



Innovation is just an app away

**How to connect Consumer Goods
production lines – without an IT project**

A joint
whitepaper by
Bosch Rexroth
and **oee.ai**

**Your factory, Your way.
YOU DECIDE.**

rexroth
A Bosch Company

Innovation is just an app away

From a large-scale IT project to an easy-to-activate feature

Many production lines in the consumer goods industry are optimized for maximum productivity. However, the potential of data- and transparency-driven production often remains untapped because machines and systems don't communicate with one another. The only way to connect them seems to be through a complex IT project.

This whitepaper presents an alternative approach to bringing more transparency to consumer goods production lines.

Here, innovation doesn't require a large-scale project. It simply starts as a feature that can be activated.

On the following pages, discover an approach that:

- Takes a modular approach to both infrastructure and software
- Can be implemented in stages
- Accepts existing heterogeneity – rather than seeking to eliminate it

The starting point:

Time to act

MASSIVE DOWNTIMES:

300 **h/year**

Unplanned downtime in the CPG (Consumer Packaged Goods) industry – with average downtime costs exceeding 20,000 euros per hour¹⁾

- ▶ There is significant potential for improving OEE

COMPLEX MANUFACTURING STRUCTURES:

100% **Growth of the Co-Packing/Co-Manufacturing market through 2030²⁾**

- ▶ To collaborate effectively, consumer good brand owners and external contract manufacturers need robust digital systems and maximum project transparency

SKILLS SHORTAGE:

80% **... of companies complain about a lack of qualified workers³⁾**

- ▶ Large-scale digitalization projects often lack the capacity for planning and implementation

HIGH CONSUMER EXPECTATIONS:

500 **million products per year**

... are delivered on the same day – in Germany alone, and only by the market leader⁴⁾

- ▶ Same-day delivery requires maximum connectivity and transparency

01

The status quo: Highly automated lines – lack of digitalization

The lack of digital connectivity in consumer goods production lines often limits the potential for productivity gains through automation. However, establishing this connectivity quickly becomes a major undertaking that exceeds the capacity of ongoing plant operations and the budget.

Transparency and productivity: Room for improvement

Consumer goods production lines are among the most highly automated environments in the industry, featuring high-speed lines, fast-paced processes, and interconnected machines.

At the same time, reliable OEE (overall equipment efficiency) figures remain fragmented. Heterogeneous systems provide unconsolidated data, making it difficult to perform reliable OEE calculations. Production occurs in real time on the line, while evaluation and decision-making occur with a time lag. This creates a structural blind spot between line control and management decisions.

The root cause: Established structures

- Multi-vendor machine fleet with proprietary control systems
- Heterogenous control systems on one line
- Retrofit inspection systems
- Material handling systems from various projects

► **The line is physically connected but digitally fragmented. This problem multiplies when a work consists of many such lines.**

Processing

End-of-Line Palletizing

Secondary Packaging

Primary Packaging

In the consumer goods industry where production schedules are tight and product variety is high, **connectivity** is essential for optimizing **overall productivity**.

Digitalization without a major IT project

As pressure within the industry grows, the challenge of fragmented information becomes all the more pressing. In addition to production-related trends, such as smaller batch sizes and tighter delivery schedules, increasing sustainability and reporting requirements are also limiting the scope for action. At the same time, the availability of personnel with production line expertise is declining.

Plant managers know: Today, productivity is driven not only by machinery but also by transparency across the entire production network. However, attempts to implement digitalization often entail major projects, such as comprehensive MES projects. These projects are hindered by the demands of day-to-day operations and tight budgets.

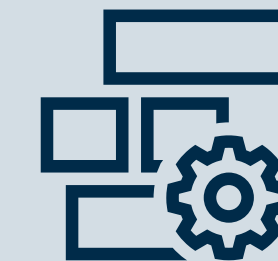
- **Packaging lines need more flexibility: a solution that works efficiently even during ongoing operations and under financial constraints.**

Digitalization in a sandwich position

Pressure to interconnect production lines

**REAL
PROJECT
OPTIONS**

**Operational and
budgetary constraints**



The paradigm shift: Accepting existing heterogeneity – and building on it

From „complete” ...

