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NETWORKING DEVICES
TREND WATCH

HOW INDUSTRIAL CONNECTIVITY IS CHANGING MODERN FACTORIES



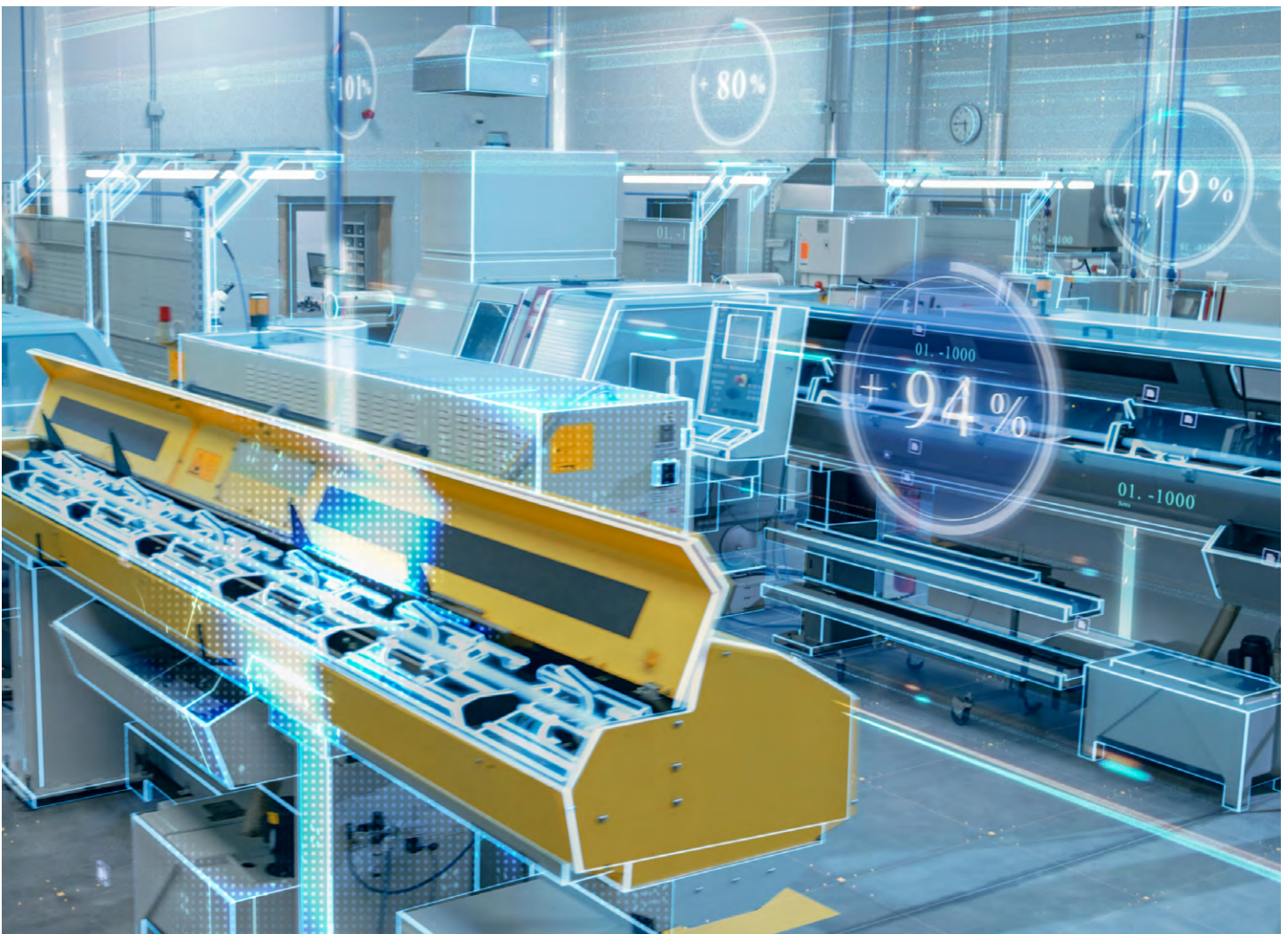
FROM NETWORK ISLAND TO INTEGRATED ARCHITECTURES

System-Level Integration in Automation Solutions

The rapid proliferation of connected industrial systems and devices is fundamentally transforming modern factories from siloed automation islands into connected, edge-to-cloud ecosystems.

