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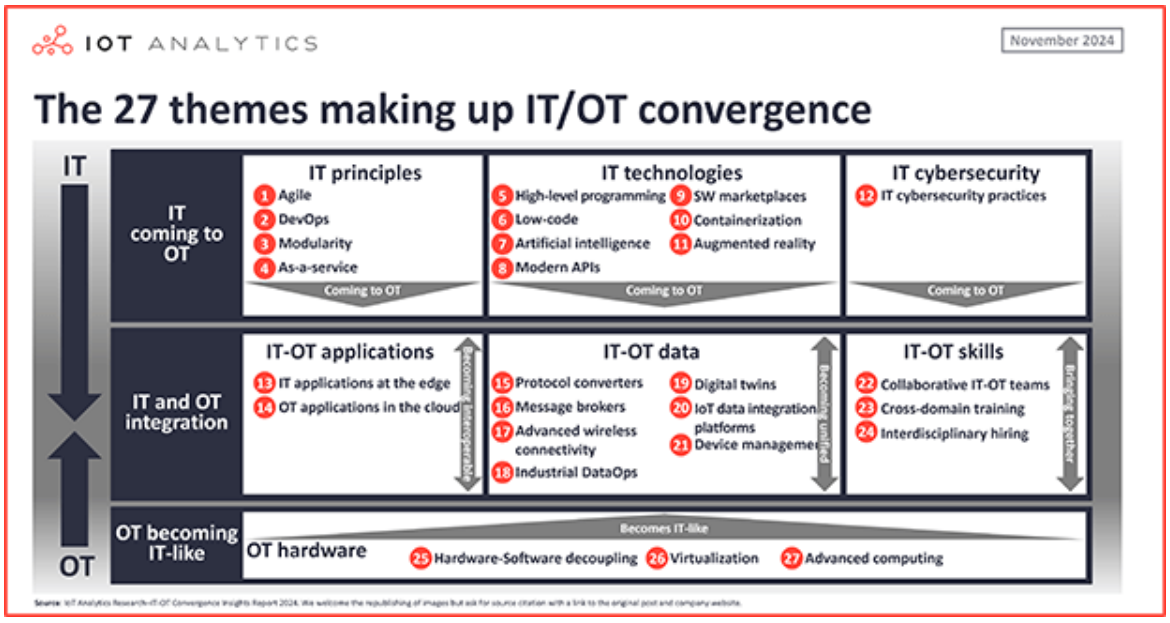
FOR IMMEDIATE RELEASE

IT/OT convergence: The 27 themes that define the future of industrial integration



[Hamburg, Germany] – [November 13, 2024] – IoT Analytics' recently published IT-OT Convergence Insights Report 2024 reveals that 27 key themes are driving the convergence of IT and operational technology (OT) sectors.

The report details the factors propelling IT/OT convergence, the challenges organizations face in implementing it, the technologies enabling this shift, and the significant market opportunities it presents. IoT Analytics forecasts growth for the combined IT/OT market, projecting an annual growth rate of approximately 8.5% until 2030. By 2027, the market is expected to surpass $1 trillion and reach nearly $1.3 trillion by the end of the decade.

The accompanying research article provides a detailed exploration of the 27 themes, categorized into seven core areas, offering valuable insights into the drivers of IT/OT convergence.

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KEY INSIGHTS

- 27 themes comprise IT/OT convergence and making it a reality, according to IoT Analytics' IT/OT Convergence Insights Report 2024.
- 12 themes involve IT coming to OT, another 12 involve IT and OT integration, and 3 involve OT hardware becoming IT-like.

SELECT QUOTES

Anand Taparia, Principal Analyst at IoT Analytics, comments that *"IT/OT convergence represents a significant market opportunity, with the combined IT software, OT software, and OT hardware market projected to approach $1.3 trillion by 2030. While data is the key currency driving efficiency and innovation in this space, the true glue will be the skilled teams/people bridging IT and OT disciplines. That said, convergence is easier said than done, with challenges like contrasting team objectives and legacy OT systems adding complexity to fully realizing this integration*."

[The full research article is attached below]

