greenfield projects, IT automation, data analytics, etc.

IndraWorks

The modular software and engineering platform

Engineering framework for configuration, sizing, communication, automatic code generation, templates, programming, visualization, operation, safety, …

Function toolkit **Packaging**	Function toolkit **Robotics**	Function toolkit **Printing**	Function toolkit **Safety**	Function toolkit **Sensors and Connectivity**	Function toolkit **Data analytics**	Function toolkit **Energy Management**	Function toolkit **Condition Monitoring**	Function toolkit **Open Core Interface**	Function toolkit **…**

System software **CNC**	System software **Motion Control**	System software **PLC**	System software **IoT**	System software **Process Control**	System software **Drives**

IndraControl

The control hardware platform

Embedded Controls	**Industrial PC**	**HMI**	**I/O**	**Safety** SAFETY ON BOARD

IndraDrive

The drives and motors platform

Frequency Converters	**Cabinet Servo Drives**	**Cabinet-free Servo Drives**	**Servo motors**	**Kit Motors**	**Gearboxes**	**Cables and Accessories**

Rexroth Bosch Group