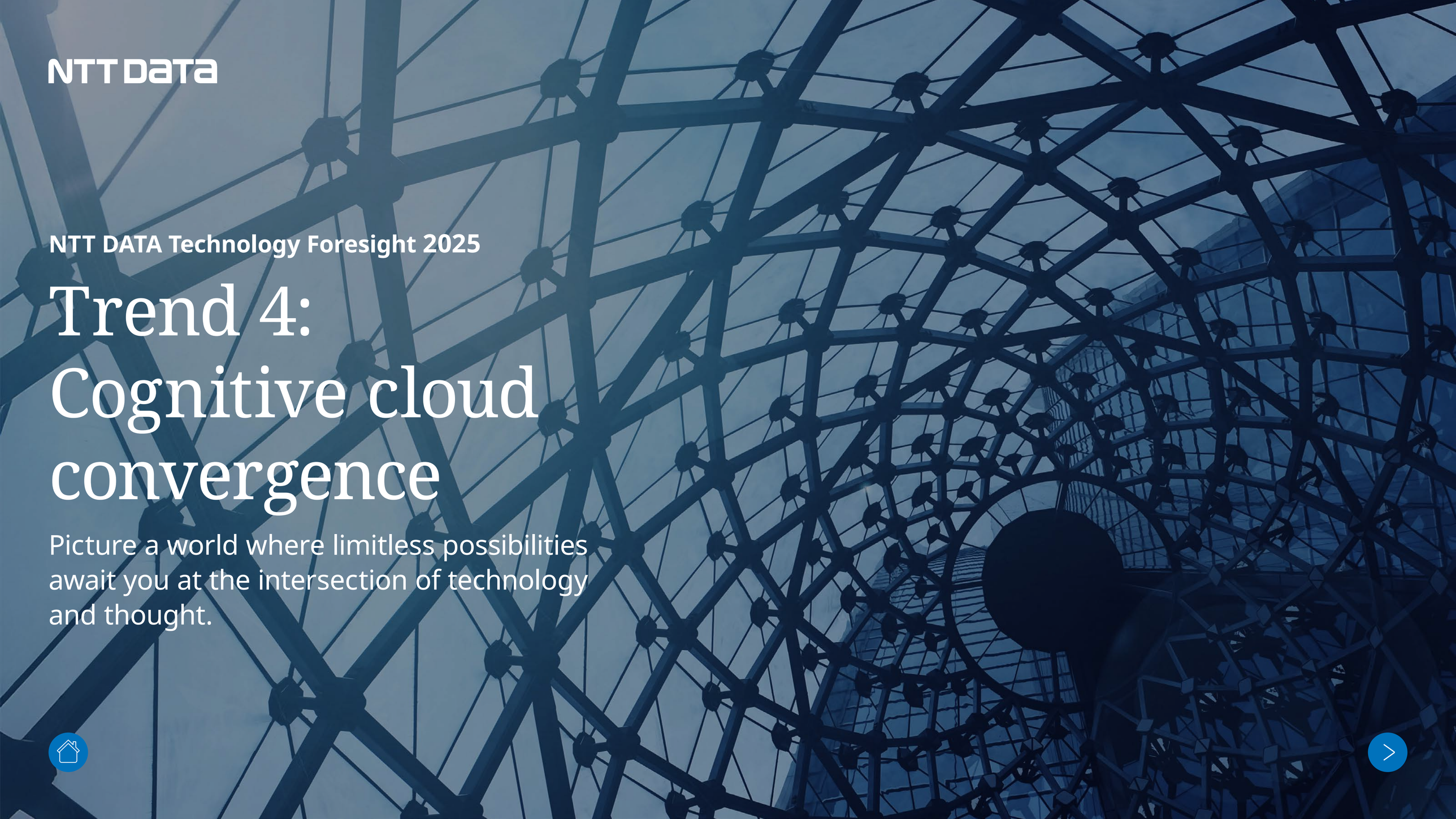


NTT DATA

NTT DATA Technology Foresight 2025

Trend 4: Cognitive cloud convergence

Picture a world where limitless possibilities await you at the intersection of technology and thought.

Contents

Introduction

Cognitive cloud convergence represents the seamless integration of advanced cloud computing technologies with AI and human cognitive abilities, empowering organizations to improve operations, enhance decision-making and derive deeper insights from their data in real time.

By using essential components such as AI-augmented software engineering, edge computing and artificial intelligence for IT operations (AIOps), organizations can streamline their operations, create personalized customer experiences and make informed decisions more effectively.

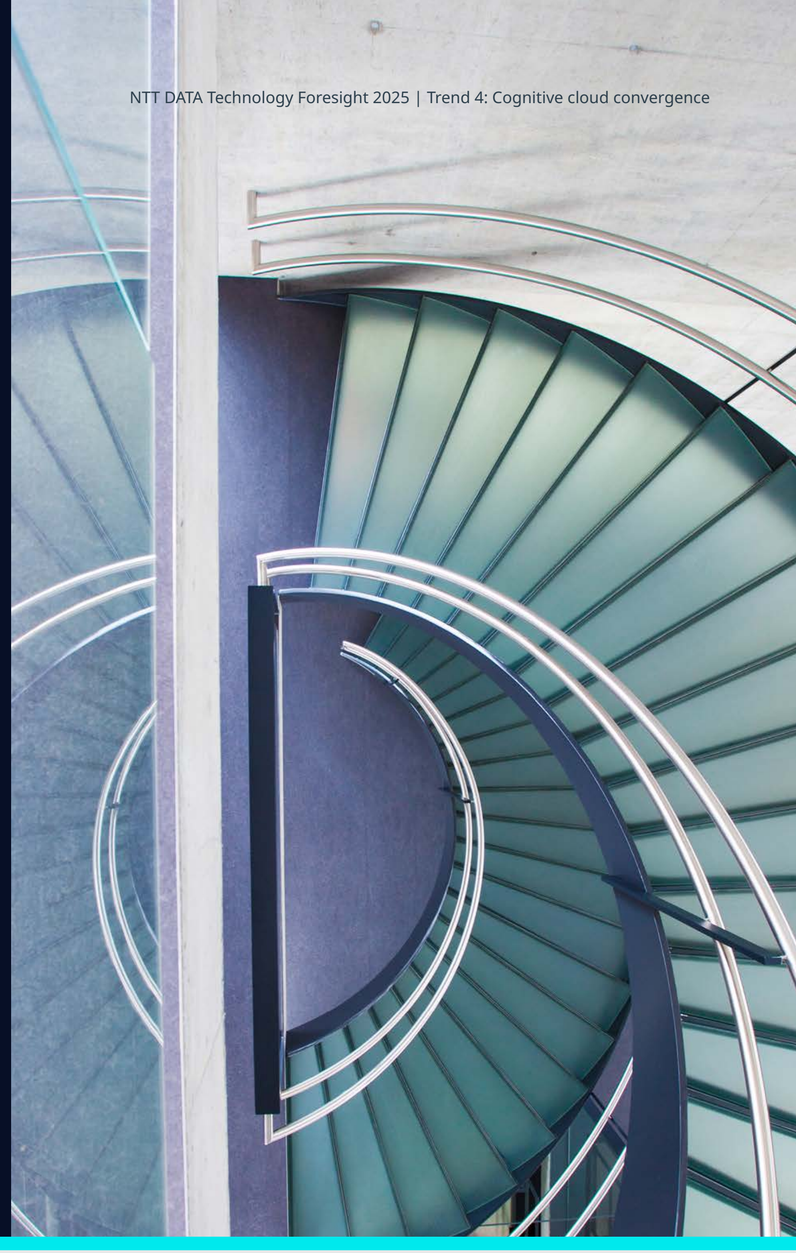
Significance and impact on business

This megatrend enables organizations to leverage data-driven insights and unlock unprecedented growth and operational efficiency. For example, they can apply predictive analytics to anticipate market trends and customer needs, which helps them prioritize strategic initiatives and gain a competitive edge.

Key drivers

A primary driver of this trend is the exponential increase in data generation. With global data volumes projected to reach 175 zettabytes by 2025, robust, intelligent cloud infrastructures are essential for effectively managing and extracting valuable insights from this vast reservoir of information.

However, cognitive cloud convergence presents several challenges that organizations must prepare to navigate. For example, data privacy and security concerns may arise due to the centralized nature of cloud systems, requiring stringent measures to protect sensitive information. Additionally, organizations may face integration complexities as they seek to unify disparate data sources and legacy systems within multiple cloud environments. Ongoing advancements in AI and cloud technology necessitate continual training and adaptation, which can strain resources and budgets. Addressing these challenges is essential for harnessing the full benefits of cognitive cloud convergence and maintaining a competitive advantage in today’s dynamic market landscape.



Technical explanation

Cognitive cloud convergence describes the intersection of AI and cloud technologies to enable smarter, more adaptive digital ecosystems. This trend is fueled by progress in cloud infrastructure, edge computing, IoT and automation. Organizations that successfully align these components will create seamless, optimized experiences that scale with demand. Key components include:

1. Cloud and AI convergence

This convergence brings AI processing closer to the data source, allowing for real-time analytics and decision-making. It enhances capabilities across industries by enabling smarter data management, predictive analytics and improved user personalization.

2. Advanced cloud infrastructure

Advanced cloud architectures support the scalability required for complex AI workloads. These infrastructures use multicloud and hybrid models to ensure agility, resilience and efficient resource allocation for continuous learning and adaptation.

3. Edge technologies and IoT

Edge computing and IoT devices are integral to reducing latency and improving data processing efficiency. By processing data locally, these technologies enable real-time responses, support remote operations and improve data security and privacy.

4. Automation and optimization

Automation within this framework leverages AI to streamline processes, optimize resource allocation and boost operational efficiency. This reduces human intervention, enabling a proactive and predictive approach to managing digital ecosystems.

> “Cognitive cloud convergence is the shift toward a unified, intelligent cloud environment where AI and cloud technologies intersect to simplify complex tasks, making processes more responsive, adaptable and resilient.

Technology

Containerization is a lightweight virtualization method that allows applications to run in isolated containers with their own code libraries and dependencies, ensuring consistency across environments. Docker is a common containerization technology.

Orchestration tools like Kubernetes automate the deployment, scaling and networking of containers, improving scalability, resource efficiency and development processes.

Edge computing platforms process data closer to the source, for example IoT devices or local edge servers. This minimizes latency and reduces bandwidth consumption, enabling features like real-time analytics, secure data transfer and support for different edge devices. Azure IoT Edge and AWS IoT Greengrass are popular technologies that improve application response time, support remote operations and strengthen data security by processing sensitive data locally.

Infrastructure as code automates IT infrastructure management through code, ensuring consistent and predictable setup and configuration. This allows developers to apply version control, repeatability and collaboration to infrastructure in the same way they do to application code. Tools such as Terraform, AWS CloudFormation and Ansible improve efficiency, reduce configuration drift and enable IT teams to rapidly scale or replicate environments.