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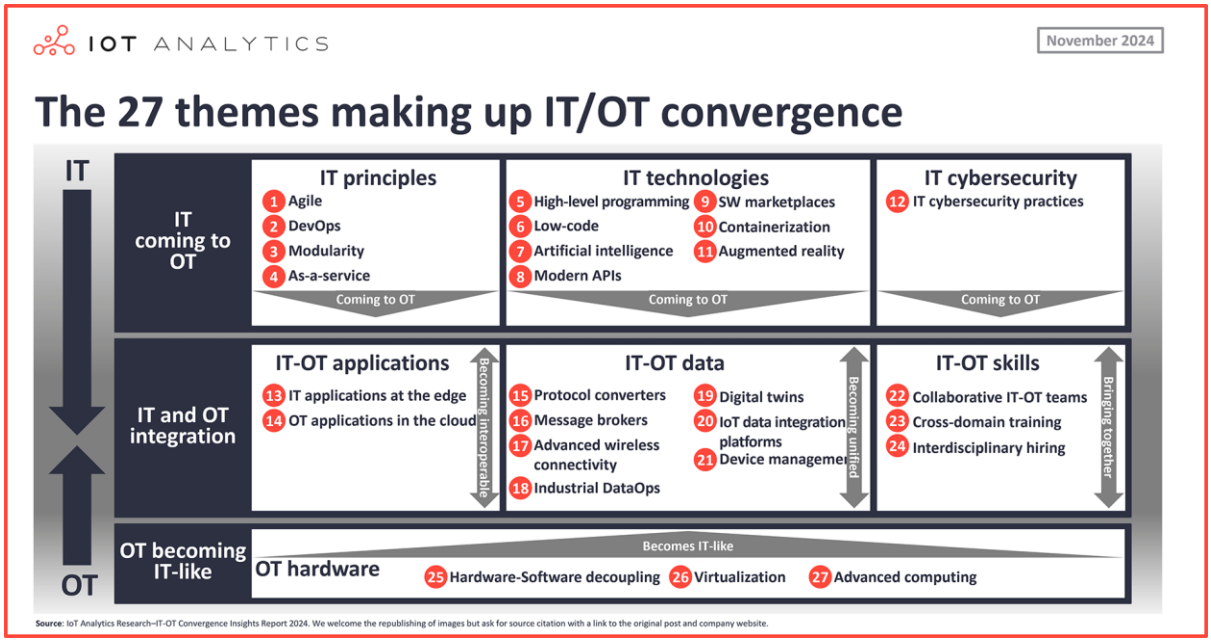

The IT/OT convergence market opportunity

IT/OT combined market expected to surpass $1 trillion by 2030. When looking at information technology (IT) software, operational technology (OT) software, and OT hardware combined (3 technologies affected by IT/OT convergence), the market size as of 2023 was $720 billion, according to IoT Analytics' 111-page IT/OT Convergence Insights Report 2024 (published October 2024). Analysis in the report—which delves into the phenomenon of IT/OT convergence, including drivers, challenges, technologies, and addressable markets— forecasts the combined market to grow approximately 8.5% per annum until 2030, surpassing $1 trillion in 2027 and approaching $1.3 trillion by the end of the decade.

While these combined market numbers outline the broader total addressable market for IT and OT convergence (including all technologies that play a role in IT/OT convergence but may be used in non-IT/OT convergence scenarios), IT/OT convergence is becoming an important driving force for each of these technologies.

IT/OT convergence definition

IT = The hardware and software that manage and deploy computer systems, networks, and applications in an enterprise setting.

OT = The hardware and software that monitor and control industrial devices, processes, and systems.

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IT/OT convergence = The integration of IT and OT technologies, processes, and organizational structures to optimize industrial operations.

Convergence is driven by the need for a scalable, robust, and secure data exchange. IT systems manage business-critical operations, while OT systems control physical processes and generate key operational data. Companies are recognizing that converging these two domains is becoming essential as they seek to enhance operational efficiency and digital capabilities, and they are investing in IT/OT convergence for several key reasons:

1. To scale digital transformation initiatives. As operational demands grow, scalable and flexible OT infrastructure powered by advanced computing, cloud applications, and alignment with IT practices enables organizations to address these needs. It also unlocks greater potential for AI and improved collaboration, driving smarter operations and increased agility.
2. To allow for robust data exchange between IT and OT systems. OT network protocols are often proprietary or differ from those used by an organization's IT systems, and the OT data may be unstructured and lack device context, creating challenges for seamless IT–OT data exchange. Protocol converters, DataOps, and IoT data integration platforms help organizations' IT and OT systems communicate and ensure OT data is usable for downstream applications.
3. To ensure secure communications in an evolved IT/OT architecture. More and more OT systems are coming online, exposing organizations to more avenues for cyber threats. With cybersecurity ranking 1st in enterprise technology priorities, applying industry cybersecurity standards (e.g., IEC-62443, influenced by IT cybersecurity practices) helps organizations defend against such threats.

Differing team roles and legacy equipment present challenges. IT/OT convergence is easier said than done. Of the 5 key challenges identified in the research, the top 2 are 1) contrasting responsibilities and objectives of IT and OT teams and 2) legacy OT systems. For example, IT teams often aim to work with agility, such as frequently updating systems, while OT teams often prioritize uninterrupted processes with a focus on reliability. Additionally, many legacy systems were not designed with IT integration in mind and currently lack the necessary communication interfaces, posing data extraction challenges.

27 themes shaping IT/OT convergence

IT-to-OT integrations dominate the 27 themes comprising IT/OT convergence. Research for the IT/OT Convergence Insights Report 2024 spanned 9 months (December 2023 to September 2024). It included interviews with experts operating at the crossroads of IT and OT—either at industrial hardware or software OEMs, as systems integrators, or as consultants—to gain practitioners' perspectives on