Driven by the increasingly complex requirements of Industry 4.0, industrial companies are adopting artificial intelligence (AI), machine learning (ML), high-speed networking, remote monitoring, and advanced analytics. These technologies are critical to maximize operational efficiency, enable predictive maintenance, and create a scalable infrastructure baseline.

But as the complexity increases in these automation systems, a shift is occurring. Industrial operations are looking beyond isolated automation components and instead are seeking integrated, system-level networking solutions. This evolution can help maximize connectivity performance, data speed, and scalability for the future — helping to ensure that they are prepared for what is coming next in industrial automation.



INDUSTRY TRENDS IN NETWORKING DEVICES AND AUTOMATION

Over the past several years, industrial operations have made progress toward automation network adoption as the many different systems and machines on the factory floor are being connected. Emerging technologies such as Time-Sensitive Networking (TSN) and Single Pair Ethernet (SPE) are further driving the need for deterministic, high-performance industrial networks.

The move away from traditional automation islands toward system-wide hardware and controls integration involves bridging the gap between low-level field devices, such as sensors and actuators, and high-level enterprise software. The challenges posed by these changes are particularly visible in systems such as industrial robots, machine vision systems, AGVs, and PLC-controlled production line. Today, networking and control functionalities can be merged within combined hardware form factors. **This change is driven by these key industry trends:**



Substantial increase in networked sensors and connectivity complexity

Modern machine cabinets and production cells are filled with intelligent sensors, vision sensors, actuators, and other functions. Managing these real-time communication networks demands high-density, high-speed physical interfaces capable of handling massive transmission bandwidths without enlarging the machine or system footprint.



Transparency and traceability requirements

Growing corporate and regulatory mandates require many companies to enforce end-to-end data transparency across supply chains. This increasing need for product traceability necessitates continuous data harvesting from the field level to ensure total operational visibility.



Architecture evolution to edge-to-cloud data flows

Traditional centralized computing architectures are being replaced by flexible, decentralized topologies. Industrial facilities must safely migrate immense volumes of machine asset data from factory floor devices straight into cloud platforms for high-level analysis.



5 KEY BENEFITS OF SYSTEM-LEVEL INTEGRATION

Transitioning from component-isolated architectures to system-level integration provides important operational advantages across the factory floor.

- 1 Real-time, low-latency performance**

Integration across the automation pyramid — from field-level sensors up through PLCs, industrial switches, and enterprise software — ensures that critical data is transmitted on a real-time basis. In high-risk environments like oil fields, minimizing latency allows for immediate mitigation actions, helping improve operational safety through faster response times.
- 2 Significant reduction of automation islands**

Traditional setups often contain isolated sub-devices that require converters and gateways to communicate outside their small network segments. System-level architectural enablers, such as Single Pair Ethernet (SPE), which helps simplify field-level Ethernet architectures.
- 3 Interoperability and enhanced footprints**

Attempting to stitch together a networking framework using disjointed components from an array of separate vendors can limit operational visibility. Implementing a unified system architecture helps promote reliable performance, enhances overall hardware functionality, and eases compliance with product specifications and dimensions.
- 4 Increased protection and network uptime**

Systems designed for industrial use provide a performance buffer in data integrity that results in low packet loss. By utilizing specialized vibration-resistant latching mechanisms and components engineered to withstand extreme physical and thermal stressors, integrated networks can help lessen structural vulnerabilities, reducing unscheduled downtime and maintenance labor costs.
- 5 Future-ready and modularity**

A comprehensive system allows OEM engineers to plan modular, decentralized infrastructures. When manufacturing needs inevitably evolve over the coming years, a modular system permits designers to quickly update or change segments of the system without an expensive top-to-bottom replacement of the entire chain.





TECHNICAL CONSIDERATIONS FOR SYSTEM-LEVEL INTEGRATION

As industrial networking becomes more complex, engineers must address several key challenges when designing scalable architectures. For example, applications such as robotic welding cells, motion control systems, or automated inspection equipment require high-speed, reliable connectivity under demanding conditions. Creating a unified networking foundation across a decentralized automation architecture that also offers flexibility for the future requires consideration of numerous factors.



Safety and cyber security

The risk of data breaches or losing data is significant at large operations where critical processes are run. Protecting critical operational data from exposure or interception represents an ongoing corporate security hurdle that must be considered. In addition, the growing adoption of industrial cybersecurity standards such as IEC 62443 is driving demand for secure industrial networking architectures that help support system resilience, data integrity, and operational continuity.