AI and machine learning (ML) services are cloud-based platforms for building, deploying and managing AI models, including data preparation, training, deployment and monitoring. For example, Amazon SageMaker and Azure Machine Learning offer prebuilt algorithms, automated machine learning (AutoML) and cloud integration. These services simplify AI implementation and streamline model lifecycle management.

Business explanation

The integration of cognitive technologies with cloud infrastructure marks a new era of digital transformation. This convergence enables organizations to leverage vast amounts of data and process it with exceptional speed and intelligence to generate actionable insights in real time. Adopting these technologies gives organizations a means to optimize their operational frameworks and accelerate the processes that support innovation.

Cognitive cloud convergence improves operational efficiency through improved data processing, automated workflows and intelligent decision-making. By using advanced analytics, organizations can streamline internal processes and resource allocation and enrich team collaboration. As a result, they are better positioned to anticipate operational needs, proactively address potential challenges and foster agility and continuous improvement, ultimately driving sustainable success.

Key advantages of this shift include:

Automated decision-making

Cognitive cloud convergence enables data-driven decision-making at scale, allowing organizations to make informed decisions across operations.

Better resource allocation

AI-driven models improve efficiency and cost-effectiveness in resource management, from inventory to human resources.

Enhanced cybersecurity

Integrating cognitive technologies with cloud infrastructure strengthens threat detection and response systems.

Accelerated innovation

Cloud-based cognitive services facilitate rapid prototyping and deployment, reducing time to market and fostering continuous innovation.

Underlying concepts

Underlying concepts

Cognitive cloud convergence represents a fundamental shift in how organizations apply technology to improve their operations. Core components include the fusion of AI and cloud computing, advanced infrastructure management, the integration of edge technologies and IoT, and process automation.

By understanding and embracing these interconnected elements, organizations can inspire innovation, optimize workflows and achieve a deeper understanding of their data in real time.

Cognitive cloud convergence

Cloud and AI convergence

- Automation and continuous improvement
- AI-managed cloud workloads
- Edge intelligence and IoT integration
- Intelligent operations and management
- Cloud and AI oversight

Advanced cloud infrastructure

- Cloud-native
- Multicloud administration
- Next-generation computing
- Serverless computing
- Software-defined infrastructure

Edge technologies and IoT

- Localized AI processing
- Hybrid computing model
- Connected-device solutions
- Smart manufacturing connectivity
- On-device intelligence

Automation and optimization

- Continuous delivery (DevSecOps)
- Network management automation
- Machine learning operations (MLOps)
- Cross-functional process integration (XOps)
- Smart infrastructure

Figure 1: Cognitive cloud convergence — underlying concepts and supporting trends

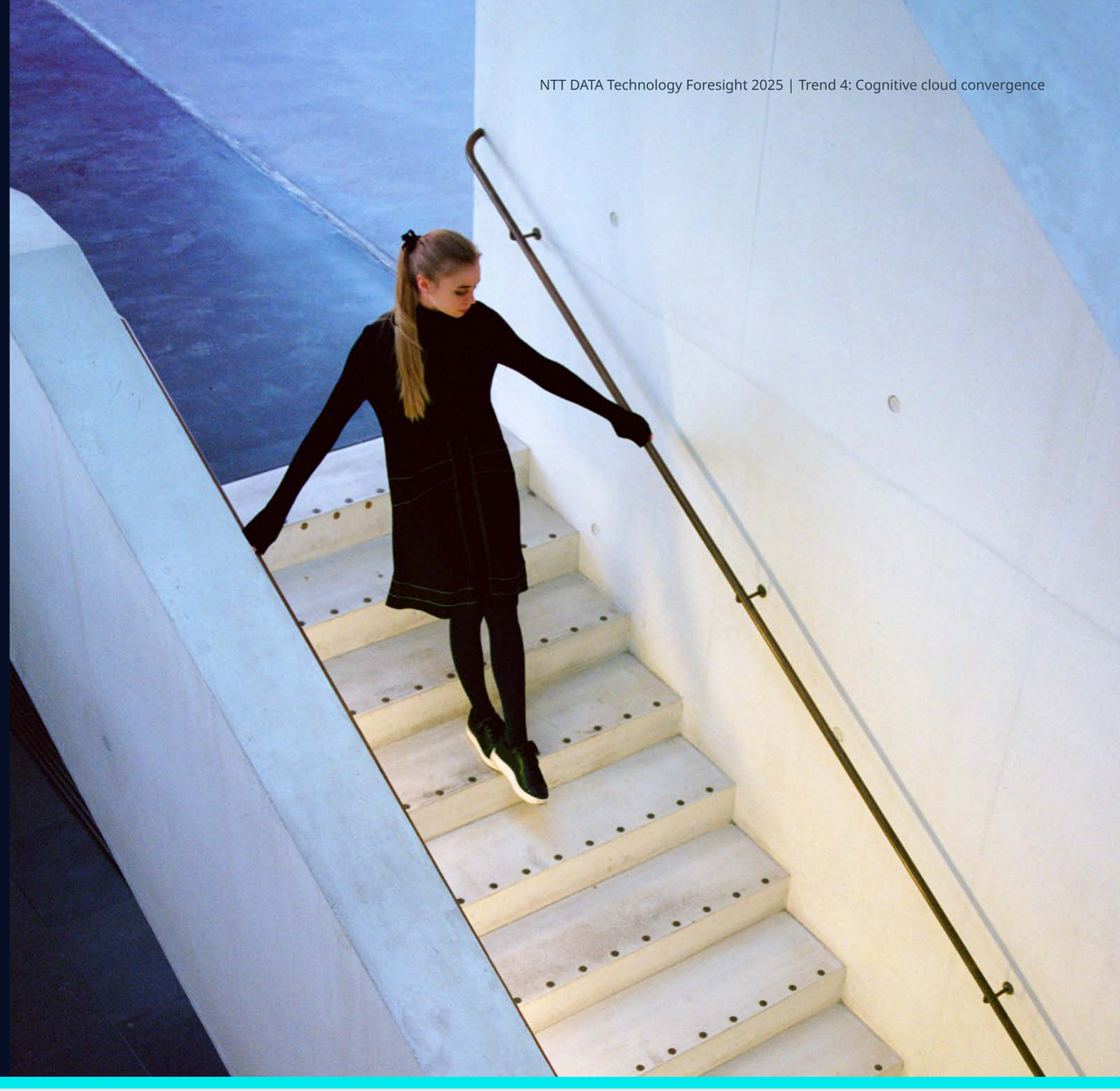
Underlying concepts

Cloud and AI convergence

Cloud and AI convergence represents a transformative shift in which cloud computing and AI integrate to create intelligent, scalable solutions. This convergence enhances decision-making, accelerates innovation and streamlines operations through advanced analytics and automation.

A key development is the integration of infrastructure for traditional transactional and AI workloads, enabling streamlined operations and improved efficiency for AI applications.

> “GenAI in cloud services, AI-augmented software engineering and operational AI systems act as transformation enablers, giving organizations a competitive edge in an evolving digital economy.



Automation and continuous improvement

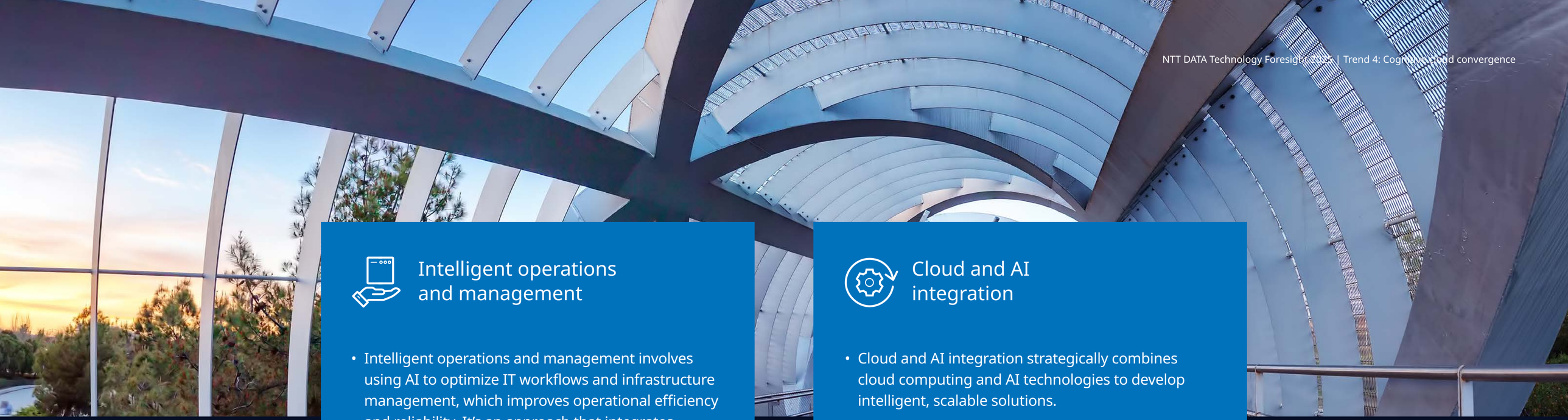
- Automation and continuous improvement encompass managed AI workloads and GenAI for edge. The goal is to enhance efficiency through AI-driven automation and edge computing. This approach streamlines operations and continuously refines AI models.
- For example, manufacturers can leverage locally managed AI workloads to predict equipment failures, while GenAI for edge enables real-time quality control. These technologies help organizations boost productivity and reduce downtime, leading to cost savings and improved competitiveness.

AI-managed cloud workloads

- Advanced cloud infrastructure and AIOps use AI and ML to enhance and automate IT operations within cloud environments. This approach improves system reliability and efficiency by leveraging data analytics for predictive insights.
- For example, cloud providers like Amazon Web Services (AWS) offer AIOps tools that automatically identify and resolve infrastructure issues, minimizing downtime. These technologies help organizations optimize resource allocation and reduce operational costs, leading to improved customer satisfaction.

Edge intelligence and IoT integration

- Edge intelligence and IoT integration, also known as operational AI systems, involves deploying AI at the network's edge to process data generated by IoT devices, in real time. This approach enables faster decision-making and reduced latency, making it ideal for applications that require immediate responses.
- For example, smart-home devices like Amazon Echo use edge AI to process voice commands locally, resulting in faster responses and greater privacy. They give customers a more responsive and secure smart-home experience while protecting the privacy of their personal data.



Intelligent operations and management

- Intelligent operations and management involves using AI to optimize IT workflows and infrastructure management, which improves operational efficiency and reliability. It's an approach that integrates advanced analytics and automation into the lifecycle of IT systems, enabling proactive monitoring, anomaly detection and predictive maintenance.
- AI-powered tools, such as intelligent assistants, streamline processes by automating repetitive tasks like system configuration, incident resolution and performance tuning. These capabilities reduce downtime, minimize human error and ensure smoother operations, allowing organizations to focus on innovation and strategic goals.

Cloud and AI integration

- Cloud and AI integration strategically combines cloud computing and AI technologies to develop intelligent, scalable solutions.
- This integration allows organizations to draw on extensive computational resources and analytical capabilities to support better data processing, decision-making and innovation, across industries.
- Streaming services like Netflix use these technologies to deliver personalized content recommendations by analyzing user data stored in the cloud. Tailored suggestions keep viewers engaged and improve customer retention.