Transparency and consecutive decision-making can only begin with a digital architecture implemented.

... to „flexible“

Digitalization can start small by accepting and dealing with existing

Decision-makers in the consumer goods industry know that transparency, consistent overall equipment effectiveness (OEE), and data-driven decisions are key factors for success. However, they put it off because the task seems too daunting, and the hurdle gets higher with each passing month. Resolving this dilemma requires a different mindset:

- **No more proprietary platforms with new dependencies.** Many automation providers offer their own digitalization solutions, but these are usually tied to their respective control systems. Anyone who operates machines from different OEMs on a packaging line must



ctrlX AUTOMATION and its environment perfectly align with our intended direction: complete, modular, and expandable production lines tailored precisely to our customers' needs.

Olivier Lecorre
Head of Automation
BFR Systems

then choose between separate digitalization islands or a cross-platform system. Either way, a new major project is required.

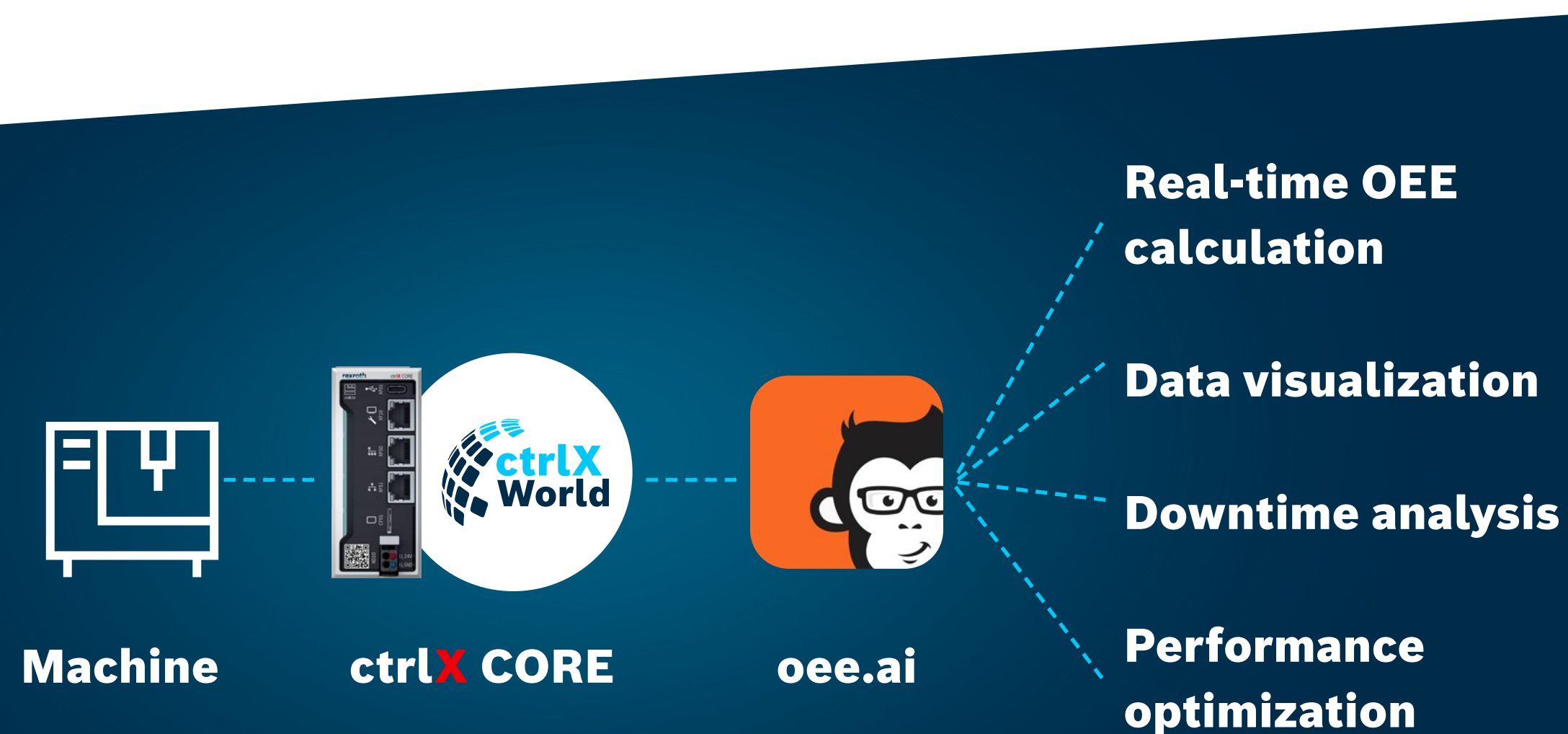
- **What's needed instead: an infrastructure that integrates into the existing heterogeneity** rather than attempting to eliminate it. It should be designed as an open platform where different applications, including those from third-party providers, can coexist. This type of infrastructure can be expanded during ongoing operations.

