Predicts 2022: 4 Technology Bets for Building the Digital Future

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Initiatives: Technology Innovation

Enterprise architecture and technology innovation leaders should actively sense and respond to trends and disruptions. Consider four potentially independent next-generation key trends that will provide opportunities and drive strategic business innovations beyond technology.

Additional Perspectives

- Summary Translation: Predicts 2022: 4 Technology Bets for Building the Digital Future
  (29 December 2021)

Overview

Key Findings

- Enterprise needs have evolved beyond most computing solutions based on general-purpose processors implemented on a silicon chip.
- Climate change impacts can be analyzed and reduced through the application of artificial intelligence.
- People are replicating their daily activities in separate digital worlds, which will eventually converge into a single metaverse.
- More organizations are relying on process mining to provide an accurate digital twin of the organization in a format that can be understood by anybody in the organization.

Recommendations

To best sense and respond to disruptions using technology innovation, enterprise architecture and technology innovation leaders should:

- Task an innovation team to look for opportunities where next-generation computing technologies could optimize digital business or even create new products and services. Motivate the team with sensing workshops and inviting potentially disruptive technology providers to demonstrate their technology or help clarify direction and potential.
- Provide AI-based insight and guidance to the CEO and environmental, social and governance (ESG) committee to guide the scope and level of investment planned to address the impact of climate change on business and operating models, products and services, employees, and customers.
- Develop technology strategies that leverage the built-in infrastructure and participants of the metaverse, and provide digital product or service opportunities.
- Add learning and awareness capabilities to process mining and digital twins to optimize the agility, resilience and performance benefits in business operations.

Strategic Planning Assumptions

By 2026, the annual shipments of tiny IT tags and sensors will exceed 100 million units, enabling new real-time inventory and smart packaging opportunities.

By 2026, 30% of global enterprises will use AI to accurately measure and analyze the impact of climate change on their business.

By 2026, 25% of people will spend at least one hour a day in the metaverse for work, shopping, education, social and/or entertainment.

By 2024, 25% of global enterprises will have embraced process mining as a step-up to autonomic business.