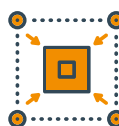
Physical and electrical stressors

Unlike in standard enterprise environments, industrial networking devices must have the ability to operate inside severe thermal bands and under persistent structural vibration, intense mechanical shock, humidity, and other harsh environments. Simultaneously, they must handle electrical noise and voltage fluctuations without dropping packets or disrupting real-time connectivity.



Network reliability and real-time communication

The system and components must be able to handle high-volume data transmissions minimizing data loss. Supporting reliable real-time communication over the operational lifetime of these systems is key.



Miniaturization and space constraints

The ongoing push for smaller components and smaller system footprints is affecting component design and selection. This increases demand for micro-pitch, space-saving components and solutions on the internal PCBs of networking hardware.

TACKLE THESE CHALLENGES WITH TE CONNECTIVITY SOLUTIONS

Building scalable, future-ready automation infrastructures requires evaluating tomorrow's data problems early in the initial hardware design cycle. Rather than thinking about solving today's challenges, think about the challenges that will come in the next 5 to 10 years. TE Connectivity (TE) has a broad portfolio of connectivity solutions to help OEM engineers design reliable, modular system-level automation architectures.



INTERCONTEC Connector Series

TE Connectivity offers a wide variety of solutions that make connecting easy with the INTERCONTEC product range. These power, signal, and hybrid connectors consist of only a few single parts with a modular design, making them highly compatible and usable in many different combinations.



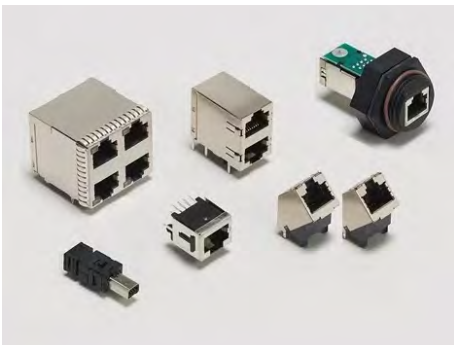
Industrial Mini I/O Connectors

These rectangular connectors transfer data between devices in applications where space constraints and vibration resistance are critical. TE's Industrial Mini I/O connectors (IEC 61076-3-122) portfolio consists of various board and cable connectors: R/A, straight board connectors, and solder and piercing cable connectors for harness makers. Adopting alternatives like Mini I/O connectors can help achieve up to a 75% space savings over a standard RJ45 connector while providing robust vibration resistance.



M8 and M12 connector systems

These connectors are designed to help reduce downtime with a reliable industry-standard solution, including quick-turn prototype cable assemblies. They help support long-term equipment reliability and support up to 10 Gbps bandwidth needs. Operations can leverage sealed M8/M12 architectures (D-coded for 100 Mbps, X-coded for future-ready 10 Gbps) to achieve IP67/IP68 sealing against fluids and dust.



Industrial RJ45 Connectors

For robust Ethernet connectivity in harsh industrial environments, our industrial RJ45 connectors are designed to terminate Ethernet cables and connect into computers, routers, LANs, and other types of data communications equipment. Our portfolio features RJ45 connectors manufactured in multiple port and single port configurations with jack and plug modular connector styles. Our high-speed RJ45 connector systems have been designed to meet the requirements of high-speed data connections.



ERNI MicroSpeed connectors

The MicroSpeed connector system supports high data transmission rates. Thanks to high signal integrity, data rates up to 25 Gbps can be realized. The space-efficient, interference-resistant connectors are electromagnetically compatible and safe. Offering a miniaturized design, the connectors have reliability and a high degree of robustness.



Single Pair Ethernet (SPE) solutions

Moving toward miniaturized, cost-efficient, one-cable automation standards via IEC 63171-7 and IEC 61076-2-117 profiles help operations to concurrently distribute both power and up to gigabit data.

INDUSTRIAL AUTOMATION OF THE FUTURE

With increasing Industry 4.0 demands, industrial systems face higher bandwidth loads, greater requirements for speed and connectivity, and added system complexity. The physical component layer of an automation system helps dictate the success and performance of the AI, machine learning, and automation software. This makes system-level integration — and the connectivity solutions that enable it — critical as industrial companies prepare for the future.

Engaging a partner early in the design cycle can help ensure a solid system-level networking foundation that is reliable, modular, and scalable. TE brings decades of cross-industry innovation and expertise along with a global portfolio of interconnect and sensor technologies.



Connect with us

Discover how TE's broad portfolio of reliable networking components and solutions can help facilities adapt to key industry trends and optimize system performance.

TE Connectivity NETWORKING DEVICES

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