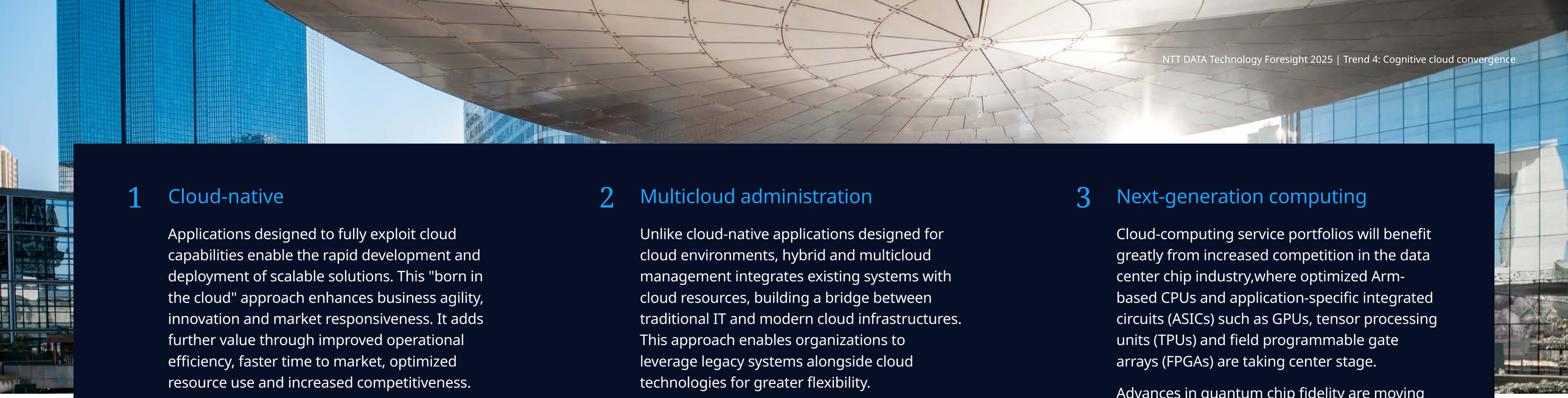
Underlying concepts

Advanced cloud infrastructure

As they explore advances in cloud infrastructure, organizations must prioritize:

- **Governance** for compliance and risk management
- **Cost optimization** for resource efficiency
- **Operational agility** for scalability
- **Business continuity** to minimize downtime
- **Skills development** for an effective workforce
- **Vendor management** for enhanced service delivery
- **Robust security measures** for data protection

> These elements are essential for aligning the use of cloud technology with strategic goals, fueling innovation, improving service quality and delivering better user experiences.



1 Cloud-native

Applications designed to fully exploit cloud capabilities enable the rapid development and deployment of scalable solutions. This "born in the cloud" approach enhances business agility, innovation and market responsiveness. It adds further value through improved operational efficiency, faster time to market, optimized resource use and increased competitiveness.

Companies like Netflix, Uber and Airbnb exemplify successful cloud-native adoption. By embracing this approach, they've achieved digital flexibility, scaled efficiently and rapidly adapted to market demands. And they’ve built and maintained a competitive edge through improved user experiences and quick product iterations.

2 Multicloud administration

Unlike cloud-native applications designed for cloud environments, hybrid and multicloud management integrates existing systems with cloud resources, building a bridge between traditional IT and modern cloud infrastructures. This approach enables organizations to leverage legacy systems alongside cloud technologies for greater flexibility.

Unified cloud management streamlines operations by centralizing and integrating management processes across different IT environments. It simplifies complexities, enhances visibility and maximizes the scalability and efficiency of cloud technologies.

3 Next-generation computing

Cloud-computing service portfolios will benefit greatly from increased competition in the data center chip industry,where optimized Arm-based CPUs and application-specific integrated circuits (ASICs) such as GPUs, tensor processing units (TPUs) and field programmable gate arrays (FPGAs) are taking center stage.

Advances in quantum chip fidelity are moving quantum computing out of the lab and into the business mainstream. This likely won’t be the result of increased hardware investments but rather the growing sophistication of cloud services environments where quantum and quantum-inspired chips offer users more application-specific options.

Organizations should continually monitor data center chip technologies, evaluate their potential and understandt he internal transformations required to benefit from them fully.

4 Serverless computing

This approach dynamically allocates resources to execute specific tasks, abstracting away the need for infrastructure management. This approach automatically scales with demand, processes data efficiently and charges based on usage, making it highly cost-effective.

While it doesn't directly reduce latency (since processing still depends on the underlying infrastructure), its adaptability and efficiency make it ideal for applications requiring scalable and responsive systems.

For example, in healthcare, serverless computing enables the real-time processing of vital signs collected from wearable devices. Instantly analyzing and transmitting data gives healthcare providers timely updates, improves patient care, reduces emergency response times and drives better health outcomes.

5 Software-defined infrastructure

Programmable infrastructure refers to the provisioning and management of IT resources through software rather than manual configuration, allowing for greater automation and flexibility. This approach enables organizations to quickly adapt their infrastructure to changing needs and streamline operations.

Programmable infrastructure can significantly reduce deployment times, allowing organizations to implement changes in minutes instead of days, accelerating innovation and increasing responsiveness to market demands.

Underlying concepts

Edge technologies and IoT

Processing data near its source significantly reduces latency and enables real-time decision-making. For example, it enhances the performance of applications used in autonomous vehicles and smart cities, where immediate responses are crucial for functionality and user experience.

Programmable infrastructure enables dynamic resource allocation and automation, allowing organizations to adapt to changing demands and optimize performance quickly.

> This flexibility is especially crucial in rapidly evolving environments, such as 5G networks, where traditional configurations would be inadequate.

On-device intelligence

- This trend focuses on deploying AI directly on edge devices, enabling real-time data processing and decision-making without relying on cloud connectivity. By reducing latency and bandwidth usage, on-device intelligence enhances performance across various applications, particularly healthcare and autonomous systems.
- Companies like NVIDIA enable real-time processing of data on devices like drones and cameras. Users can receive immediate insights and take action without relying on cloud connectivity.

Smart manufacturing connectivity

- Integrating IoT technologies into industrial settings enables smarter manufacturing processes through real-time monitoring and analytics. This connectivity improves operational efficiency, predictive maintenance and resource management, ultimately leading to cost savings and increased productivity.
- With IoT technology, manufacturers can monitor their equipment in real time and perform predictive maintenance. This reduces downtime and improves product quality.

Connected-device solutions

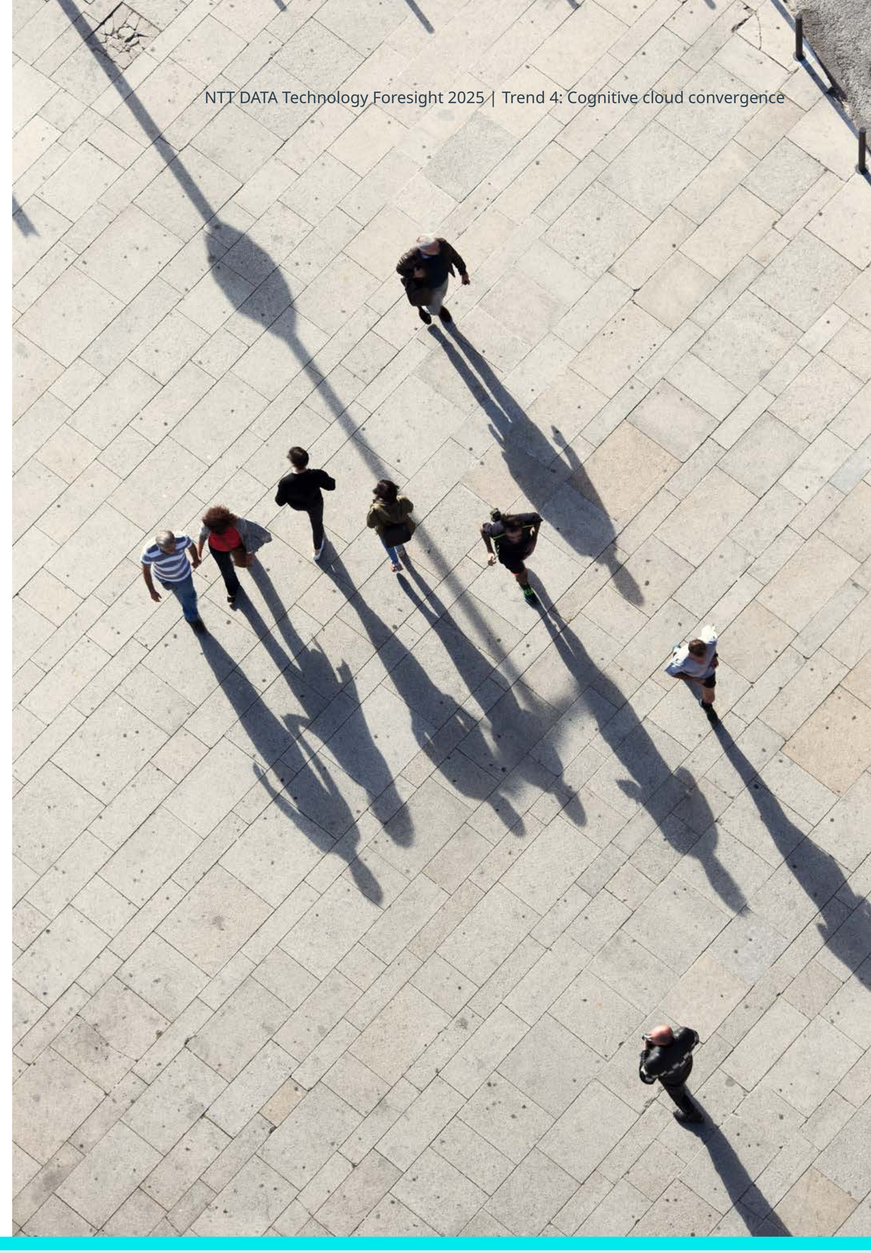
- These applications leverage IoT devices to enhance functionalities in everyday settings, such as smart homes and connected vehicles. They enable users to interact with their environments more intelligently, offering automation and improved user experiences through data-driven insights.
- Modern health devices like continuous glucose monitors (CGMs) and wearables such as the Oura Ring exemplify this integration. Both employ a three-tier architecture: a device collects real-time data, a smartphone app displays and analyzes this information, and cloud services provide advanced insights and long-term trend analysis. This seamless system empowers users to monitor their health, receive actionable recommendations and share data with healthcare providers. The results include more proactive care and healthier lifestyles.

Hybrid computing model

- Edge-to-cloud combines the benefits of edge computing with cloud capabilities, allowing for a hybrid model where data is processed locally at the edge before being sent to the cloud for further analysis or storage. It optimizes resource use, improves security and provides scalability for businesses.
- In the healthcare industry, processing sensitive patient data locally while using cloud capabilities enhances security and compliance, ensuring better protection of personal health information.