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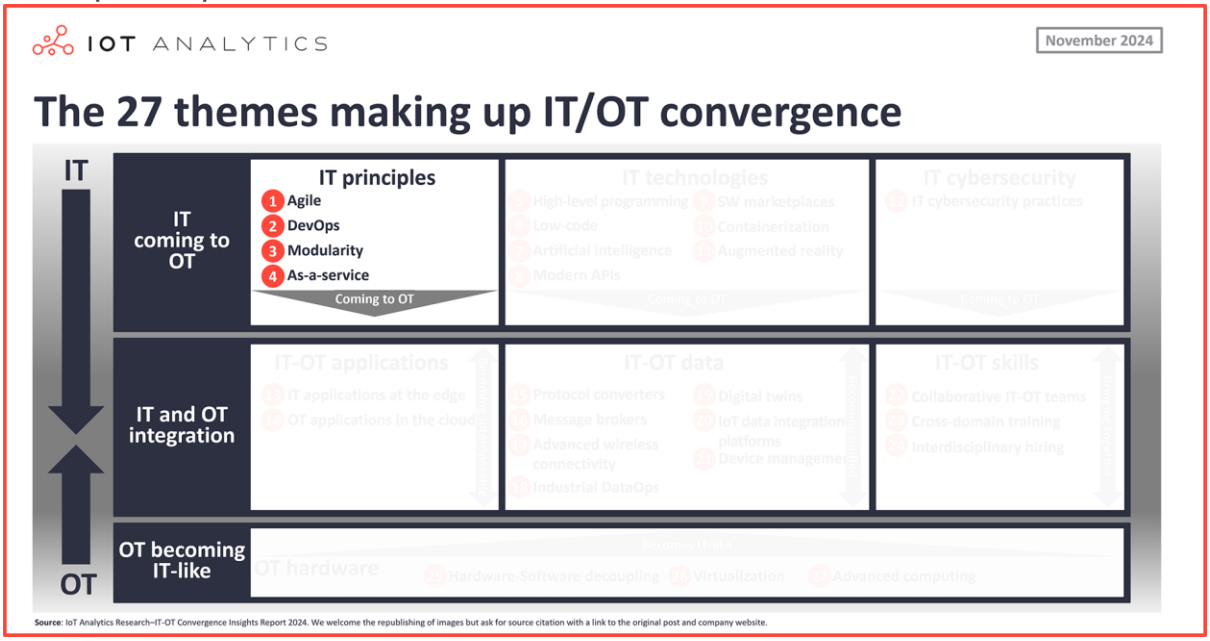
what comprises IT/OT convergence. The analysis revealed 27 themes split among 7 core categories. Most categories fall under IT principles and technologies coming to OT, with the others reflecting either IT/OT applications, data, skills, or OT hardware becoming IT-like.

A. IT principles



1. Agile

In the traditional sense, Agile is an iterative software development approach focused on collaboration, rapid delivery, and continuous improvement. While the conventional OT software development approach (Waterfall) focuses on well-defined deliverables and often excludes stakeholders (e.g., end users) during projects until the end, adopting Agile into OT brings about evolving deliverables based on regular interactions with stakeholders as projects progress.

Example: In 2020, US-based industrial automation company Rockwell Automation worked with Luxembourg-based technology consulting and services company Globant to adopt Agile into Rockwell's OT software development processes. Starting with small, manageable changes, Rockwell implemented sprint cycles and engaged directly with their customers to refine and iterate designs. Soon after adopting Agile, Andrew Stump (then the business director at Rockwell Automation) stated, "The approach to Agile software development was very good for our culture to evolve as a software company."

2. DevOps

DevOps combines software development (Dev-) and IT operations (-Ops) to shorten the development life cycle and provide continuous delivery. Applied to OT, DevOps introduces concepts like automatic code version tracking and backups for OT software, such as PLC code, which has not been a common practice in OT software development.

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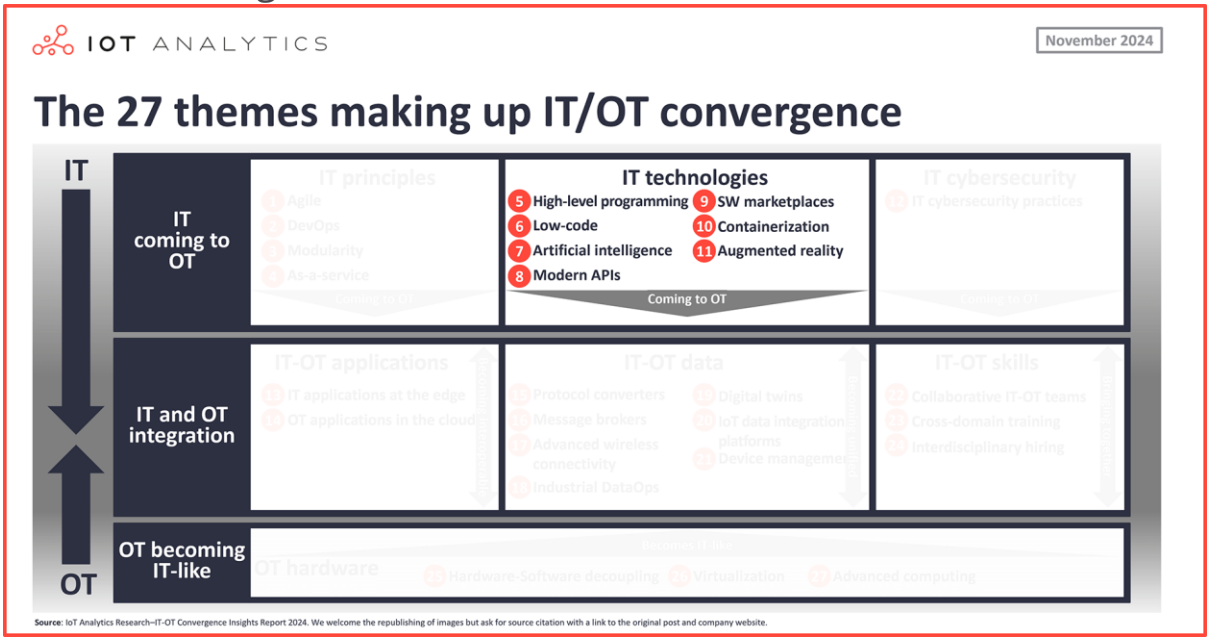
3. Modularity