► **Solution approach: an infrastructure that functions in an open, vendor-neutral, and scalable way.**

02

The new way of thinking: From monoliths to modularity

Thanks to modularity based on an open integration layer, it is now possible to activate digital functions selectively or add mechanical functions without altering the overall architecture. Previously complex changes or innovations to the production line can now be implemented in small, quick, and manageable steps.



Using an edge device with ctrlX CORE, machine data can be utilized independently of the control logic – and “enriched” with oee.ai for analysis and optimization.

From complexity to openness

The traditional approach: A centralized, closed architecture is applied across the entire line. A single system is designed to standardize all machines, controls, and data flows.

► **The Problem:** In the real world of packaging lines, each OEM brings its own control system. Retrofits do not follow a uniform standard. A complete overhaul would jeopardize ongoing production.

The path of innovation: An open integration layer integrates directly with the machine or at the line level, rather than sitting above the production line. An edge device running ctrlX OS connects to existing control systems and their interfaces, standardizes the data, and makes it available via standardized interfaces. The control logic of the machines remains unaffected.

► **The advantage:** A technical foundation emerges that encompasses control connectivity, edge intelligence, and a data layer. This foundation allows to access and use existing data without the need to reprogram any machine controllers.

A phased approach to MES capabilities

An open integration layer allows for a modular, flexible, and phased approach to MES capabilities. Two key components make this possible: Composable infrastructure and Composable MES. The process begins with simple apps, such as OEE dashboards.

Composable infrastructure: ctrlX AUTOMATION

Technically, the integration layer is based on ctrlX AUTOMATION, the open automation platform from Bosch Rexroth. ctrlX AUTOMATION consists of modular control hardware, engineering tools, and a growing partner ecosystem of over 110 companies that collaborate to develop industrial apps and solutions. At the heart of the platform is ctrlX OS, a Linux-based operating system for industrial controllers and edge devices.

In addition to Bosch Rexroth hardware, ctrlX OS also runs on devices from other manufacturers such as Advantech or WAGO. What's the fundamental difference from conventional automation platforms? Rather than relying on a closed ecosystem with proprietary interfaces, ctrlX OS uses an app-based architecture built on proven open-source technologies. Functions are provided as standalone, encapsulated

apps that can be installed, updated, and removed while other functions continue to run unaffected.

Existing controllers can be integrated via standardized protocols and open interfaces without modifying the production line. Furthermore, all devices can be centrally managed and updated via the ctrlX Device Portal, even across multiple locations. ctrlX AUTOMATION thus provides the infrastructure – while users decide what runs on it.



Composable MES: oee.ai

oee.ai relies on this open infrastructure as a modular application platform. Instead of a monolithic MES, which only delivers value after the basic implementation is complete and a step-by-step rollout over a period of several months to a year, oee.ai provides ready-to-use functional modules: OEE monitoring, downtime analysis, shop floor management. All of them can be activated as individual modules and expandable during operation.

oee.ai runs directly on ctrlX OS and accesses normalized machine data from the integration layer. No parallel IT structure is created, and no additional integration project is required. Connecting a machine to a key performance indicator requires only a single configuration.

With Saru, the AI-powered production assistant, oee.ai takes it a step further. Employees can interact directly with their production data in natural language and in context without reporting tools.



What is „composable“?