Localized AI processing

- The shift of AI workloads from centralized cloud systems to localized environments, such as micro data centers or on-device processing, enables faster response times and improved privacy. This trend supports the growing demand for efficient data handling in applications that require immediate feedback, such as autonomous vehicles and smart manufacturing systems.
- For example, Tesla uses localized AI processing in its vehicles for features like autopilot, enabling quick decision-making for safety and efficiency while driving, which improves the overall user experience.



Underlying concepts

Automation and optimization

When discussing process improvement, it’s essential to consider the impact on operational efficiency, cost reduction and employee satisfaction. Streamlining processes enhances productivity and allows teams to focus on higher-value tasks, ultimately driving innovation and improving overall business performance.

The trends and technologies we cover in this section collectively enable organizations to streamline processes, minimize human error and adapt quickly to market demands.

> “ This helps them unlock opportunities for innovation and maintain a competitive edge in an increasingly digital landscape.

Continuous delivery or development, security and operations (DevSecOps)

- This process describes the seamless integration and delivery of software updates that allow teams to release new features and fixes rapidly. By automating testing and deployment, organizations can respond to user feedback faster, which enhances customer satisfaction.
- Security is integrated throughout the development lifecycle, ensuring the appropriate measures are implemented early and continuously. This reduces vulnerabilities and builds trust in the software.
- With frequent software updates, organizations can respond to customers' feedback faster and increase their satisfaction and loyalty by continuously improving their experiences.

Network management automation

- As organizations adopt hybrid and multicloud environments, network topologies become increasingly complex, necessitating more sophisticated management strategies. Streamlining the configuration and oversight of network devices improves efficiency and reduces operational costs. This approach also minimizes human error and ensures consistent network performance.
- By automating network configurations, organizations can further decrease operational expenses and bolster service reliability, enhancing customer satisfaction and trust.

Machine learning operations (MLOps)

- Establishing a framework for managing ML models facilitates smoother collaboration between data scientists and IT operations teams. This integration allows businesses to deploy models faster and ensure they remain effective over time, ultimately improving decision-making processes.
- By establishing efficient management frameworks for ML, organizations can leverage data insights more effectively and create personalized experiences that boost customer engagement and retention.

Cross-functional operations (XOps)

- This approach fosters collaboration across various departments, breaks down silos and enhances communication. By aligning operations, development and support teams, organizations can become more agile and responsive to market changes.
- Players in the automotive industry are implementing collaborative platforms that enable design, engineering and production teams to work together seamlessly, resulting in faster product development cycles and improved vehicle quality.

Smart infrastructure

- Implementing intelligent systems improves resource utilization and operational efficiency by leveraging data analytics for proactive management. This capability lowers costs, improves service delivery and benefits users through enhanced reliability and performance.
- In the building management sector, firms that adopt intelligent infrastructure solutions can achieve significant energy savings and operational efficiencies. This helps them meet sustainability goals and improve tenant comfort and safety.

Tech radar

Tech radar

In the constantly changing tech landscape, keeping up with the latest developments is essential, not just advantageous.

Continually analyzing technology trends and tracking their evolution will help you anticipate changes and prepare yourself for upcoming shifts.

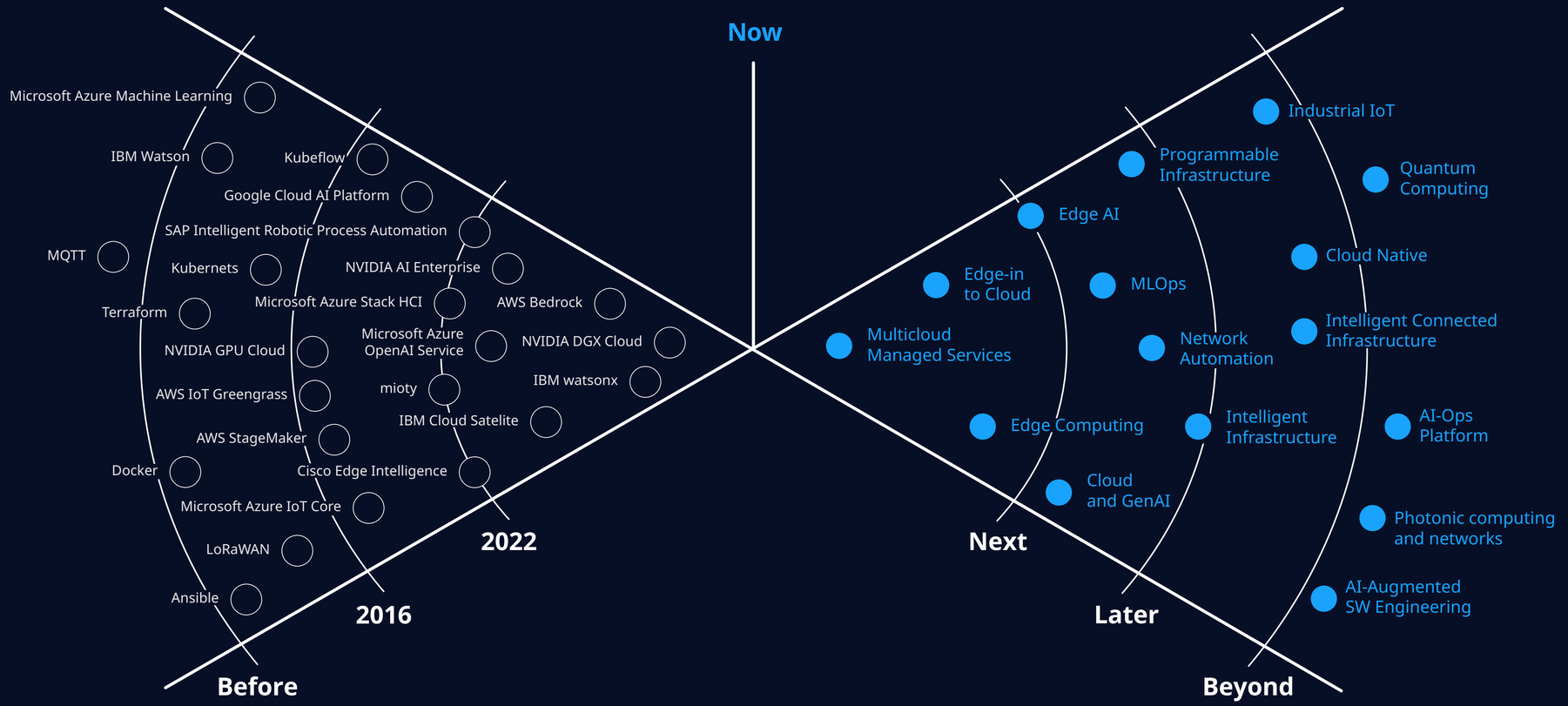


Figure 2: Tech radar — past and future technology

Future tech: now and next

A **Multicloud managed services**
A centralized platform manages resources from multiple cloud providers, integrating and governing them for better control and reduced complexity. This enables the unified management of public and private cloud resources, simplifies provisioning, orchestration and monitoring, and enhances database security across different cloud providers by managing access, tracking interactions, detecting vulnerabilities and addressing security and compliance requirements.

B **Edge-to-cloud**
This architecture is designed to enable edge systems to function independently from the cloud but still connect to it when needed. It prioritizes functionality at the edge, allowing for flexible deployment and responsiveness even if cloud connectivity is temporarily unavailable.

C **Edge computing**
Edge computing places data processing and storage closer to where data is generated, minimizing the need to send information to centralized data centers. This approach reduces latency and bandwidth usage, offering a practical solution for applications that require real-time responses, such as IoT deployments.

D **Edge AI**
Edge AI brings AI capabilities closer to the user in devices such as IoT devices and gateways. Local data-processing reduces latency and improves real-time responsiveness, making edge AI suitable for applications like autonomous vehicles and smart devices.

E **Cloud and GenAI**
GenAI in the cloud draws on the scalability and flexibility of cloud infrastructure to create new content, designs and strategies based on existing data. This supports innovation across various sectors, enhancing automation, content creation and complex problem-solving processes.

F **MLOps**
MLOps manages the lifecycle of ML models, including model deployment, monitoring and updates. Maintaining model performance and ensuring compliance makes ML applications easier to operate at scale.

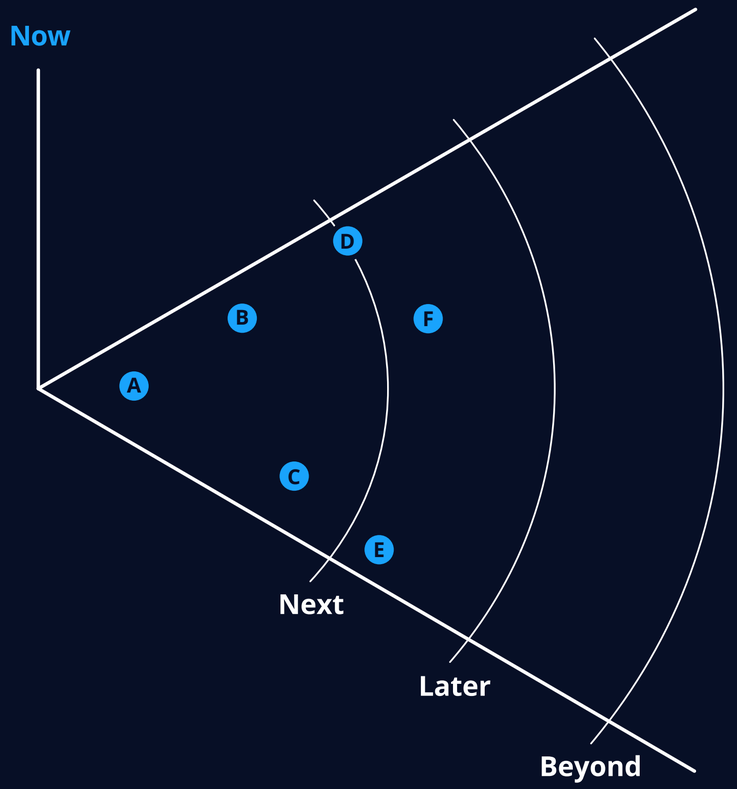


Figure 3a: Tech radar — future technology

Future tech: next and later

G **Programmable infrastructure**
Programmable infrastructure applies principles from software development to IT infrastructure, allowing for greater agility and resilience. APIs and automated processes enable the flexible and responsive management of resources and align infrastructure with modern application needs.

H **Network automation**
Network automation tools handle the setup, management and maintenance of network devices, reducing the need for manual intervention. By automating tasks like configuration, troubleshooting and reporting, these tools help improve network efficiency and reliability.

I **Intelligent infrastructure**
Intelligent infrastructure integrates AI and ML to manage resources dynamically. This approach optimizes the configuration of infrastructure components, making them adaptive and efficient. It's particularly valuable for supporting applications in complex, cloud-based environments.

