

# Edge Layer:

## An Architectural Concept for Secure, Scalable, and Easily Connection of Production Machines

from Robin Schubert, Product Manager Manufacturing Automation at Kontron AIS GmbH

An edge layer represents the Internet of Things (IoT) put into practice with a clear concept. Data flows are structured, security mechanisms are embedded end-to-end, and scalability becomes predictable. While the early days of IoT were driven by enthusiasm for new connectivity options, the focus today has shifted toward a more fundamental question: how can heterogeneous, highly interconnected IoT landscapes in production be operated securely, maintainably, and sustainably over the long term?

This is exactly where the edge layer concept comes into play. By establishing a structured architecture, it clearly organizes data flows from the machine level to the cloud and provides targeted security and management solutions at every layer.

### Challenges of IoT Connectivity

Increasing digitalization introduces three major challenges for production environments:

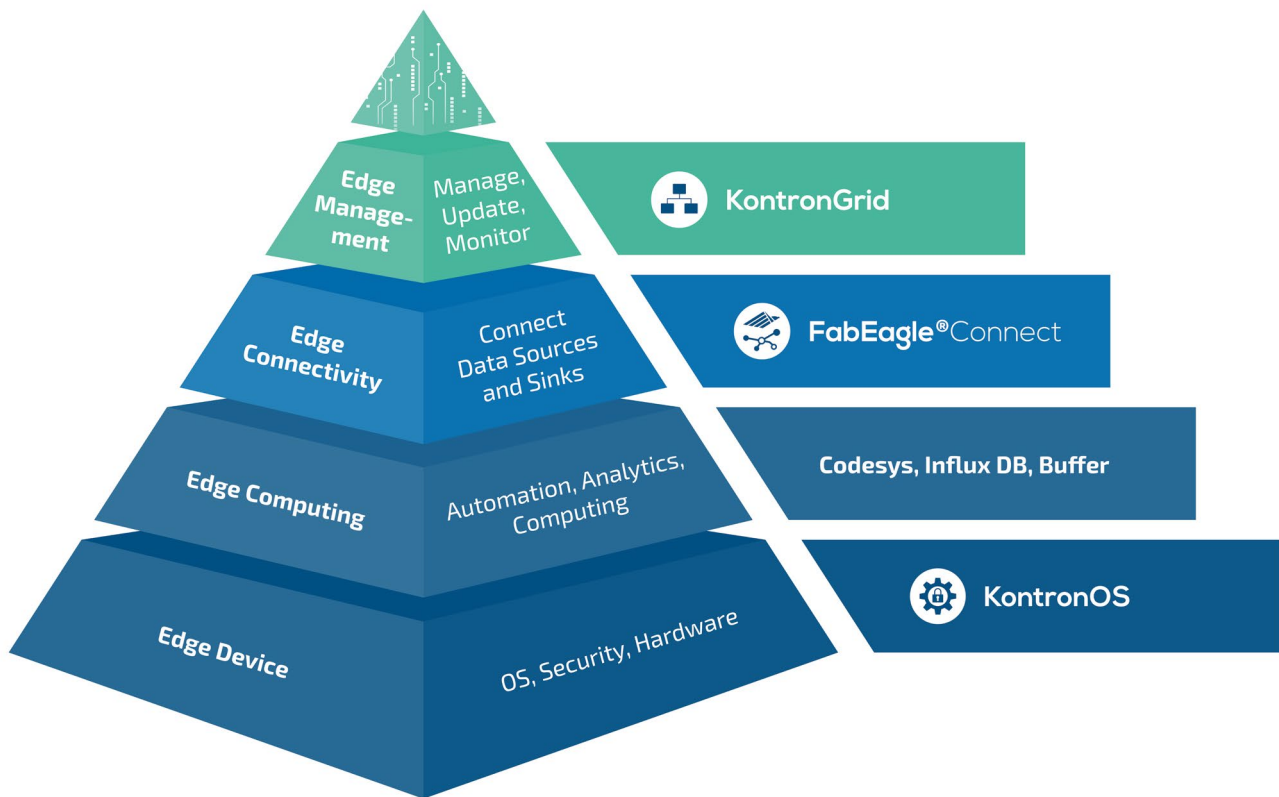
- › **Decentralization and heterogeneity:**  
Different protocols, multiple generations of machine PLCs, and legacy IT systems often result in a fragmented, difficult-to-maintain landscape.
- › **Growing security risks:**  
Every additional device and interface expands the attack surface. Particularly critical are devices that connect directly to the cloud without secure gateways.
- › **Management and updates:**  
Software is now deployed on almost every sensor and gateway. Without a centralized update strategy, security risks increase, and meeting regulatory requirements such as the Cyber Resilience Act (CRA) becomes significantly more complex.

### What an Edge Layer Can Deliver as a Strategic Architecture Model

The edge layer directly addresses these challenges and goes far beyond a purely technical layer. It provides a strategic framework that combines easy integ-

ration, security, scalability, and maintainability. Three core principles are key:

1. **Clear layered architecture:**  
A clear separation of functions brings structure and transparency to complex production environments. Standardized data flows and interfaces simplify integrations, increase visibility, support international rollouts, and accelerate the connection of new machines or production lines. Innovations such as new AI models or additional protocols can be integrated without disrupting existing systems.
2. **Automated update and lifecycle management:**  
Since software now runs on nearly every sensor and gateway, continuous updates have become a critical success factor. A sustainable edge layer approach therefore relies on automated processes covering the entire software and operating system lifecycle – from initial installation and updates to decommissioning. Container technologies such as Docker form the foundation by enabling reproducible, secure, and scalable software rollouts. This ensures a stable IT and OT landscape, even when managing hundreds or thousands of devices across multiple sites. »



From the shop floor to the cloud – the architectural structure of an edge layer.