Analysis

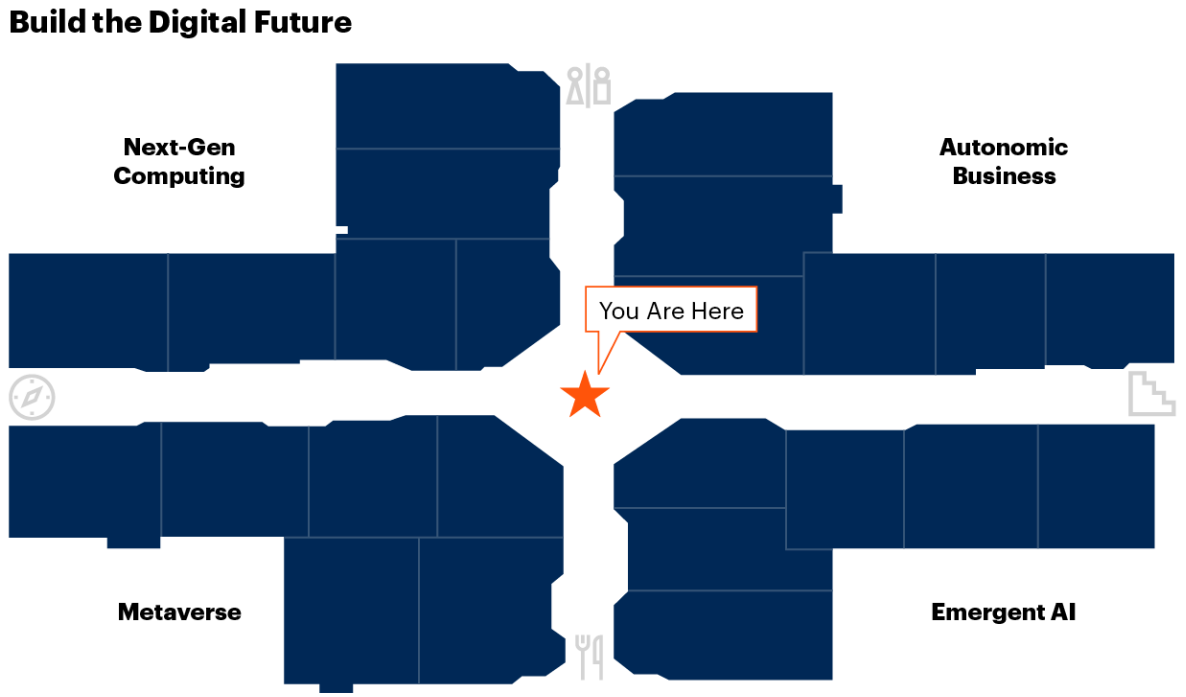
What You Need to Know

Business leaders rely on enterprise architecture and technology innovation leaders, including chief technology officers (CTOs), to identify, examine and track technology trends that will impact the business — either to develop new products, transform the business or mitigate business risk. Emerging technologies have become key enablers of competitive differentiation and catalysts for transforming many industries. Understanding shorter-term technology trends, with proven use cases and business outcomes, is just the beginning of the value technology innovation brings to the enterprise. However, the longer-term bets are the true differentiators that could disrupt an entire industry.

Over the next three to five years, Gartner sees four technology innovation areas as "technology bets." Organizations should consider investing in these bets, or at the very least explore them in detail because their digital future may be molded by them. The sooner organizations identify these technology bets, assess them and prepare for early adoption, the better (see Figure1). These bets are:

- **Next-generation computing** — New computing platforms and technologies that will impact, and be necessary for, technology innovation. This includes new computing architectures, new computing methods and storage technologies.
- **Emergent AI** — Breakthrough innovations in the field of AI such as reinforcement learning, federated learning and generative AI that will enable it to take on complex and most pressing challenges in the enterprise and across humanity.
- **Metaverse** — A collective virtual shared open space, created by the convergence of virtually enhanced physical and digital reality. The metaverse is physically persistent and provides enhanced immersive experiences.
- **Autonomic business** — The application of technologies that are able to learn from experience and modify their behavior to deliver to or realize defined or evolving business objectives.

Figure 1: Build the Digital Future



Source: Gartner
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Gartner

Strategic Planning Assumptions

Strategic Planning Assumption: By 2026, the annual shipments of tiny IT tags and sensors will exceed 100 million units, enabling new real-time inventory and smart packaging opportunities.

Analysis by: Nick Jones and Arun Chandrasekaran

Key Findings:

Until recently, most computing solutions were based on general-purpose processors loosely conforming to a Von Neumann architecture implemented on a silicon chip (see Note 1). But computing needs have evolved to demand functions and performance that traditional architectures can't deliver. Tasks like simulation and AI demand extreme performance. Sustainability demands extreme efficiency for computationally intensive algorithms. Applications like massive sensing and embedded IoT demand ultralow cost and extreme battery life. General-purpose chips are increasingly mismatched to the needs of innovators needing such capabilities.

The next generation of computing will exploit a broader range of hardware architectures to deliver new combinations of price, performance, efficiency, cost and power consumption better aligned with application needs.

Next-generation computing will be a decade-long trend. Some technologies, such as "extreme parallelism," are available today (see Note 2). Some, such as quantum computing and neuromorphic computing, are embryonic and will take a decade or more to scale up to their full potential. Many of these new generation technologies don't involve general-purpose processors. They achieve goals such as efficiency or performance using architectures optimized for specific tasks such as AI.

Market Implications:

Next-generation computing will be a highly influential trend because it will enable organizations to perform tasks that are impractical in 2021 for cost, performance or sustainability reasons. Examples include simulation, new forms of AI and ultra-low-power sensing. Some of the many opportunities and implications include:

- **The cost of deploying computing and sensing will fall.** Tiny IT enables computing devices with impossible levels of power efficiency, physical size, form factor and cost. It will enable sensors and tracking tags to be deployed at low cost in a wide range of situations. Active devices will replace some passive RFID, enabling new functionality such as real-time inventory. Innovations such as smart packaging will be accelerated by printed electronics.

- **New classes of problems will become solvable.** In the long term, we expect quantum computing to open up a wide variety of complex optimization and simulation tasks. This will benefit domains as diverse as material science, financial services, chemical and process industries, and medicine. Future hybrid IT architectures will combine the strengths of quantum computers and conventional high-performance computing systems in areas such as optimization.

- **Energy efficiency of some computing tasks will be significantly enhanced.** Compute-intensive tasks such as simulation and AI training will become more sustainable. Special-purpose chips will enable small battery-powered devices to perform complex AI functions such as image or audio recognition.