The term “composable” means that resources – such as computing or networking capacity – can be freely “assembled” and used as separate building blocks for a specific task. Therefore, composable infrastructure is also seen as the next logical step on the path to fully stateless, dynamic Infrastructure-as-a-Service¹⁾.

The relevance for packaging lines: Investment protection meets agility

For the first time, the combination of open infrastructure (ctrlX OS) and modular applications such as oee.ai makes it possible to integrate existing heterogeneity. ctrlX OS acts as an intermediary between the machine level and the data layer, rendering existing data usable without disrupting the control logic. This concept respects the reality of typical consumer goods production lines. The line remains as it is, with all its established differences, while allowing for a rapid response to seasonal changes, new product trends, and innovative technologies.

Goal: Making transparency and productivity reproducible

The goal is to create an architecture that enables reproducible transparency and productivity. Rather than organizing new requirements as projects, they can be addressed through configurable extensions within a clearly defined framework.

Three challenges

... that used to disrupt operations – and how to react in the future:

New machine?

- ▶ **Simply integrate it**

New feature at the edge level?

- ▶ **Simply install an app without having to rebuild the entire system**

New requirement from the customer or quality management?

- ▶ **Simply check whether a suitable partner app already exists in the ctrlX OS ecosystem before considering an expensive in-house development**

- ▶ **Conclusion for the consumer goods industry: Existing investments are preserved because the open infrastructure allows for integration without displacement. New features and transparency are introduced gradually through activatable apps. The infrastructure and applications interact in a modular way, making innovation manageable.**

03

**The benefit:
Know the OEE,
improve the KPIs**

Within the architecture described, oee.ai serves as the application layer. It enables production data to be automatically consolidated into reliable OEE and KPI structures. Line statuses are visible in real time, issues are contextualized, and performance trends become traceable.

As a partner app from the ctrlX OS ecosystem, oee.ai runs directly on ctrlX OS. It can be activated on the production line, eliminating the need for a system integration project. Access to new functionality for other applications in this ecosystem can also be achieved simply by installing the app, rather than requiring an IT project.

The result? A significantly more precise and easily achievable picture of actual performance. This not only applies at the machine level but also at the line and plant levels – especially on high-speed lines with frequent format changes or micro-downtime.



We are transitioning from the pilot phase to a group-wide rollout with oee.ai because the tool delivered one key thing: results that we could immediately see and discuss right on the shop floor. What typically takes years with classic MES projects, we achieved here in just weeks – and with full buy-in from everyone, from the works council and shop floor employees to the executive board.

Florian Steigenberger
Head of Digital Innovations & Business Models,
Hermann Waldner GmbH & Co. KG

From performance metrics to added value

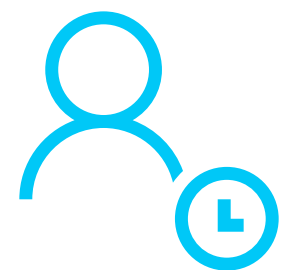
What's the best way to deal with the aggregated performance metrics? Real value is created when the platform can seamlessly expand with apps that provide analysis and actionable insights. The shared ctrlX OS and oee.ai platform fosters the evolution of a modern production environment based on real-world requirements, not the software cycles of individual vendors. This includes, for example:



A shop floor management app where actions are derived directly from performance data



A predictive maintenance app that identifies and predicts recurring failure patterns

