



## Seamless, efficient and sovereign: secure AI-supported manufacturing with ECC4P

### Edge Cloud Continuum for Production (ECC4P)

Production data provide crucial leverage for making manufacturing processes more efficient, precise, and predictable. Machines and sensor systems continuously provide valuable information for this – as long as it is reliably recorded, processed, and made available for AI-based analysis. This is precisely the advantage of seamless interaction between the edge and the cloud: real-time responses join forces with scalable computing power to reduce scrap rates, improve quality and improve system availability.

The Fraunhofer Cluster of Excellence Cognitive Internet Technologies CCIT (Fraunhofer CCIT) has developed the **Edge Cloud Continuum (ECC)** to harness this data potential. The comprehensive approach ensures that data is processed at the most efficient point – either quickly and locally at the edge or powerfully in the cloud.

**Edge Cloud Continuum for Production (ECC4P)** specifically applies this principle to industrial manufacturing. It combines smart sensors, local data processing, artificial intelligence and secure data spaces in an integrated comprehensive solution. ECC4P establishes a seamless data cycle between machine, edge and cloud. This enables production to be seamlessly monitored, controlled, automated, and continuously improved.

*The Edge Cloud Continuum for Production (ECC4P) developed by Fraunhofer CCIT demonstrates the ideal interaction of IoT sensors, edge computing, cloud technology and artificial intelligence within a secure and sovereign data space. The intelligent data cycle enables continuous optimization of production processes.*



## ECC4P questions and answers



### What is ECC4P?

ECC4P is a modular monitoring system for the manufacturing industry. It is based on an edge/cloud infrastructure and includes all steps from sensors to edge and cloud processing and to sovereign data spaces and AI algorithms.

### Why edge AND cloud?

The edge provides for fast, low-latency responses directly at the machine. The cloud provides the computing power to train AI models. ECC4P combines both worlds in a continuous cycle suitable for industrial implementation.

### What is the role of AI?

AI recognizes patterns, anomalies and wear at an early stage. It enables automated quality control, process optimization, and predictive maintenance based on synchronized sensor and machine data.

### Are my data secure?

Yes. The Eclipse Dataspace Connector ensures that companies retain control over access to and use of their data. Automated security audits continuously check whether the edge and cloud systems are configured securely and correctly.

### Can ECC4P be integrated in existing systems?

Yes. All components are modular and brownfield-ready and can be flexibly integrated in existing machines, lines and IT infrastructures.

## ECC4P technology components

### Sensors

ECC4P is connected directly to the data source, i.e., to the machines and additional sensors. Measured data such as temperature, vibration or force are recorded. The available smart IoT sensor systems are smartGRIND (for generating grinding), smartTOOL (for milling, drilling, and grinding), and smartNOTCH (for metal forming in presses). These can communicate directly with the machine control or with monitoring and analytics systems.

### Edge processing

An edge industrial PC precisely synchronizes the acquired sensor and machine data and evaluates them locally. AI models can be run directly on the machine – without latency or dependence on the cloud. This is especially important for time-critical applications such as tool monitoring, process adaptation or quality control.

### AI models in the cloud

The cloud provides the scalable computing power to efficiently train ML models with synchronized measurement and machine data. The AI processes many different variants, recognizes patterns and anomalies and can predict conditions such as tool wear or quality deviations. After training, the models are automatically deployed back to the edge systems, where they support latency-critical decisions during operation and are continuously improved based on new data.

### ECC4P is designed for...

all data-intensive manufacturing processes – especially in mechanical engineering, machining, forming and in the production of high-quality components. This especially benefits:

- Industries such as aerospace, automotive, vehicle drive technology, and medical technology
- Manufacturers of machine tools and processing machinery, special-purpose machines and complex production lines

## Digital business models

The sovereign use of industrial data establishes the basis for new service- and usage-based business models. ECC4P provides the technical prerequisites: Production data are recorded in a controlled manner, securely processed and provided for AI analysis – across locations and in compliance with the GDPR. Machine manufacturers can use this basis to develop solutions such as predictive maintenance or pay-per-use offers. Billing is no longer based

simply on the machine, but on its actual use. At the same time, data-sovereign collaboration provides suppliers with valuable insights into wear behavior and operating conditions without the need for disclosure of sensitive raw data. Both sides benefit: Manufacturers expand their service portfolios and stabilize their revenue models, while users gain predictable costs and reliable maintenance.

### Added value for companies

- Increased productivity through real-time monitoring of machining processes, tools and machines.
- Lower scrap rates because deviations in processes are detected at an early stage.
- Predictable maintenance with AI-supported wear and anomaly predictions.
- High degree of transparency in operation: detailed insights in emissions, energy consumption, material usage and process efficiency.
- Automated documentation of all manufactured components – including complete traceability.
- Secure data spaces for sovereign collaboration with customers, suppliers and partners.
- Modular design for simple integration in existing production environments.
- Comprehensive solution combining sensors, the edge and the cloud as necessary.

### Secure data space

Production data are often critical for business. This makes it all the more important to ensure a viable concept for secure, sovereign data transfer—whether decentralized at the edge, in the cloud, or across companies with partners. ECC4P implements technologies that make trust and usage control technically feasible. This includes the Eclipse Dataspace Connector (EDC) as a central component for federated data ecosystems, through which data can be exchanged with clearly defined terms of use. This gives companies control over who can view and process which information at all times. Automated security audits also ensure correct configuration of the edge and cloud infrastructures. This makes ECC4P a comprehensive tool for transparent and secure AI-supported manufacturing processes—with higher efficiency, predictability and quality.

### Contact and collaboration

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*“ECC4P combines scientifically sound technologies with the requirements of industrial practice and establishes a reliable foundation for sovereign data ecosystems. As a neutral technology provider, we support companies in the controlled use of data, stable process management and implementing service-oriented business models.”*  
 Michael Fritz, Head of Office of the Fraunhofer Cluster of Excellence Cognitive Internet Technologies CCIT