Modularity is the division of a system into independent, interchangeable components that enable flexibility, scalability, and easier integration or replacement. In OT, modularity allows OT vendors to update individual modules independently rather than updating an OT system entirely, which reduces deployment time and costs.

4. As-as-service

The as-a-service business model is the deployment of software products and services over the Internet on a subscription basis, providing users with on-demand access without the need to own or manage the underlying resources. The OT domain is embracing as-a-service models, with industrial software like computer-aided design (CAD) and product lifecycle management (PLM) applications becoming available as software-as-a-service (SaaS) and industrial IoT platforms being deployed as platforms-as-a-service (PaaS), leveraging the scalability and flexibility of the cloud.

B. IT technologies



5. High-level programming

High-level programming involves coding in human-readable languages that simplify complex tasks, such as memory management and data typing, to build desktop, web, and mobile applications. Typical languages include Python, JavaScript, Visual Basic, Delphi, Perl, PHP, Ruby, C#, and Java. Engineers, especially young ones, can smoothly transition to OT hardware programming using these familiar high-level languages and tools like Microsoft Visual Studio and Eclipse. Further, IT coding environments such as Visual Studio Code allow engineers to code using PLC programming languages like Structured Text.

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6. Low-code

Low-code software development allows users to create applications with minimal manual coding using visual interfaces and prebuilt components. Applied to OT, it allows OT personnel (also called citizen developers) to create and tailor applications to their specific OT needs without needing coding expertise. A machine operator, for example, may be able to produce a tailored dashboard with all the necessary data connections without coding knowledge.

Example: US-based industrial IoT vendor Litmus Automation's Litmus Edge is a low-/no-code platform offering drag-and-drop analytical workflows for KPIs such as OEE, uptime, and downtime. For example, an end user may want to monitor the moving average of a flow sensor for a pump. They begin by creating a process flow, adding a new "processor," and designating the sensor as the data source. When that processor receives data from the sensor, it passes it to a processor assigned to calculate moving averages over a specified time or number of values reached. Once the moving average is calculated, it can send the data to a publishing processor linked to a local or cloud database.

7. AI

Now a commonplace term, AI is the ability of machines to exhibit intelligent behavior, involving the use of analytics to learn from IT and OT data and achieve outcomes such as decision-making and predictions. In OT, AI is used to automate manual processes (e.g., inspection, maintenance, and troubleshooting) by analyzing operational data and images to predict impending equipment failure or detect anomalies and defects, among other applications.

8. Modern APIs

Modern APIs are tools, protocols, and definitions that enable software applications to communicate with each other beyond traditional data exchange. They facilitate interaction between independent OT and IT systems, such as querying data, adjusting settings, and initiating actions. Most modern APIs follow representation state transfer (or REST) principles, using HTTP methods (GET, PUT, POST, and DELETE) to perform operations on resources.

9. Software marketplaces

Online B2B marketplaces are platforms where vendors provide software for users to buy, access, manage, and update from a central point. In recent years, B2B marketplaces have started to play an increasing role in enterprise IT software (e.g., AWS Marketplace). These marketplaces are also starting to distribute and manage OT software (e.g., SCADA, MES, and various other edge applications).

10. Containerization

Containerization is the process of packaging software with its required libraries and dependencies into a container for consistent operation across diverse infrastructures (such as differing hardware or operating systems). Popularized by Docker in 2013, containerization has become a de-facto standard for IT software development,