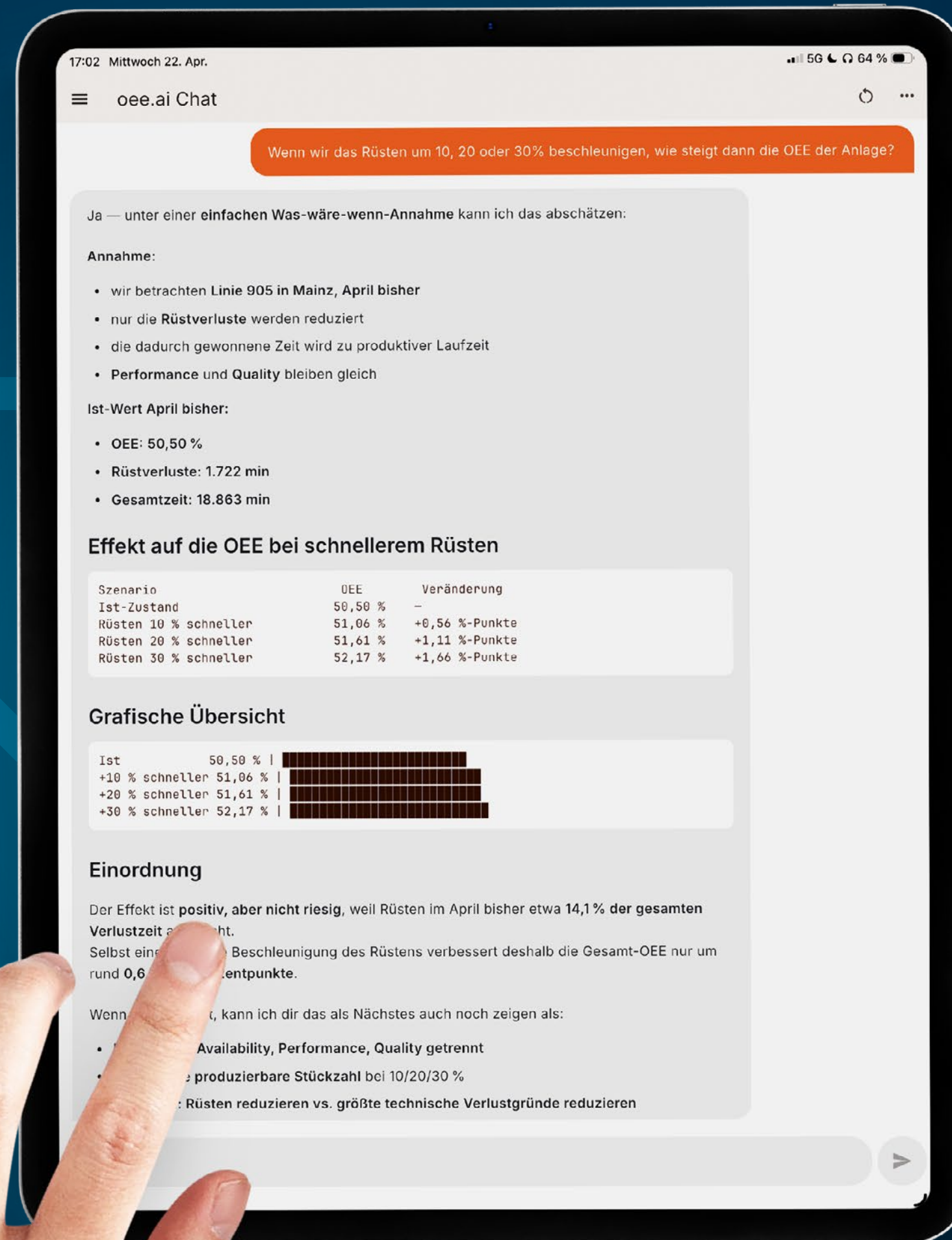


An app for employee time tracking at the plant level, enabling precise allocation of labor costs to individual orders



What does this mean in practice for the consumer goods industry?

- 1 Get started with oee.ai for automated line OEE**
 - 2 Flexibly expand the solution with additional apps where further benefits can be realized**
 - 3 Develop a productive platform that grows step-by-step with the line – rather than redefining it**
- **A landscape based on easily activatable (and deactivatable) apps grows in tandem with requirements – without a project, without a new system landscape, and without a parallel IT structure.**



Saru links oee.ai and other app data to create an intelligent dialogue for users and decision-makers.

Saru – production insights through dialogue

Saru is the AI-powered chat assistant from oee.ai. It acts as an agent that goes beyond analysis to provide context-specific recommendations for action. Through a simple chat interface, employees can interact directly with their production data – without complex reports or manual evaluations.

Typical questions in the consumer goods industry:

- “Why was the OEE on Line 3 lower than planned yesterday?”
- “Which malfunction has occurred most frequently during format changes in the last 4 weeks?”
- “How have setup times changed compared to last month?”
- “Is there a pattern in quality deviations on Shift B?”

Saru draws on current data and historical production knowledge to provide context-specific answers – clear, understandable, and directly applicable in the operational environment.

