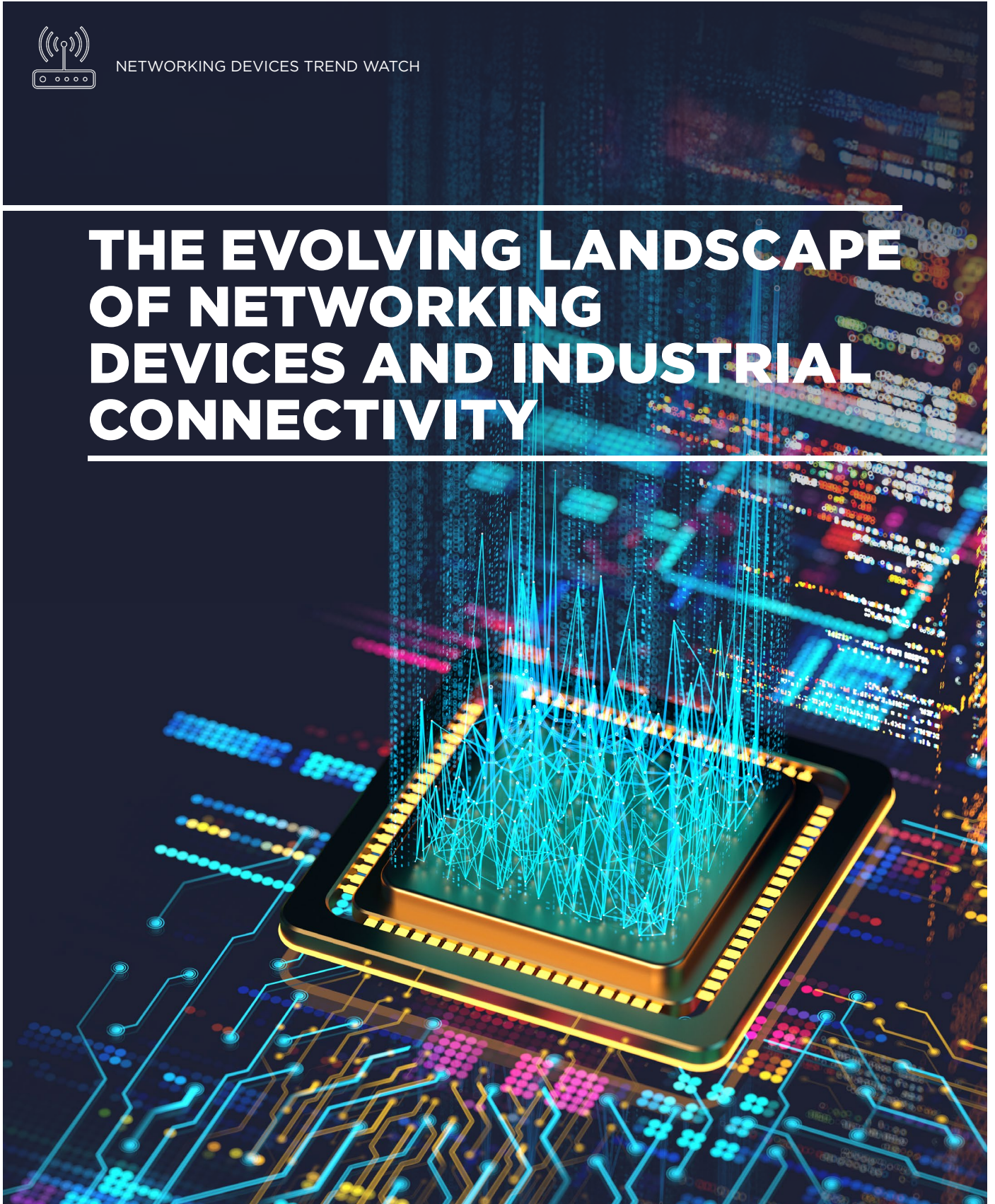NETWORKING DEVICES TREND WATCH

THE EVOLVING LANDSCAPE OF NETWORKING DEVICES AND INDUSTRIAL CONNECTIVITY

The rapid expansion of industrial connectivity is causing a parallel evolution in networking devices. Across diverse industries and applications, the need for seamless, reliable, and high-speed communication has become critical in modern industrial environments.