- **Supercomputing moves to the edge.** Extreme parallelism means that on-premises supercomputing will become more feasible. This will enable workloads such as simulation and AI training to be conducted locally for greater resilience and responsiveness. It will also enable new forms of real-time control based on sophisticated monitoring and simulation of airflow or combustion processes.

- **Skills, hardware and software will become more fragmented.** Because hardware diversity will increase, portability will decline and opportunities to share skills and code will be reduced.

- **Smarter "things" will become more affordable.** Advanced technologies such as embedded AI will become mainstream, e.g., in consumer electronics. Hardware that accelerates AI training will aid trends such as autonomic systems that continuously learn and adapt their behavior.

- **More-affordable and sustainable high-power computing enables new approaches to old problems by trading scarce resources (e.g., staff) for technology (e.g., AI).** For example, train an AI system instead of programming and testing an algorithm.

- **Advances in next-generation computing will support generative AI use cases, such as creating synthetic data and acceleration, in new material discovery.** The latter can significantly shift R&D economics and enable rapid new product development of, for example, new alloys or pharmaceutical compounds.

Recommendations:

- Identify situations where order-of-magnitude performance improvements in compute-intensive tasks such as simulation, searching, AI or optimization would be transformative. Examples include real-time process monitoring, materials science, financial services risk analysis, identification of pharmaceutical compounds or biomedical research.
- Identify information shadows where low-cost embedded computing and sensing could deliver significant advantages. Examples include areas such as smart packaging or supply chain monitoring, and perishable goods monitoring.
- Prepare for the long-term security disruptions that will emerge if large-scale quantum computing emerges. Establish crypto-agility as an architectural requirement.
- Educate business peers on the opportunities of next-generation computing. Run ideation sessions for each key technology area to discover opportunities.
- Identify situations, such as simulation or AI, where the carbon footprint of specific computational tasks is high enough (relative to the organization's sustainability goals) to warrant using alternative and more efficient hardware platforms.

Related Research:

4 Advanced Computing Algorithms That Lead to Next-Generation Profits

Predicts 2021: Disruptive Potential During the Next Decade of Quantum Computing

When and Why Enterprises Should Implement RFID to Track Critical Assets

Quick Answer: 3 Reasons to Be Cautious About Investing in Environmentally Sustainable Software

Strategic Planning Assumption: By 2026, 30% of global enterprises will use AI to measure and analyze the impact of climate change on their business.

Analysis by: Arun Chandrasekaran

Key Findings:

- ESG and sustainability initiatives rank among the top three priorities for the board of directors in 2022 and 2023 according to the 2022 Gartner View From the Board of Directors Survey.
- Climate change, which is one of the greatest challenges facing humanity, can benefit from the application of AI in two ways — mitigation and adaptation. There is a growing ecosystem of startups that are using AI and cloud services to provide solutions for carbon accounting, accurate carbon offsets, predictive climate intelligence and climate insurance.
- Applying AI to assess and reduce the impact of climate change offers immense potential. However, it suffers from issues such as lack of high quality and adequate data, lack of coordination across teams, half-hearted management support, and black-box-oriented results, all of which needs to be addressed.
- Data modeling and AI advancements, particularly synthetic data, GANs (a form of neural nets) and transfer learning evolution, combined with cloud services will enable enterprises to pilot and adopt AI as a tool for combating the effects of climate change.

Market Implications:

CTOs and CIOs are increasingly being asked by their boards and executive leaders to outline how technology can help boards meet their ESG goals. Addressing climate change challenges requires CTOs to craft a response that addresses both mitigation and adaptation strategies as both are vital for business success. Use of machine learning and other AI techniques for climate change mitigation is already well underway. For example, AI is already helping across several industries such as energy management (development of clean energy, optimization of energy supply), transportation (optimized transport transit, route optimization), and food and agriculture (precision agriculture, reducing food wastage).

AI's value in the future will be most pronounced in its predictive nature of allowing organizations to better adapt to climate change. We predict that AI will make a substantial difference in the near future within the following areas:

- **Carbon accounting —** It is hard to act on climate change unless you are clear on what your carbon footprint is. AI models can be vital in identifying continuous improvements to your carbon offset process and suggesting the most effective opportunities. By connecting your business activity data to AI applications, enterprises can measure and offset greenhouse gases on a per-activity basis. Startups such as Emitwise, Patch and Persefoni, as well as large vendors such as IBM, provide AI-powered carbon accounting through unified APIs.