J **Industrial IoT**
Industrial IoT, a specialized segment within IoT, enhances decision-making and boosts organizations' ability to monitor and control assets and infrastructure in industries like manufacturing, logistics and utilities. It integrates connected devices to improve operational visibility and efficiency in environments where managing physical assets closely is crucial.

K **Cloud-native**
Cloud-native refers to applications and services designed to capitalize on the flexibility and scalability of cloud technology. These solutions are dynamic, scalable and resilient and offer efficient, on-demand resources metered by usage and accessible through internet-based technologies.

L **Intelligent connected infrastructure**
This infrastructure setup connects various technologies to enable seamless data exchange between the systems, people and devices in an ecosystem. It's especially relevant in industries like transportation, where data flow among vehicles, equipment and technicians is essential for smooth operations.

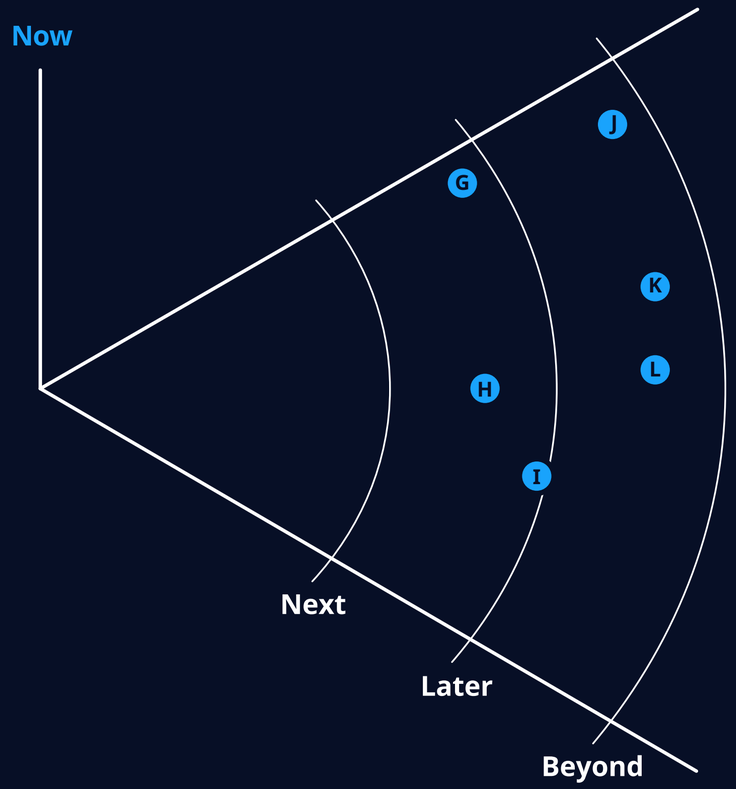


Figure 3b: Tech radar — future technology

Future tech: beyond

M **Quantum computing**

Quantum computing applies the principles of quantum mechanics to perform computations at unprecedented speeds, solving complex problems infeasible for classical computers. This revolutionary technology uses qubits, which can represent multiple states simultaneously through superposition and entanglement, allowing for massive parallelism and faster problem-solving capabilities.

N **AIOps platforms**

AIOps platforms apply AI to streamline IT operations by analyzing telemetry data across multiple sources. They identify patterns, predict issues and suggest possible fixes, ultimately enhancing automation and reducing the workload associated with incident management.

O **Photonic computing and networks**

Photonic computing uses light to process data, enabling faster speeds and lower energy consumption than traditional electronic computing. This approach leverages photons' high bandwidth and fast transmission capabilities, resulting in reduced latency and improved performance. Photonic networks enhance data transmission and routing, benefiting areas such as AI, big data analytics and high-performance computing.

P **AI-augmented software engineering (AIASE)**

AIASE uses AI technologies like ML and NLP to help software teams create applications faster, with less effort and with higher quality.

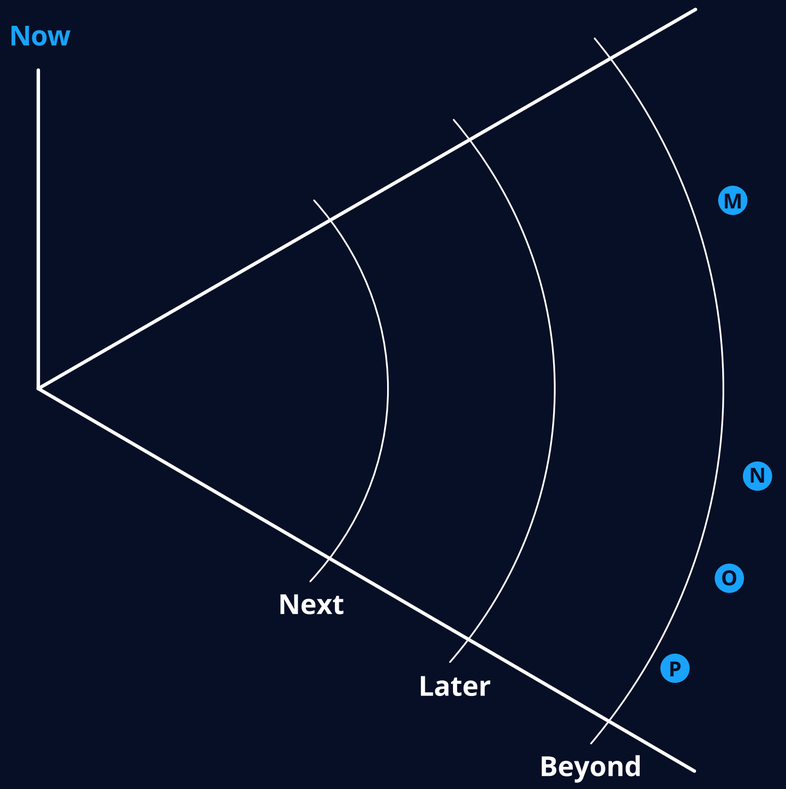


Figure 3c: Tech radar — future technology

R&D highlight

R&D highlight

Space Integrated Computing Network

NTT and SKY Perfect JSAT lead the Space Integrated Computing Network (SICN) through their joint venture, Space Compass.

This initiative aims to develop a sustainable, efficient space-based communications infrastructure to ease the strain on current terrestrial networks and mitigate risks posed by natural disasters and failures.

Using Innovative Optical and Wireless Network (IOWN) technology, the SICN plans to create high-speed optical wireless communication networks in space, supported by stratospheric cellular networks. This facility is designed to advance beyond 5G/6G mobile networks, using high-altitude platform stations and low Earth orbit satellites for real-time data collection and analysis.

The SICN will establish space-based data centers to speed the transmission and processing of imagery and environmental data. Geostationary satellites will reduce latency and improve by tracking of extreme weather events. Combining IoT sensors on Earth with optical data relays in space will enable rapid data analysis for multiple applications.

Innovations in optical technology will dramatically improve data communication speeds while significantly reducing energy consumption by using solar power for operations. The SICN aims to eliminate network interruptions and extend mobile coverage to remote areas. Initial trials began in 2023, with end-to-end implementation planned for 2025, ushering in a new era of sustainable and resilient telecommunications.