From enabling real-time communication across machines and systems to supporting preventive maintenance and streamlined management of manufacturing infrastructure, networking devices are at the heart of the Industrial Internet of Things (IIoT) movement.

This paper explores the key trends shaping the development of these essential capabilities and components. It will examine how they are adapting to meet the demands of increased traceability, the rise of decentralized architectures, and the proliferation of networked sensors in automation processes.

Gain a deeper understanding of how evolving connectivity and networking needs are being addressed through these solutions:

▶ **CUTTING-EDGE CONNECTOR SOLUTIONS**

▶ **STATE-OF-THE-ART CONNECTIVITY**

▶ **SCALABLE I/O SOLUTIONS**

▶ **SMALL FOOTPRINT SWITCHING TECHNOLOGIES**

KEY INDUSTRIES AND SUB-APPLICATIONS

For everything from commercial transportation and energy plants to data centers, aerospace and industrial automation, networking devices provide the foundation for a safer, sustainable, productive, and connected future.

Within the networking devices segment, there are several **key sub-applications: industrial switches and routers, protocol converters, IIoT gateways, and wireless access points**. These play crucial roles in various applications across discrete, process, and hybrid automation landscapes.

Networking devices rely on a range of components to enable effective communication and control in industrial settings. **Key components include rectangular, circular, and board connectors; terminal blocks; cable assemblies; and power connectors**. Additionally, the segment utilizes **components like switches, passives, and relays** to ensure reliable and efficient operation of industrial networks.

All of these components and devices play a role in connecting systems and processes with the internet and to each other, delivering "smart" operation in industrial environments. Power monitoring and control are especially critical in industrial environments, resulting in a significant increase in the use of sensors and smart machine functions.

INDUSTRIAL SWITCHES

INDUSTRIAL ROUTERS

PROTOCOL CONVERTERS

IIOT GATEWAYS

WIRELESS ACCESS POINTS

4 KEY MARKET DRIVERS AND INDUSTRY TRENDS

The demand for networking devices is driven by several trends and changes across industries and applications.

1 INCREASED DEMAND FOR DATA TRANSPARENCY AND TRACEABILITY

Modern industries require data visibility and real-time data collection and analysis in order to optimize production efficiency, performance, and streamlined management of manufacturing and equipment infrastructure. Key data collected includes information such as material flow, output, shutdowns, or quality control — factors that influence the entire process.

These metrics, paired with workflow analyses, show optimization potential and can help troubleshoot problems in advance. The "big data" approach makes sense only with interpretation and actions. The device enables this data collection and the real-time connections across machines and systems that are required for this visibility. For example, data transparency in an oil field could provide information on every sensor at the ground level, so a leak or malfunction could be diagnosed at the exact location and controlled remotely.

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2 ADOPTION OF DECENTRALIZED AND EDGE-TO-CLOUD ARCHITECTURE

This is a shift from traditional centralized cloud computing to a model where computing resources and data processing are distributed closer to the source of data generation, at the "edge" of the network, while still leveraging the power of the cloud. This means distributing computing tasks across multiple, smaller locations closer to where data is generated, such as IIoT devices, sensors, and other edge devices. By bringing data processing and storage closer to the source of data, edge computing enables faster data analysis, reduced latency, and improved bandwidth utilization. Edge-to-cloud architecture combines the benefits of both edge and cloud computing.

Data can be processed locally at the edge for real-time applications, while more complex analysis and storage can be handled in the cloud. In a factory setting with edge connectivity, there is a cloud on premises that is transmitting data. It requires networking devices to enable edge-to-cloud communication at the local premises level. This has led to increased adoption of IIoT communication protocols, such as EtherCAT, Ethernet APL, Profinet & Ethernet IP, with OPC-UA as the standardized language the devices use to communicate with each other. Many industrial users are working toward establishing private 5G campus networks for their communication and computing needs. Wireless 5G and wired copper networks often coexist in industrial facilities, so there may be a need to combine copper and fiber in one device for a higher bandwidth.