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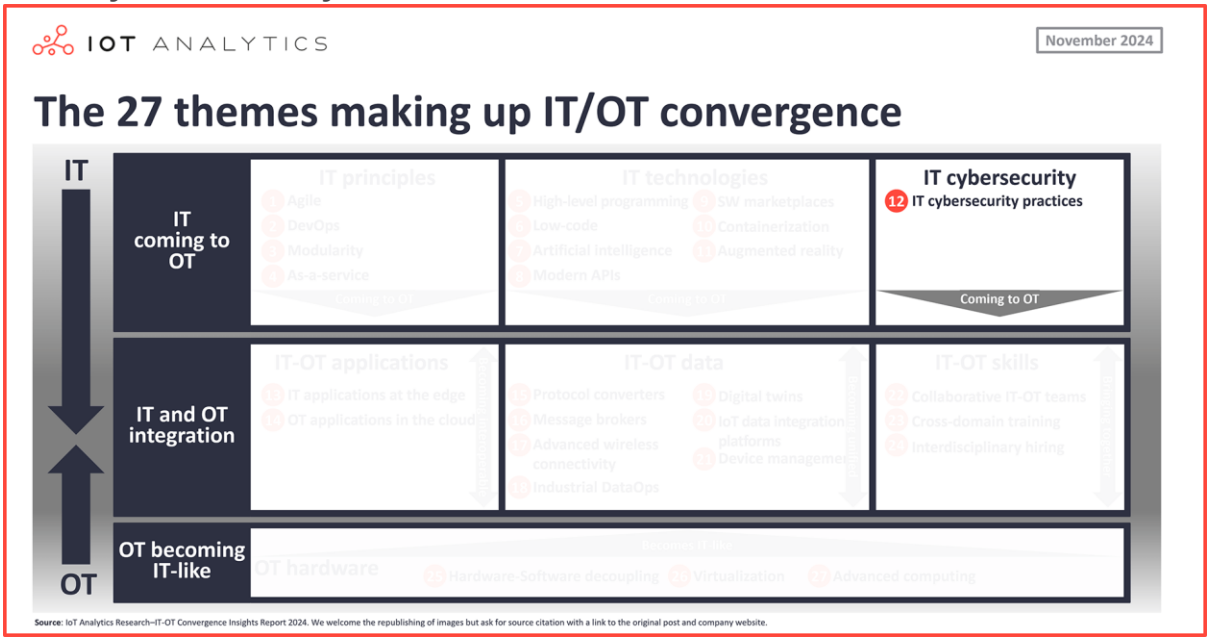
including Kubernetes for managing containerized workloads. Containerization is becoming an industry standard for OT software development and deployment, and recent IoT Analytics research identified containerization as an element that leading factories of the future do well.

11. Augmented reality (AR)

Augmented reality overlays digital data onto the physical world through smartphones, tablets, or AR glasses. AR in OT can improve connections of local on-site personnel with—and instructions to—remote experts.

C. IT cybersecurity



12. IT cybersecurity practices

IT cybersecurity practices are sets of procedures, strategies, and technologies designed to protect an organization's IT systems and data from cyber threats. OT vendors are adopting cybersecurity practices that have become standards in IT departments, such as the Zero Trust model, Trusted Platform Modules (TPM), and network segmentation to address rising security needs as OT systems face increasing internal and external risks. The popular industrial cybersecurity standard, IEC-62443, is also influenced by IT cybersecurity standards.

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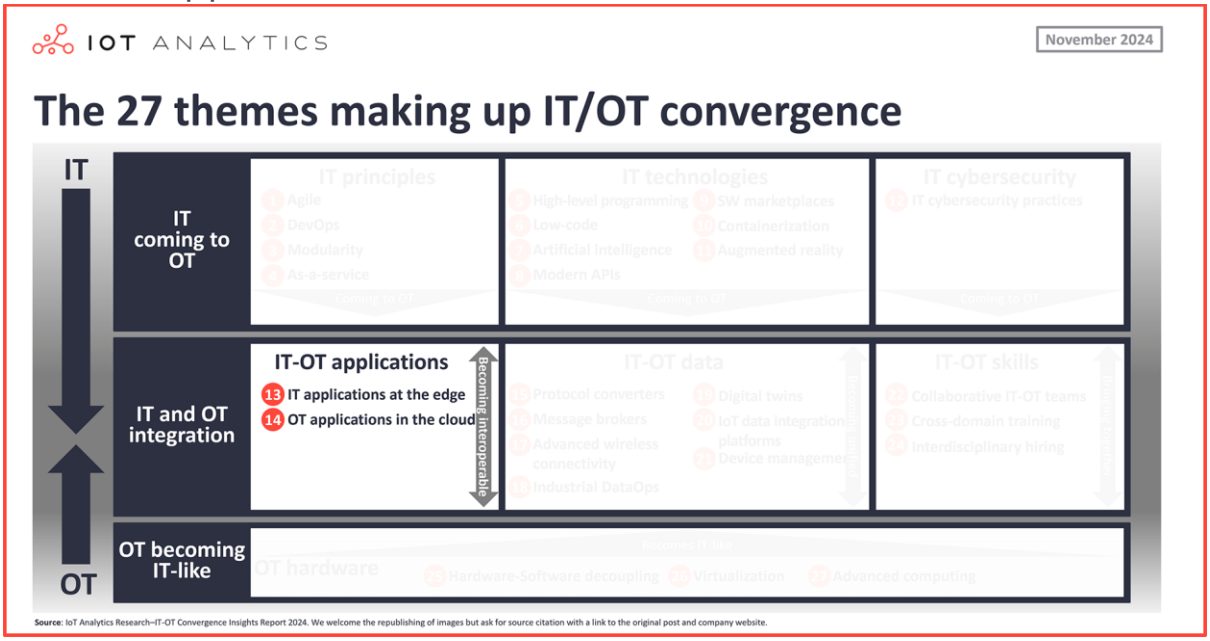
D. IT/OT applications



13. IT applications at the edge

Running IT applications at the edge moves workloads traditionally run on the cloud or corporate servers (e.g., Node-RED for low-code application development or VPNs or multi-factor authentication for enhanced security) to the factory floor (i.e., on industrial PCs and other industrial equipment). Moving IT workloads to the edge allows data to be processed closer to the source, which helps reduce latency and bandwidth usage and enables real-time data analysis and decision-making.