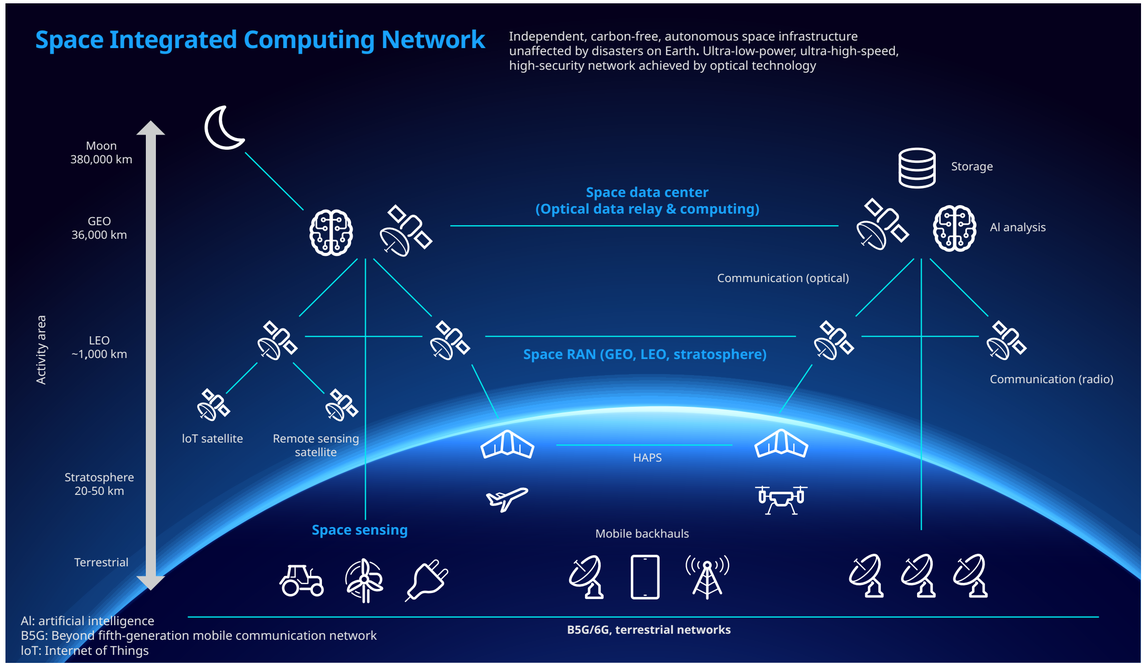


Figure 4: Space Integrated Computing Network

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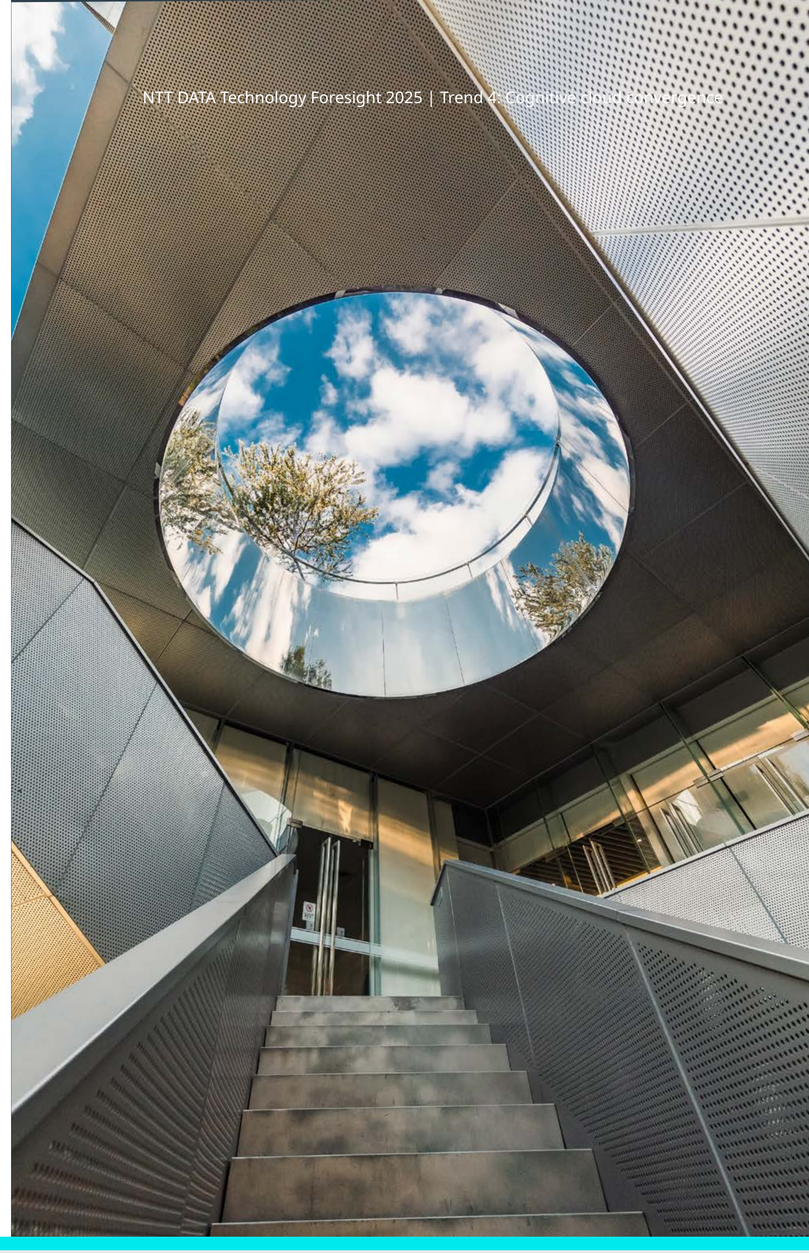


Quantification

Relevant financials

Cognitive cloud convergence market

Market size, 2024:

$70.5 billion

Market size growth, 2023–2024 (YoY):

+23%

Forecast CAGR, 2024–2030:

22.4%

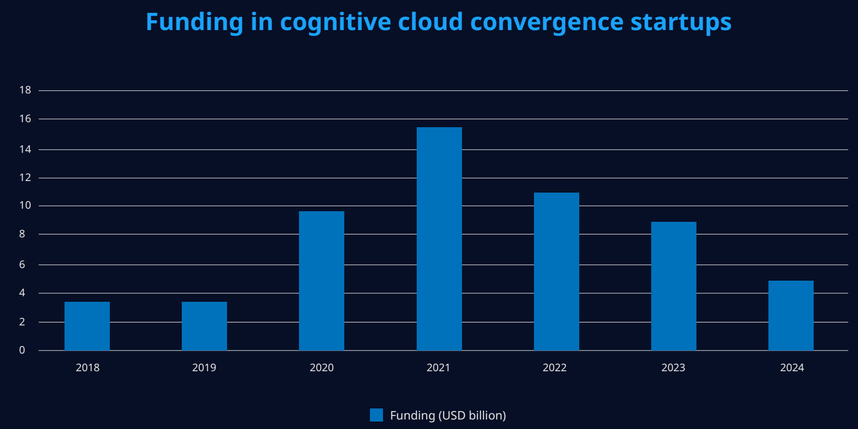


Figure 5: Funding in cognitive cloud convergence startups

> The number of large organizations with a multicloud strategy rose from 76% to 85% during 2024.

Key projections and impacts

In 2024

55%

of workloads operated within data centers, while **45% operated within clouds.**

By 2025

75%

of enterprise-generated data is expected to be created and processed outside a traditional centralized data center or cloud.

Cloud computing sales are forecast to reach **$2 trillion by 2030,** with generative AI accounting for about

10% to 15%

of this spending.

AI platforms in the platform-as-a-service (PaaS) category are projected to experience the fastest growth with a five-year CAGR of

51.1%

Over the next five years, AI lifecycle workloads are expected to grow at an

18.8%

CAGR, making them one of the fastest-growing workload categories.

Edge AI helps smart-grid energy-management agencies reduce energy losses by

25%,

according to the International Energy Agency.

Research and development

7,000*

Patents registered 2023

*Approximate figures

Use cases

Smart agriculture

Industry: **Agriculture**

Precision agriculture is a leading solution for achieving higher crop yields while reducing chemical usage. Unlike traditional, reactive methods that rely on generalized, experience-based practices, precision agriculture uses data-driven approaches to optimize each step in crop management.

Business value

1 Enhanced operations through seamless monitoring and complete lifecycle management of various crop inputs, such as fertilizers and pesticides, by fully automated, cost-effective systems

> “Cloud-enabled precision farming boosts crop yields while minimizing chemical use, delivering sustainable food production.

Digital immune systems for supply chains

Industry: **Cross-industry; manufacturing**

A consortium of manufacturers, logistics providers and retailers are implementing a digital immune system to enhance the resilience and stability of their interconnected supply chain networks, enabling real-time threat detection, automated recovery from disruptions and continuous optimization of operations across industries.

Business value

1 Operational excellence by improving product availability and delivery reliability for customers while lowering operational costs for businesses

2 Risk mitigation by reducing the impact of supply chain disruptions to ensure business continuity and customer trust

Quantum-powered drug discovery

Industry: **Pharmaceuticals**

Pharmaceutical companies and materials scientists are collaborating to use cloud-based quantum computing to simulate complex molecular interactions, accelerating drug discovery and optimizing new materials without investing in expensive quantum hardware.

Business value

1. Cost-efficiency by accessing quantum capabilities without significant upfront investment, reducing financial barriers to innovation
2. Accelerated R&D with quantum algorithms, potentially leading to faster breakthroughs in drug development and materials science

> “Cloud-based quantum simulations accelerate drug development, reducing costs and enhancing patient outcomes.

AI-powered network optimization

Industry: **Telecommunications**

A telecom provider is implementing AI to optimize network operations and enhance the user experience. The system automates management tasks, predicts outages and dynamically adjusts radio access operations based on real-time data.

Business value

1. Reduction in manual network-management tasks through AI-driven automation
2. Decrease in customer-reported issues due to improved network reliability

Smart cities

Industry: **Public sector; energy and utilities**

To enhance citizens' safety, cities are using real-time data from closed-circuit television (CCTV) and sensors (for example, noise, pollution and temperature readings) to monitor city activity, analyze demand changes, identify emergencies and generate insights (such as linking traffic with pollution). Sensors may be stationary or mobile (for example, on public transport).

Business value

1. Edge processing reduces latency and operating costs by eliminating the need to stream all video to a central cloud
2. The cognitive cloud autonomously manages the edge-to-cloud infrastructure, improving citizen services while minimizing waste in energy, processing capacity and resources

> "Cloud-integrated retail systems enhance customer satisfaction with frictionless self-checkout and 24x7 operations.

Autonomous retail

Industry: **Retail**

An advanced autonomous retail platform integrates cognitive cloud capabilities and AI, enabling frictionless self-checkout experiences in convenience stores, stadiums and universities. The solution offers modular standalone retail units for rapid deployment, and embedded systems for existing store layouts, revolutionizing retail operations.

Business value

1. Lower labor costs through automated inventory management and checkout processes
2. Ability to increase stores' hours of operation
3. Increase in customer satisfaction and transaction volumes thanks to self-checkout and AI-driven personalization

Smart grids for energy efficiency

Industry: **Public sector; energy and utilities**

AI-driven cloud and IoT technologies, coupled with drone inspections, monitor energy assets like wind turbines and solar panels. This system uses predictive analytics to optimize energy distribution and employs intelligent grid technology to regulate supply based on real-time demand, improving efficiency and informing customers of energy-saving opportunities.

Business value

1. Reduced energy waste, thanks to predictive analytics and intelligent grid management
2. Lower operational costs for providers
3. Reduced energy bills for consumers

> “Cloud-powered energy grids optimize supply and lower bills, creating a more efficient and consumer-focused energy future.

Cloud-based AI for financial security

Industry: **Financial services**

A global bank implemented a multicloud strategy, migrating 75% of its data to the cloud to support AI-driven fraud detection and risk assessment. This approach leverages public and private cloud systems, enabling the real-time analysis of transaction patterns across multiple channels. The bank deployed ML algorithms to detect and prevent fraudulent activities swiftly, improving security and operational agility.

Business value

1. Reduction in fraud losses, which has improved customer trust
2. Optimized capacity, streamlined operations and reduced risk of vendor lock-in

Use cases

Success case

Europe | Cross-industry

Machine learning systems operations (MLSysOps) for autonomic system management

Business need

Modern industries, especially in the smart cities and agriculture sectors, increasingly rely on distributed edge-to-cloud infrastructure to manage data-intensive applications that demand low latency, high resilience and high energy efficiency. As cloud infrastructure expands to integrate deep-edge resources, there's a pressing need for autonomous adaptive systems that manage resources dynamically and seamlessly across cloud and edge layers.

Businesses often face challenges in achieving efficient orchestration, securing trusted data flow, managing power consumption and ensuring resilience to network imperfections. Moreover, they need open, extensible systems to integrate new ML models as technology advances. Addressing these challenges requires a robust, AI-driven approach that improves application performance, minimizes operational costs and supports sustainable practices.

Solution

MLSysOps provides a complete AI-controlled framework for autonomic system management across the edge-to-cloud continuum.

Using a hierarchical, agent-based AI architecture, the framework enables intelligent orchestration, adaptive resource allocation and low-latency performance, improving security and energy efficiency. It dynamically learns and updates configurations with continual ML training, supported by explainable AI and an API for integrating new models.

Designed with container-based portability, MLSysOps ensures flexible deployment on heterogeneous nodes and infrastructure. Validated through testbeds in smart-city and agriculture applications, this solution offers resilient, adaptable and scalable edge-to-cloud operations that align with evolving technological and sustainability demands, bridging current infrastructure with future-ready AI advancements.

Outcomes

The MLSysOps concept has been submitted to the European Union by an industrial and academic consortium promoted by NTT DATA. The idea has been accepted and granted with with full multiyear funding by the European Union. MLSysOps will demonstrate its efficacy through two well-defined use cases in precision agriculture and smart cities, using cloud, smart and deep-edge infrastructures. The use cases correspond to dynamic, impactful applications with heterogeneous demands.

Startups

Startup radar

In this section, we review a selection of startups relevant to cognitive cloud convergence, based on our observations, partnerships and investments.