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3 GROWTH IN NETWORKED SENSORS ENABLING REAL-TIME MACHINE & SYSTEM COMMUNICATION

As the world becomes more connected, intelligent, and automated, the role of sensors is expanding. Sensors perform the critical task of collecting input from the environment and turning it into useful data. They also enable real-time communication across machines, systems and components, which helps enhance performance. Engineers must consistently innovate to

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develop sensors that more precisely detect such conditions as position, speed, vibration, and pressure, as well as temperature, humidity, and fluid conditions. The resulting data expands the capabilities for preventive maintenance and equipment management. From a factory owner's standpoint, it's better to know exactly when a machine needs maintenance to maximize uptime. Predictive maintenance is now possible thanks to sensor systems that can monitor a machine's performance, detect when there is excessive wear and tear or risk of a breakdown, and alert operators that it needs attention.

And with manufacturers embedding sensors in more and more devices, the key trends are to be smaller, more rugged, and more reliable — as well as more modular. In general, modularization brings flexibility, which in turn brings cost effectiveness. These trends also bring greater demand for high-speed and high-integrity board-signal solutions that have capabilities of ≥16 Gb/s.

4 INCREASING ADOPTION OF THE INDUSTRIAL INTERNET OF THINGS

The growth in IIoT adoption is driven by several factors, including declining costs, increased accessibility, and more computing power and capabilities. Ultimately, because IIoT increases the number of networked sensors in automation processes, this adoption leads to improved operational efficiency, reduced downtime, and enhanced productivity in industrial settings across sectors, including discrete, hybrid and process applications.

The growth in IIoT adoption is driven by several factors, including declining costs, increased accessibility, and more computing power and capabilities.

This is increasing the demand for high-processing power and communication capabilities. In any case of expanding digital communication, connections are critical, whether they be data, power, or a combination of connections through copper or fiber optics. The possibilities available depend on the power needs, as separate power solutions are needed for higher power. When it comes to power management and distribution, it is important to consider the connection in front of the device but also how to connect all of the ports inside and how to address the EMC challenges that result when higher power levels are present. The in-device transmission and distribution via board to board connections shows the technology transformation, as well. Higher data rates, EMC requirements, and power and temperature management can be challenging for manufacturers.

TECHNOLOGICAL ADVANCEMENTS AND IMPLICATIONS

The industry trends discussed above are driving capability and technological advancements in the industrial sector. These include:

Higher bandwidth and more powerful connectors

High-speed connectors that provide higher bandwidth play a crucial role in enabling the rapid transmission of large volumes of data in many environments. Rugged connectors are needed to meet stringent requirements while supporting the increasing bandwidth demands of advanced electronic systems. Key benefits of the right high-speed connectors include signal integrity, crosstalk reduction, high frequency operation, and differential signaling. The higher bandwidth demands are driving advancements of M8 and M12 connectors.

Miniaturization, modular design, and customization driven by decentralization demands:

The concepts of miniaturization and modular options go hand in hand with decentralized design. As you increase the number of devices and interactions, it is necessary to reduce the size of those devices. Miniaturization of connected devices reduces the space requirement and can also reduce costs at a certain level. A smaller device size and smaller PCB area often mean lower material costs. In addition, the demand for miniaturization will drive the increase in the degree of production automation, thereby improving production efficiency and reducing overall assembly costs. Also, using modular design in networking devices, like switches and routers, allows for customization and scalability by using interchangeable, standardized components — making upgrades and maintenance easier and more cost-effective.