14. OT applications in the cloud

Taking a reverse approach from IT applications at the edge, many vendors are moving OT software solutions and tools (e.g., MES) to cloud platforms, often offering them as SaaS.

Example: In 2023, US-based industrial automation software company Inductive Automation released Ignition Cloud Edition, a cloud-optimized version of its popular SCADA platform, Ignition. It is a fully hosted enterprise offering available on the AWS and Azure marketplaces and focuses on leveraging cloud capabilities such as machine learning and business intelligence. Inductive Automation's goal in launching Ignition Cloud Edition was to create a hybrid architecture that connects one or more on-premises and edge gateways and sends information to a Cloud Edition gateway for enterprise-wide data aggregation and monitoring.

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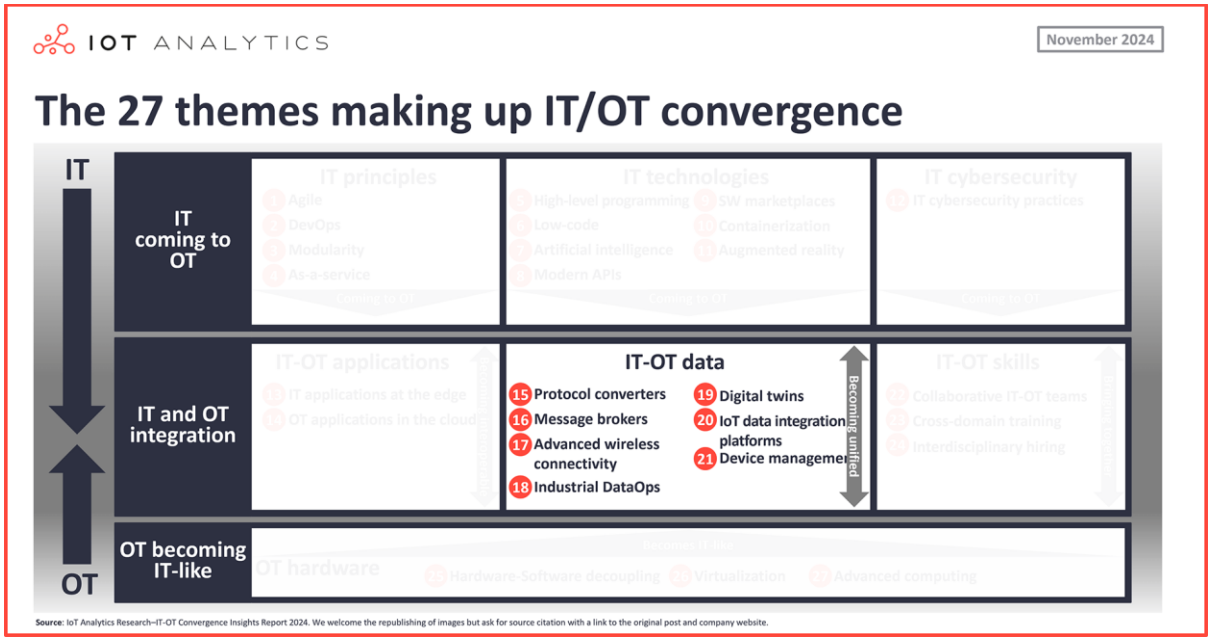
E. IT/OT data



15. Protocol converters

Protocol converters are devices or software applications that enable communication between different protocols (e.g., Modbus or OPC-UA) by translating data formats, communication rules, or syntax. Protocol converters allow for seamless data exchange between IT and OT systems, highlighting a unique form of convergence where OT data becomes accessible and actionable within the IT domain.

Example: Taiwan-based industrial computing solutions company Moxa's MGate 5105-MB-EIP translates between MODBUS RTU/TCP, Ethernet/IP, and MQTT protocols and facilitates communication between different industrial devices and cloud systems.

16. Message brokers

A message broker is an intermediary that allows OT/IoT data producers to publish topic-based messages containing the data. Multiple consumers (e.g., IT systems and even other OT systems) can subscribe to these topics, but it is increasingly common for IT systems to use message brokers to access OT data. MQTT brokers (e.g., HiveMQ) are becoming key to the data infrastructure connecting OT and IT systems.

17. Advanced wireless connectivity

Advanced wireless communication technologies, such as 5G and Wi-Fi 6/7, offer enhanced performance, greater efficiency, and improved capabilities compared to previous generations of these standards. These technologies offer more reliable OT networks with higher data rates and low latency—critical for unified IT-OT environments and real-time decision-making.

18. Industrial DataOps

Industrial DataOps aims to enhance data quality by providing structure and context for accurate, logical data representation, ensuring usability by downstream applications.

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DataOps enables deeper alignment between data producers (e.g., sensors, machines, SCADA) and consumers (e.g., various IT applications, analytics applications).

19. Digital twins

A digital twin is a virtual model replicating the behavior of an existing or potential real-world asset or system—or multiple systems. They abstract an asset's (OT) data, overlay them with data from IT systems, and enable both IT and OT to perform data-driven decision-making.

Note: IoT Analytics published a detailed market report about digital twins here: Digital Twin Market Report 2023-2027.