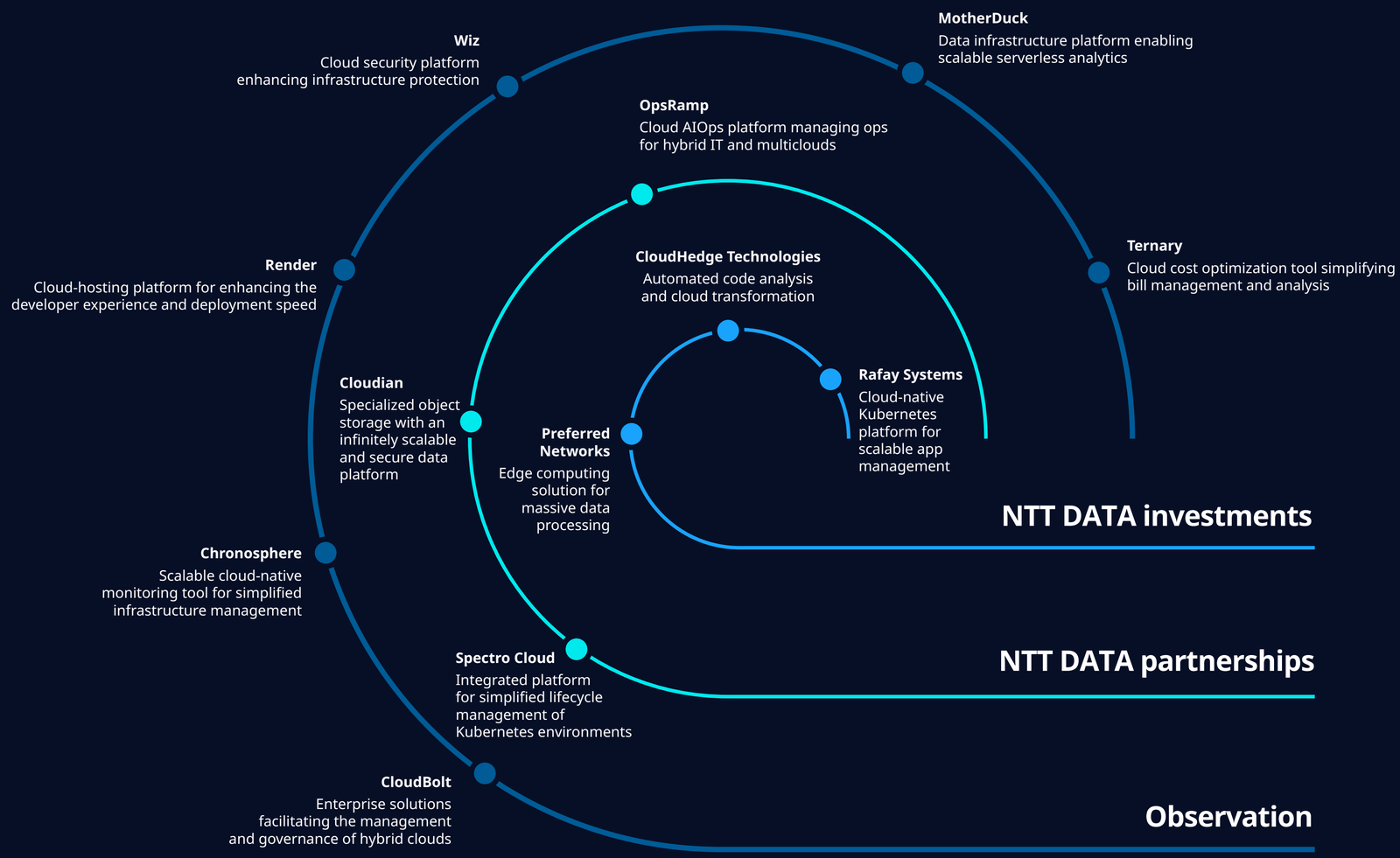


Figure 6: Investment in cognitive cloud convergence startups

Startups

Observation

CloudBolt

Founded in 2012, CloudBolt provides solutions to help organizations manage and govern their hybrid cloud environments and optimize their automation strategy. With CloudBolt, they can configure and manage private and public cloud resources — quickly, securely and cost-effectively — while empowering DevOps and end-users with self-service provisioning environments.

Stage
Series B

Funding
$61.6 million

Valuation
Not disclosed

Industry
Cross-industry

Chronosphere

Founded in 2019, Chronosphere has developed a scalable cloud-native monitoring tool designed to eliminate the cognitive load associated with monitoring infrastructure and tracking data locally. The tool analyzes the health of infrastructure, applications and businesses in a single place and solves complex issues by following them through the different layers of the stack, enabling organizations to operate reliably at scale and make precise, data-driven decisions.

Stage
Series C

Funding
$350 million

Valuation
$1.6 billion

Industry
Cross-industry

Render

Founded in 2018, Render operates a cloud-hosting platform designed to improve the developer experience. Its platform builds and runs all applications and websites with a free secure sockets layer (SSL) and a global content delivery network (CDN). Auto-deployment enables software teams to ship products quickly and at any scale by reducing complexity and cost.

Stage
Series B

Funding
$76 million

Valuation
Not disclosed

Industry
Cross-industry

Wiz

Founded in 2020, Wiz has developed a cloud-security platform to help organizations secure their infrastructure at scale. The platform provides cloud-visibility services for enterprise security, giving an overview of security risks across clouds, containers and workloads without the need for agents or sidecars. As a result, organizations can identify vulnerabilities, misconfigurations and network exposures, manage identities and privileges, and discover exposed data.

Stage
Series D

Funding
$2 billion

Valuation (approximate)
$10 billion

Industry
Cross-industry

MotherDuck

Founded in 2022, MotherDuck has developed a data infrastructure and serverless data analytics platform designed to scale systems into the cloud with hybrid execution. The platform uses an embedded database to analyze big data and build infrastructure for large and small data prototyping with local and remote data. This allows businesses to analyze their data and maximize profits in an integrated and collaborative environment.

Stage
Series B

Funding
$100 million

Valuation
$400 million

Industry
Cross-industry

Ternary

Founded in 2020, Ternary has developed a tool for cloud-cost optimization that's designed to reduce the complexity of cloud economics. The tool makes costs visible, ensures the optimal use of data, encourages collaboration and accountability, surfaces new data and optimizes expenditure in real time. As a result, clients can maximize every cloud dollar spent and easily monitor, prioritize and track their expenses.

Stage
Series A

Funding
$18 million

Valuation
Not disclosed

Industry
Cross-industry

Startups

NTT DATA partnerships

Spectro Cloud

Founded in 2019, Spectro Cloud has developed an integrated platform that helps organizations easily manage the full lifecycle of any combination of new or existing, simple or complex, small or large Kubernetes environments, whether in a data center or the cloud.

Stage
Series B

Funding
$67.5 million

Valuation
Not disclosed

Industry
Cross-industry

Cloudian

Founded in 2011, Cloudian is a file and object storage company specializing in S3 object storage in the data center. It turns information into insight with an infinitely scalable platform that consolidates, manages and protects enterprise data.

Stage
Private equity

Funding
$280.1 million

Valuation
Not disclosed

Industry
Healthcare; financial services; public sector

OpsRamp

Founded in 2014, OpsRamp helps IT teams control the chaos of managing their hybrid IT operations so they can act as a service provider back to the business. Built in the cloud, the service-centric OpsRamp AIOps platform provides visibility across hybrid infrastructures. It also offers complete multicloud infrastructure monitoring and the management of business-critical services, and optimizes services through automation and integration with IT service management (ITSM) and DevOps tools.

Stage
Acquired

Funding
$57.5 million

Valuation
$300 million

Industry
Cross-industry

Startups

NTT DATA investments

CloudHedge Technologies

Founded in 2018, CloudHedge Technologies has developed a platform that analyzes code for cloud-readiness,, auto-classifies workloads and suggests the right approach for transformation. It also offers automated containerization and refactoring, application blueprinting and audit control, enabling clients to deploy, monitor, manage and share application blueprints within minutes without using custom automation scripts.

Stage
Corporate minority

Funding
Not disclosed

Valuation
Not disclosed

Industry
Cross-industry

Preferred Networks

Founded in 2014, Preferred Networks develops edge-heavy computing solutions for the distributed, collaborative processing of large data volumes generated by devices at the network edge. It aims to spark innovation in various fields, focusing on three major business areas: transportation systems, manufacturing and bio-healthcare.

Stage
Unknown

Funding
$165 million

Valuation
Not disclosed

Industry
Manufacturing; transportation; healthcare

Rafay Systems

Founded in 2017, Rafay Systems offers the industry's first cloud-based Kubernetes operations platform to help enterprises maximize the value of containerized applications. With Rafay's unified platform, teams can operate modern application infrastructure at scale across public clouds, data centers and the edge. End-to-end services help streamline the process of deploying clusters and apps across multiple environments, and deliver enterprise-grade control and governance to DevOps workflows.

Stage
Series B

Funding
$33 million

Valuation
Not disclosed

Industry
Cross-industry

Future scenarios

As industries transform, new value chains emerge and technological advancements grow exponentially, companies must navigate complex, evolving landscapes.

Future scenarios and GenAI-powered personas allow organizations to explore possible futures, simulate realistic business environments and minimize risk through scenario-based planning.

Uncertainties represent what we cannot know, but identifying them can reduce the risks of blind spots down the road.

Future scenarios

Uncertainty: data privacy and security

AI-driven trust ecosystem

What if giving users control over their data leads to new business models where users can actively participate in and even profit from data usage?

In the future, cognitive cloud providers will prioritize AI-powered, privacy-first frameworks that give users unprecedented control. This trust-driven ecosystem will enable secure, data-driven innovations in sensitive fields like healthcare and finance, fueling broad confidence and adoption.

Global data stewardship

What if regional data-privacy solutions become so effective and trusted that they inspire global standards, leading to unified regulations?

In response to diverse privacy concerns and fragmented regulations, region-specific solutions will build consumer trust locally while fostering resilience. Organizations will successfully adapt to shifting rules, strengthening connections with regional customers and setting the stage for a more unified global approach.