As usage increases, Saru learns the specific designations, plant structures, and terminology of a facility – thus becoming an interactive knowledge interface between people and the production system.

04

Implementation: Start small – expand as needed

Once the pilot has been implemented on a packaging line, the next step is to scale it across the packaging site – bridging different lines, OEMs, control system generations, and levels of automation. The modular, open architecture helps prevent the typical problem of digital initiatives resulting in isolated solutions and, consequently, new fragmentation.

Start with the pilot – scale in a controlled way

Because the infrastructure and application logic are based on open platforms, a successfully tested use case can be rolled out in a structured way:

- from a single machine to the entire line
- from a single line to the entire plant
- from a single plant to multiple sites

Infrastructure: The ctrlX Device Portal enables centralized management of all ctrlX OS devices in the field. This includes rolling out app

updates, synchronizing configurations, and monitoring device status across locations. A validated use case on a single line can be used as a reproducible template for others.

Application: The application layer scales in tandem with the infrastructure – including OEE configurations, fault categories, and AI models such as Saru, which incorporates the acquired production knowledge.

This offers a key advantage for consumer goods manufacturers with multiple production sites: transparency and productivity logic can be scaled together. What works on Line 1 at Plant A can be rolled out to Line 3 at Plant B – using the same app configuration via the same ctrlX Device Portal.

At the same time, the architecture remains flexible. For example, additional reporting obligations, energy analyses, and cross-site performance comparisons can be added without modifying the core system. This creates a digital foundation that meets current needs while accommodating future requirements.

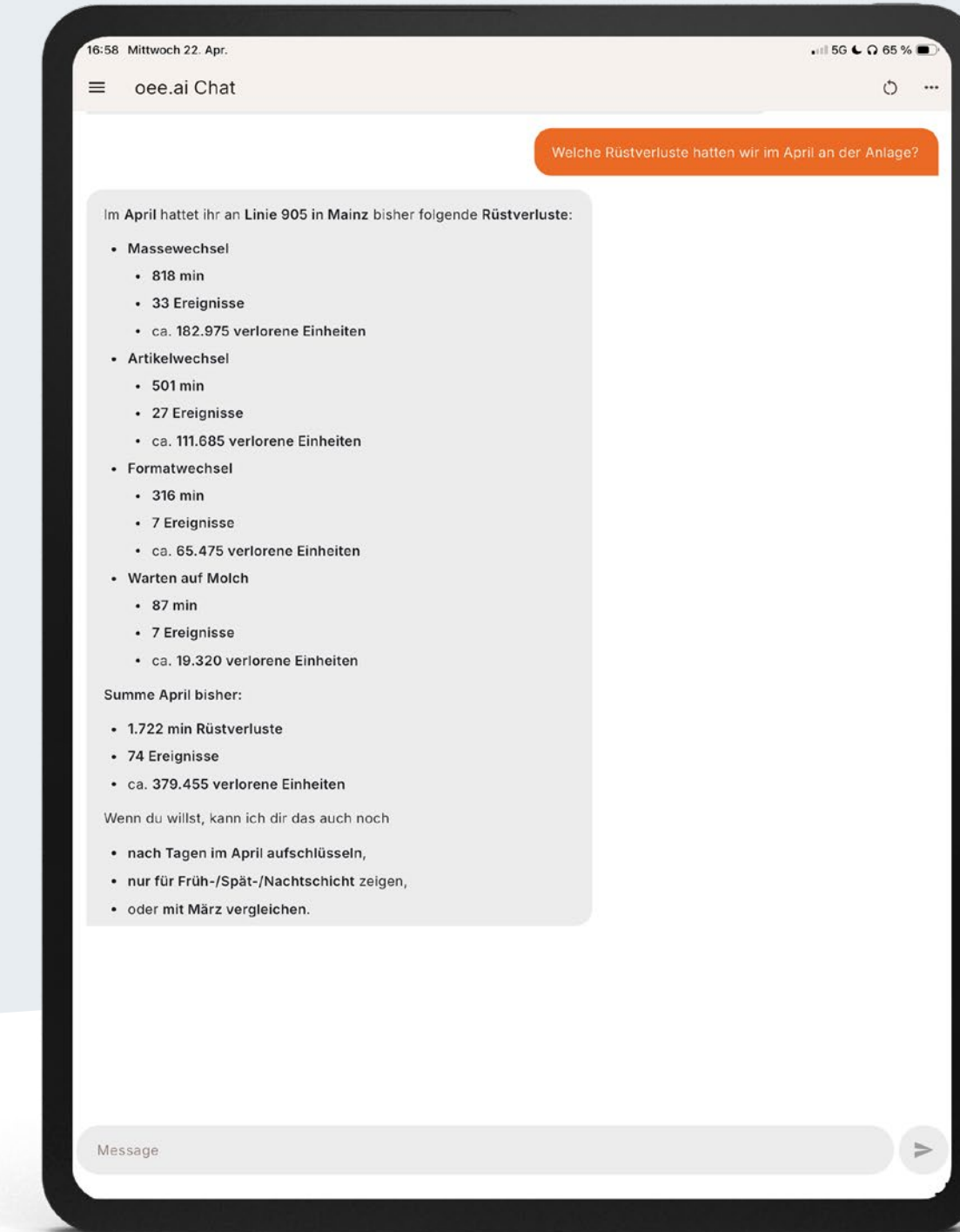
- **Scaling based on reproducible logic: Consumer goods manufacturers no longer depend on isolated solutions but can build a long-term, strategically viable platform consisting of infrastructure and applications.**