### 3. Security at every layer:

Security is an integral part of the edge layer architecture. Hardened operating systems with encrypted protocols, secure remote access, and cloud-level security standards protect against external attacks while also establishing trust in access rights and operational methods.

#### Edge Devices: Gateways as a Secure Foundation

Edge-optimized industrial PCs form the backbone of any edge architecture. They collect and aggregate data directly from machines and systems and convert it into the required formats. This reduces the number of direct cloud connections, protects existing systems, and minimizes potential attack surfaces.

Kontron relies on technologies such as the KBox series or the AL i.MX8M Mini, combined with the hardened Linux®-based operating system KontronOS, to provide a reliable and update-ready hardware foundation. Regular security and feature updates are delivered via container technologies, ensuring that

even large gateway fleets remain easy to maintain over the long term. When hardware and software come from a single source, support and maintenance are simplified, resulting in a higher overall level of security.

#### Edge Computing:

##### Real-Time Processing Before Cloud Upload

Large volumes of data can be preprocessed close to the machine on gateways or within production control systems such as FabEagle®LC. This reduces bandwidth requirements and minimizes latency. The result is efficient data processing for use cases such as AI-based image analysis or KPI calculations. Data is then aggregated and analyzed on local servers before being transferred to the cloud.

Example: In optical quality inspection, image data is analyzed directly on the gateway using AI algorithms. Only the result – OK or NOK – is sent to the cloud. This significantly reduces data volume while enabling immediate process adjustments. »

### Edge Connectivity:

#### Integrating Data Interfaces and Formats

The true strength of the edge layer lies in standardized integration software. In everyday production environments, OPC UA, MQTT, REST APIs, and traditional protocols such as Modbus coexist with different systems and data formats. Without flexible middleware like FabEagle®Connect, efficient connectivity is hardly achievable.

These solutions enable data format conversion, secure interface connections, and the implementation of application-specific data transformations. User management, encrypted protocols, and centralized administration via Docker further enhance operational security and maintainability.

### Edge Management:

#### Cloud-Based Device and Software Management

The cloud forms the backbone for management and scalability. Without centralized management functions, keeping hundreds of gateways and devices up to date and secure across multiple sites would be nearly impossible. With EquipmentCloud® and the IoT device management solution KontronGrid, Kontron provides a platform for efficient remote updates, monitoring,

and fleet management. Software is centrally provided as Docker images and automatically distributed to all connected devices. Diagnostic and logging functions help identify and resolve issues more quickly.

#### Implementing an Edge Layer Architecture in Three Steps

A proven, practical three-step approach has emerged for the structured introduction of an edge layer:

1. **Specification:**  
Assessment of the current situation, including the existing machine landscape, interface protocols, security requirements, and network topology.
2. **Reference architecture:**  
Definition of the desired layers, security measures, update processes, and responsibilities between IT and OT.
3. **Pilot project:**  
Selection of a representative area and definition of objectives, such as cloud connectivity or dashboard implementation. Where necessary, hardware is replaced to operate the IoT edge layer in a prototype environment. »



Example of a practical edge stack for manufacturers.

### IoT Ecosystem in Practice

IDC and Gartner predict that by 2025, more than 75 percent of industrial data will be processed at the edge.<sup>1</sup> Companies that act now gain clear competitive advantages: lower bandwidth costs, higher operational reliability, and better foundations for AI applications.

**What truly matters is not individual technologies, but their interaction:**

- › **Edge devices:**  
High-performance gateways for harsh production environments, such as the KBox A-251
- › **Secure operating system:**  
Ideally hardened, Linux®-based systems like KontronOS
- › **Connectivity:**  
Easy-to-implement middleware such as FabEagle®Connect for interface integration and monitoring

- › **Manufacturing systems:**  
Production line controller systems like FabEagle®LC for local orchestration and preprocessing
- › **Device management:**  
Scalable rollouts and secure fleet management with solutions such as KontronGrid

### Setting the Course for the Future Now

Edge layers are not a theoretical model. They are a proven, practical concept marking a turning point in industrial production. Data is no longer a by-product – it is the key raw material for innovation and efficiency. The edge layer enables secure and economical use of this resource through clear architecture, automated update management, and security by design. Companies that take a structured approach today reduce integration effort in the long term, lower risks, create a solid foundation for AI applications and global rollouts – and, most importantly, gain a decisive competitive edge as agile organizations. ■

<sup>1</sup> <https://www.gartner.com/smarterwithgartner/what-edge-computing-means-for-infrastructure-and-operations-leaders>

## About Kontron AIS GmbH

For over 35 years, we have been setting the benchmark in industrial software development. Our proven software products and customized digitalization solutions are backed by an experienced team of more than 250 employees. We enable equipment manufacturers as well as factory operators to break new ground in automation and secure long-term competitive advantages. Together with our customers, we implement intelligent digitalization strategies worldwide, paving the way for the smart manufacturing of tomorrow.

As a subsidiary of Kontron AG, we provide comprehensive IoT solutions from a single source – covering both hardware and software. Our global network ensures project management, service and support on a global scale.

Further information: [www.kontron-ais.com](http://www.kontron-ais.com)

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