Customizable components and systems offer users the ability to select and configure specific modules to meet their unique requirements, whether it's adding more ports, implementing advanced security features, or integrating new technologies. Be aware, however, of the challenges posed by these trends. The reduction of available space with miniaturization brings challenges to the design of the devices. If not handled properly, the performance of the devices will be affected. Therefore, at the beginning of the design, engineers should consider such questions as how to guarantee the performance of the devices and how to make optimized choices of miniaturized components and modular design.

COMPONENTS FOR NETWORKING DEVICES

When choosing components, look for solutions from a connectivity expert and partner that provide:

• **The ability to communicate in Ethernet standardized protocols**

• **Highly engineered connector solutions that support high-speed and integrity requirements**

• **State-of-the-art connectivity solutions enabling one-cable automation**

• **Expertise in scalable and modular I/O solutions**

• **Small-footprint switching solutions that enhance reliability and uptime**

PRODUCT AND SUB-APPLICATION CATEGORIES INCLUDE:
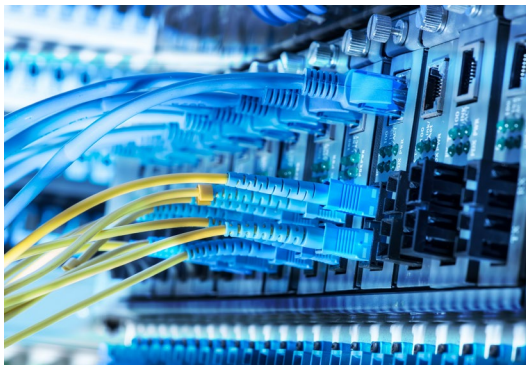
Industrial Switches

Also known as industrial Ethernet switches and specifically designed for use in industrial settings. They can operate in hard industrial environments with the ability to withstand extreme temperatures, humidity, vibrations, electrical noise, and physical contamination. They provide reliable, high-speed data transmission for industrial networks, including 10G industrial switches for faster speeds. Rugged enclosures are available with IP30, IP40, or higher-level protection ratings.

Industrial Routers

These operate on the network layer (Layer 3) of an industrial Ethernet network, forwarding and routing data based on IP addresses. They feature industrial-grade components and materials that are more resistant to shock, interference, and temperature changes and can operate stably under extreme conditions of temperature, humidity, vibration, and dust. They usually have multiple Ethernet ports and serial ports and can connect and manage many industrial devices and sensors, supporting a variety of mainstream communication protocols and industry standards: Ethernet, Modbus, CAN, etc. They provide high-speed data transmission and bandwidth management capabilities to meet the needs of real-time data transmission and large-scale data processing.

IIoT Gateways

Industrial IoT gateways play a key role in an IoT infrastructure. IIoT gateways collect, process, and transfer machine asset data at the edge, ensuring complete shop floor connectivity. In the past, manufacturers have managed OT devices with SCADA systems and other locally based solutions. Industrial gateways ensure that OT device data is propagated in the cloud for production monitoring, condition monitoring, and shop floor visibility. Gateways are secure, reliable, and easy-to-use sensor-to-cloud IIoT solutions that transform data into actionable insights effortlessly. They can be of several types, including ready-to-deploy or programmable IIoT gateways.

Wireless Access Points

Industrial IEEE 802.11n wireless AP/bridge/client products are designed to overcome the challenges of harsh industrial environments. High electromagnetic immunity protects against electromagnetic disturbances, galvanic isolation guards against voltage instability, and wide-temperature ranges and shock and vibration resistance ensure reliable operation even in difficult environments. For increased flexibility in varied working environments, they can be mounted on a DIN rail or wall-mounted. These are powered via Power over Ethernet (802.3at PoE) or redundant dual DC input.

ENGINEERING THE FUTURE

The networking devices market is undergoing a significant transformation driven by the convergence of IIoT, edge computing, and requirements for faster and higher data transmission, creating both challenges and opportunities for connectivity solutions.

Connect With Us

TE Connectivity offers a broad portfolio of networking device components and solutions — cutting-edge next-generation products that perform reliably in the field. TE's support helps drive industrial networking applications toward a more connected future of everything. **Connect with us today.**