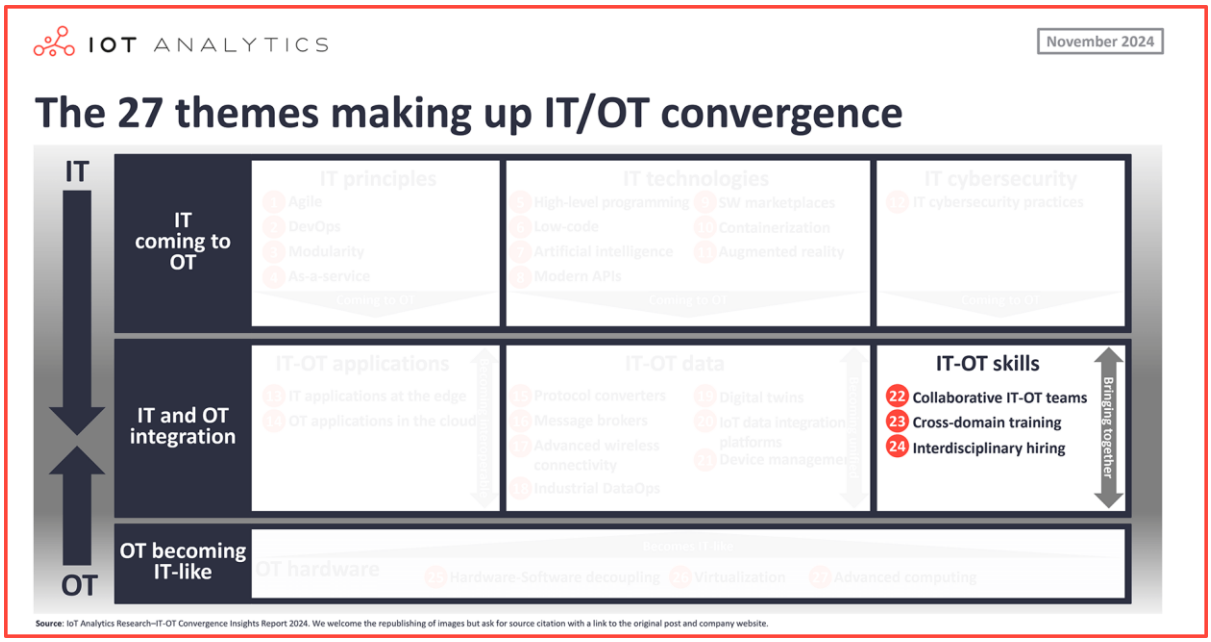
20. IoT data integration platforms

IoT data integration platforms facilitate the collection, processing, and unification of data from various IoT/OT devices and sensors across different networks, protocols, and formats to merge and store this data with IT data. These platforms aim to create a single source of truth for all IT and OT data.

21. Device management

Centralized device management is the process of overseeing, configuring, monitoring, and maintaining OT and IoT devices within a network or system. Historically, OT assets were managed on-premises, often managed with software provided by the same vendor who provided the asset, but there is an increasing movement toward cloud-based OT device management. Bringing IT-style centralized device management helps to reduce device management complexity and improve scalability.

F. IT/OT skills



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22. Collaborative IT/OT teams

Collaborative IT/OT teams are groups of IT and OT specialists working together toward a common goal, leveraging their diverse skills, knowledge, and perspectives.

Example: Japan-based automotive manufacturer Toyota's Toyota Production Engineering department consists of 4 key IT and OT roles: 1) IT software engineers, 2) R&D and automation engineers, 3) manufacturing processes experts, and 4) strategists.