The next step: Information becomes the basis for decision-making

Every day, millions of data points are generated on a production line, including performance metrics, error messages, quality deviations, setup times, and employee interventions. However, as long as this information remains isolated in individual reports, it only supports analysis, not real decision-making. The next step toward productive plant management is therefore to correlate and coordinate this information.

For example:

- A declining OEE is not only displayed but also correlated with recurring failure patterns.
- Quality deviations become apparent in connection with specific formats or shifts.
- Extended setup times are automatically linked to staffing or line configurations.



As a cross-app AI agent, Saru helps organizations leverage their existing data infrastructure in practical ways. More than just being an analytical tool, it also aids in decision-making.

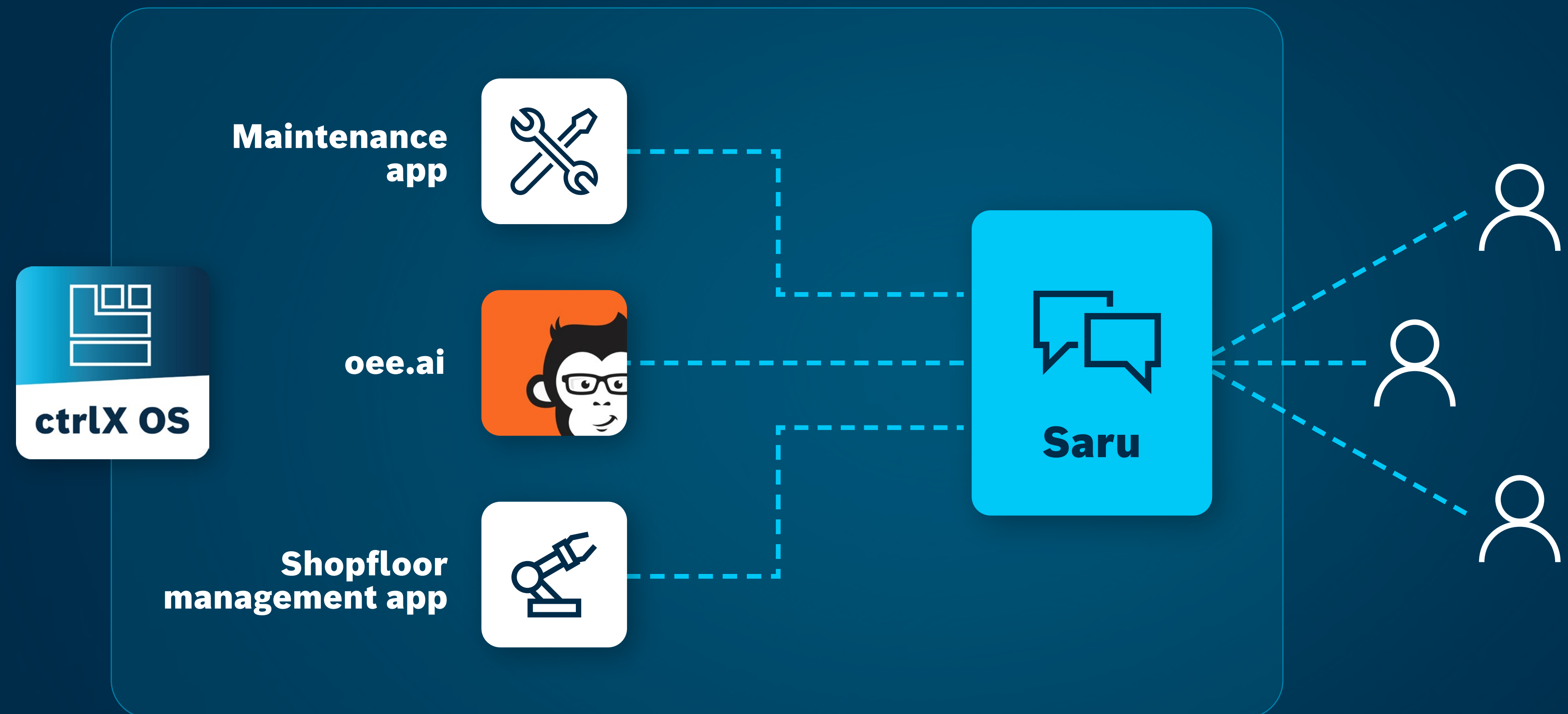
- **Conclusion: Through the interplay of open infrastructure, modular apps, and agentic AI, the platform does more than just provide key metrics. It structures relationships, thereby creating an adaptive productivity environment – and a new way to make information usable on the factory floor.**