Uncertainty: environmental impact and sustainability

A sustainable cognitive cloud revolution

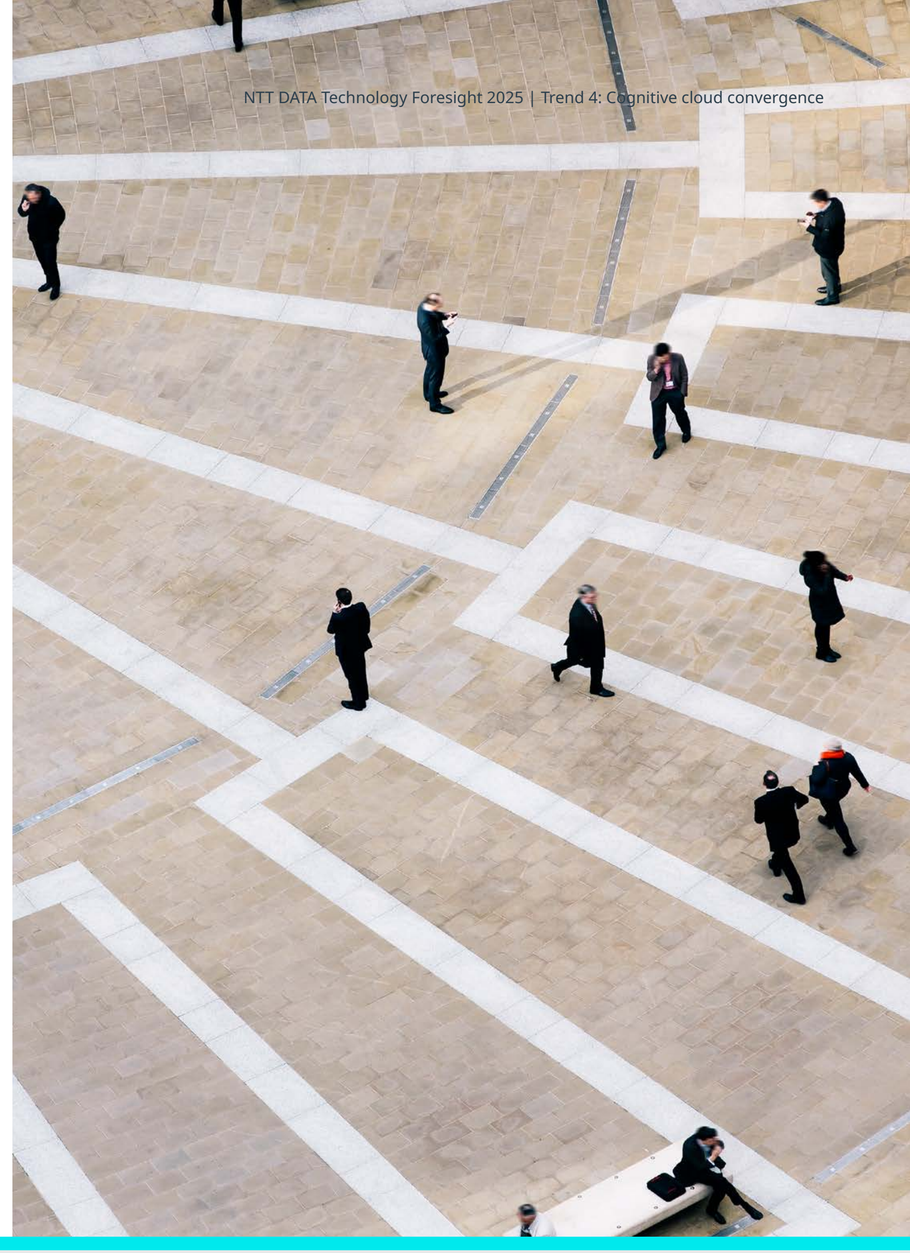
What if the cognitive cloud's commitment to eco-friendly practices sets new standards across the tech industry, giving eco-innovators a competitive edge?

Cognitive cloud providers are leading a shift toward sustainable, low-energy infrastructure powered by renewables. This commitment will attract environmentally conscious customers and investors, positioning certain organizations as leaders in responsible technology and creating momentum for a greener industry.

Regulatory pushback and eco-innovation

What if high compliance costs encourage partnerships between tech and environmental organizations, resulting in shared green technologies that benefit multiple sectors?

Rising regulatory demands will push cognitive cloud providers to develop innovative, resource-efficient solutions, such as self-regulating data centers. These eco-advances will not only enable compliance but also contribute to a more sustainable tech ecosystem, setting a positive example for other industries.



Conclusion and next steps

Conclusion and next steps

Think about this

As AI and cloud technologies merge, organizations can unlock powerful insights and adaptive services by embedding cloud–AI synergy into their core functions.

How effectively are you using this convergence to enhance data-driven decision-making?

Automation within cloud environments streamlines operations, minimizes manual tasks and optimizes resource allocation.

Which areas of your workflows could benefit most from automation to increase operational efficiency and free up resources for strategic initiatives?

Edge computing and IoT bring data processing closer to the source, reducing latency and improving security.

How prepared is your infrastructure to leverage edge capabilities for real-time responsiveness in critical processes?

Real-time analytics support proactive, agile decision-making and responsiveness to dynamic environments.

How is your organization embedding real-time data insights into its cloud strategy to drive timely and informed actions?

Conclusion and next steps

Do this next

5 minutes

Identify key business units

Identify one high-impact business unit where cloud–AI integration could enhance data-driven decision-making. Focus on areas requiring frequent, timely insights.

5 days

Assess edge and IoT infrastructure

Evaluate your current edge and IoT infrastructure to assess its readiness for rapid data processing, and identify key areas for improvement.

5 months

Launch an automation pilot

Set up a pilot project to automate repetitive cloud-based workflows. Track metrics like time savings, error reduction and resource efficiency to assess the project's impact and scalability.

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Glossary of key terms

Enhanced humans
People and machines are collaborating to shape a future where human potential isn't limited by time, task or knowledge.

Ambient intelligent experiences
Technologies like AI, spatial computing and automation are fundamentally changing how organizations connect with their audiences across different touchpoints.

Digital sustainability for economic resilience
A new business strategy is emerging where organizations integrate environmental stewardship with economic growth and assign individual and collective responsibility.

Cognitive cloud convergence
By integrating advanced cloud computing technologies with AI and human cognitive abilities, organizations can improve operations, enhance decision-making and understand their data in real time.

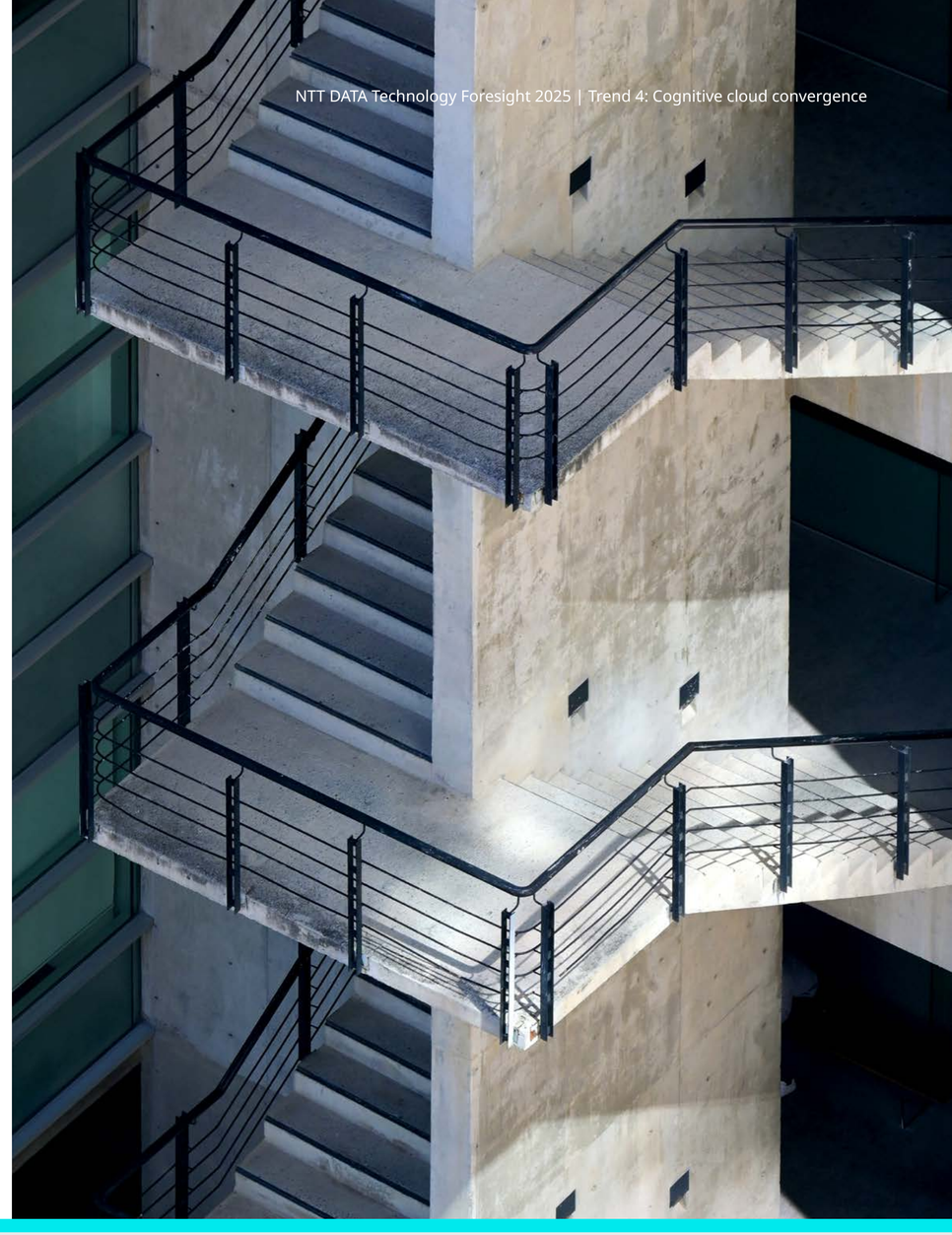
Accelerated security fusion
A new business strategy is emerging where organizations integrate automated incident response and AI-driven threat detection to adapt dynamically to emerging threats and build cyber resilience.

List of abbreviations

ADR	attack detection and response
AGV	automated guided vehicles
AI	artificial intelligence
AIASE	AI-augmented software engineering
AIOps	AI for IT operations
AMR	autonomous mobile robots
API	application programming interface
AR	augmented reality
ASIC	application-specific integrated circuit
AutoML	automated machine learning
AWS	Amazon Web Services
BAS	breach and attack simulation
CDN	content delivery network
CERT	computed emergency response team
CGI	computer-generated imagery
CGM	continuous glucose monitor
CI/CD	continuous integration and continuous delivery or deployment
CNAPP	cloud-native application protection platform
CPS	cyber-physical systems
CPU	central processing unit
CRQ	cyber risk quantification
CSIRT	computer security response team
CSPM	cloud security posture management
CX	customer experience
CVE	common vulnerabilities and exposure
DevSecOps	development, security and operations
DDoS	distributed-denial-of-service
DoT	deep learning of things
DSP	data security platform
EMS	energy management systems
ESG	environmental, social and governance
eVTOL	electric vertical takeoff and landing
FPGA	field programmable gate array
GenAI	generative AI
GPU	graphics processing units
GPT	generative pretrained transformer
IAM	identity and access management
IDE	integrated development environment
IOWN	Innovative Optical and Wireless Network
IPA	intelligent personal assistant
IRM	integrated risk management

List of abbreviations

ITRM	IT risk management
ITSM	IT service management
IoT	Internet of Things
LIME	Local Interpretable Model-Agnostic Explanations
LLM	large language model
MAG	multiagent generative system
MDR	managed detection and response
MFA	multifactor authentication
MLOps	machine learning operations
ML	machine learning
MR	mixed reality
NLP	natural language processing
OEM	original equipment manufacturer
OT	operational technology
PaaS	platform-as-a-service
PET	privacy-enhancing technology
PDE	provider data extractor
PQE	post-quantum encryption
PRM	proactive risk management
RAG	retrieval-augmented generation
RemOps	remediation operations
RPA	robotic process automation
RFID	radio frequency identification
SaaS	software-as-a-service
SHAP	Shapley Additive exPlanations
SSL	secure sockets layer
STEM	science, technology, engineering and math
TPU	tensor processing unit
UAV	unmanned aerial vehicle
VA	virtual assistant
MLOps	machine learning operations
VoC	voice of the customer
VR	virtual reality
XIoT	extended IoT
XOps	cross-functional operations



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