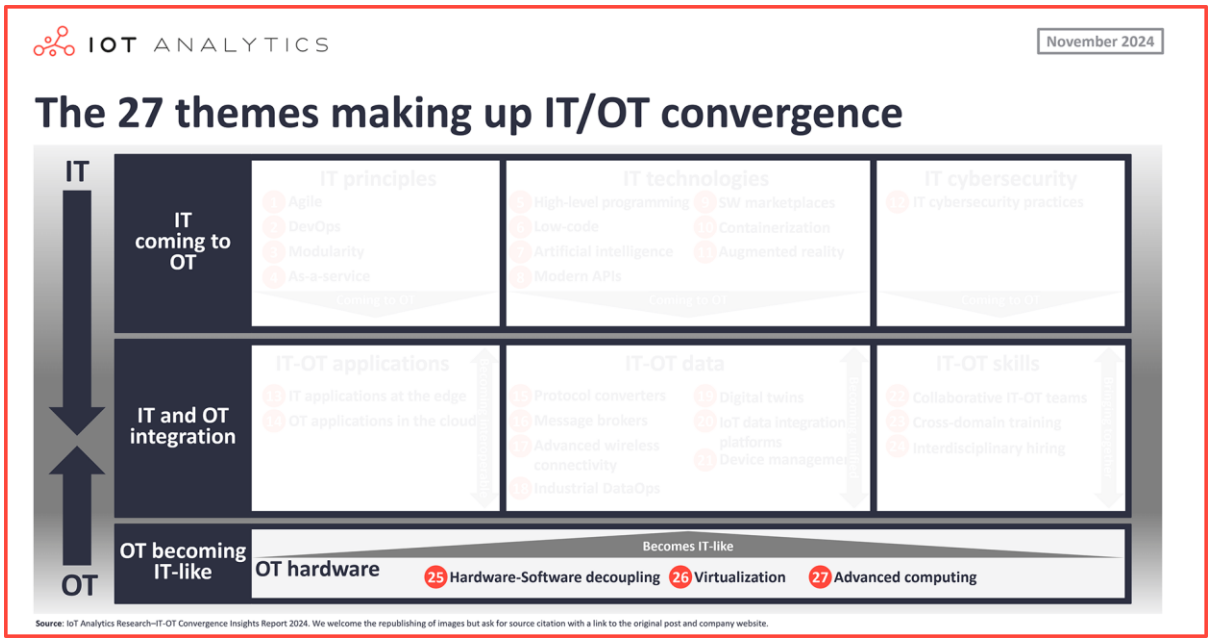
23. Cross-domain training

While a collaborative IT/OT team can bring varying skills together, cross-domain training helps individuals develop expertise that spans both IT and OT domains (e.g., an OT engineer learning data analytics).

24. Interdisciplinary hiring

Interdisciplinary hiring involves recruiting individuals whose expertise spans multiple academic or professional disciplines to help bridge IT/OT gaps (e.g., seeking a control systems engineer with Java and database skills).

G. OT hardware



25. Hardware–software decoupling

IT has long decoupled hardware and software so operating systems and applications can operate independently of hardware configurations. OT—which traditionally used software specifically designed for specific hardware (e.g., control logic only on controllers)—is adopting this approach, allowing for software deployment or updates without hardware changes. A prime example is the virtual PLC (vPLC), which enables control logic to run on general-purpose hardware, reducing the dependency on specialized, proprietary controllers.

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Note: IoT Analytics plans to publish an updated vPLC report in early December 2024. Those interested in accessing these reports when they are released can sign up for IoT Analytics' IoT Research Newsletter to receive updates on the release of these and other reports.

Sign up for Research Newsletter

26. Virtualization

Virtualization divides the hardware resources of a single computer (e.g., processors, memory, and storage) into multiple virtual computers (called virtual machines). Long used by IT to run multiple operating systems at once, virtualization in OT environments allows various virtual machines to run on a single physical system, improving efficiency and resource allocation (e.g., control logic and HMI/visualization in separate VMs on the same hardware).

27. Advanced computing

Advanced computing involves powerful processors often used in IT systems (e.g., advanced CPUs and GPUs) and allows OT systems to perform tasks that require a lot of processing power, such as edge AI capabilities.

Example: Germany-based automation company Beckhoff's C6043-0090 series IPC (an OT device slated for release in January 2025) is based on NVIDIA's RTX A4500 GPU and leverages 12th and 13th Gen Intel Core i5, i7, and i9 processors to run ultra-sophisticated applications, such as vision AI.

Analyst opinion on IT/OT convergence

IT influences OT a lot, but OT does not influence IT much. IT concepts and technologies heavily influence OT, with little reciprocal impact from OT on IT. Key IT-driven practices such as Agile/DevOps, modularity, and as-a-service models, technologies like containerization and virtualization, and concepts like marketplaces are becoming integral in the OT landscape. For example, Agile/DevOps enables faster development cycles and continuous delivery in industrial software development, while modularity introduces flexible, scalable architectures for OT systems. Additionally, OT is adopting high-level programming languages such as Python to enhance compatibility and deployment efficiency. Even in areas like cybersecurity, OT relies on established IT strategies to protect against evolving threats. This highlights the one-sided nature of influence, where OT increasingly adopts IT solutions without significant innovation flowing back into IT.

IT/OT convergence has steadily progressed throughout the years, although it remains a challenging endeavor. IT/OT convergence has been actively unfolding for years. However, despite progress, convergence remains challenging, especially for manufacturers. Key obstacles include the contrasting objectives of IT and OT teams: While IT prioritizes agility, scalability, and security, OT focuses on stability, reliability, and safety. Another major barrier is the presence of legacy OT systems (often with life cycles exceeding 20 years) that lack compatibility with modern IT tools/technologies, making

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integration difficult. These hurdles show why IT/OT convergence is easier said than done.

Data is the core of IT/OT convergence, while people bring it together. Data is at the heart of IT/OT convergence—the most valuable asset driving operational efficiency, decision-making, and innovation. Several convergence themes highlighted above and in the IT/OT Convergence Insights Report 2024 revolve around data collection, processing, and utilization. For example, industrial DataOps and IoT data integration platforms ensure seamless data flow between IT and OT environments, and digital twins rely heavily on real-time data to simulate, predict, and optimize physical processes.

Although data drives IT/OT convergence, the people (their interdisciplinary skills and collaboration) enable this transformation. A key factor in successful convergence is the creation of collaborative IT-OT teams, where professionals from both domains work together toward shared goals. This human element, the collaborative mindset and cross-functional expertise, binds the technical and operational aspects of IT/OT convergence, making people the glue of this transformation.

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About IoT Analytics

IoT Analytics, founded and operating out of Germany, is a leading global provider of market insights and strategic business intelligence for the IoT, AI, Cloud, Edge, and Industry 4.0.
Our key workstreams across the tech stack include IoT applications, IoT platforms and software, IoT connectivity and hardware, and industrial IoT.
We are trusted by 1000+ leading companies around the world for our market

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