The technical foundation: open architecture, open interfaces, one database

This integration is possible thanks to the architecture. Since all ctrlX OS apps operate on a shared data layer and communicate via open interfaces, an additional integration layer becomes obsolete.

Connecting the OEE app, maintenance app, and AI agent only requires configuration within the existing platform.

Modular apps and Saru, an agentic AI, can be easily configured based on the shared data layer ctrlX OS. There's no need for an additional integration layer



The way forward: Putting the vision into practice

In practice, the path to a modular, scalable, and adaptive production environment starts with strategically selecting a use case.

By combining the open ctrlX infrastructure with a modular application platform, an OEE use case can first be implemented on a single line and validated during operation. Once its benefits have been proven, it can be expanded to additional lines, applications, and plants at any time.

To make this process more tangible, there are different approaches you can take:

- **Live demonstration** in the Bosch Rexroth ModelFab in Ulm
- **Joint evaluation** of a specific use case on site
- **Quick initial validation** directly on the line with preconfigured ctrlX infrastructure and oee.ai connection
- **Access to the ctrlX OS Ecosystem** for available partner apps to implement the specific use case

Contact your Bosch Rexroth and oee.ai representatives at any time. Or visit our Website to take the first step – controlled, technically manageable, and organizationally manageable.

Conclusion

In the consumer goods industry, digitalization is a matter of vision and structure. Companies can reduce risk and increase speed by designing open infrastructure, adopting a modular approach to applications, and making extensions easily activatable.

Progress doesn't come from a perfect master plan. It comes from an architecture that systematically enables change. With this approach, innovation becomes a controllable component of the production strategy rather than a project. This is precisely when „the next innovation is just an app away“.

The open, Linux-based platform orchestrated by Bosch Rexroth and its growing ecosystem of partner apps paves the way, with oee.ai being part of it. Rather than creating additional dependencies, it provides the infrastructure for continuous innovation at your own pace.



Looking forward to engaging in dialogue:

Tobias Gerhard

Senior Business Development Manager
(Fast Moving Consumer Goods)
Bosch Rexroth AG

tobias.gerhard@boschrexroth.de | www.boschrexroth.com



Joern Steinbeck

Managing Partner ifp – Institute for Productivity
ifp Software GmbH

joern@oee.ai | www.oee.ai