- **Accurate carbon offsets —** Use of AI can provide better transparency and assurance to enterprises buying carbon offsets. This is often done by training AI models with satellite and ground imagery to create base maps and to predict accurate carbon offset projects through continuous monitoring. Startups such as Pachama and NCX use AI to bring transparency to carbon offsets and enable marketplaces connecting carbon buyers to land owners and carbon offset projects.

- **Climate intelligence —** According to research by insurance provider Swiss Re, the effects of climate change can be expected to shave 11% to 14% off global economic output by 2050. This amounts to as much as $23 trillion in reduced annual global economic output worldwide as a result of climate change. AI can be applied to quantify physical climate risk around the world. Enterprises can use AI to understand how current and future climate change may impact their assets, employees, partners and customers across the globe. Through earth observation data, which involves combining terrestrial systems with satellite observations, AI systems can predict risks such as crop failure, forest fires and property damage by floods and provide actionable advice on risk mitigation strategies. Startups such as Jupiter intelligence, Climavision, Gro Intelligence, and ClimateAI offer such solutions today. They leverage public data from sources such as weather stations, satellites and direct observation stations and combine them with proprietary techniques to keep the data downscaled and up-to-date. By leveraging advanced neural nets such as GANs and through transfer learning, they seek to improve model accuracy and provide continuous, real-time climate intelligence. Use advanced statistical methods, computer vision and machine learning techniques — GANs, hybrid models, super-resolution and transfer learning — to calculate your hazard risk exposure.

- **Climate insurance —** To mitigate the risks of climate change, enterprises need to calibrate their risk mitigation strategies. A growing ecosystem of AI startups such as Descartes Underwriting, Arbol, Kettle and Understory provide insurance to mitigate the risk of revenue loss or damage to your supply chain caused by climate change. They use a variety of datasets from satellite images to surface Lidar imaging to feed their neural nets and leverage synthetic datasets to swarm intelligence for improving accuracy of their underwriting models.

The growing importance of ESG initiatives combined with a rapidly evolving ecosystem of startups and advancements in AI will enable at least a third of global 2000 companies to leverage AI as part of their climate change strategy.

Recommendations:

- Seek clarity from the CEO and ESG committee within your organization on the ambition, scope and level of investment planned in addressing the impact of climate change.
- Collaborate with business unit leaders to identify use cases where AI can help in faster, accurate mitigation and where adequate data is available to make it practically feasible.
- Determine whether you will build AI capabilities internally or choose innovative vendors to work with based on business differentiation, availability of in-house talent, complexity of the use case and time to value needs.
- Start with carbon offset and accounting use cases because these directly align with pressing current needs and allow you to demonstrate early wins.
- Embark on data literacy programs and strive to enhance your data collection, availability and quality issues. Experiment with emerging AI techniques such as transfer learning and synthetic data to improve your chances of success.

Related Research:

How Executive Leaders Can Contribute When the Board Requires a Climate Change Strategy

Standardizing Climate Risk Disclosures

Applying AI in Industries

Hype Cycle for Artificial Intelligence, 2021

Strategic Planning Assumption: By 2026, 25% of people will spend at least one hour a day on the metaverse for work, shopping, education, social and/or entertainment.

Analysis by: Marty Resnick

Key Findings:

- The metaverse is a collective virtual shared open space, created by the convergence of virtually enhanced physical and digital reality. The metaverse is physically persistent and provides enhanced immersive experiences.
- Big tech companies are staking claim to the metaverse. Facebook rebranded as Meta with a strategic focus on the metaverse.
- The metaverse is now being represented as exchange-traded funds (ETF) in South Korea, with the expectation other countries will follow.

Market Implications:

Vendors are building ways for people to replicate their lives in digital worlds: from picking outfits for their avatars to wear and cars for them to drive to building virtual relationships; from buying digital land and constructing virtual homes to shopping at a virtual mall; and from participating in immersive meetings at workplace to attending virtual classrooms. These activities are taking place in separate environments, but will eventually take place in the metaverse. This metaverse provides many opportunities across multiple industries.

- The desire to offer a more immersive learning experience by higher education, medical training, military and other types of trade schools will now have a home on the metaverse. They will not need to create their own infrastructure as the metaverse will provide the framework.
- Virtual events have gained popularity over the last 18 months and now can extend more collaborative and immersive offerings.
- Retail can extend its reach to an immersive shopping experience that allows for more complex products that have been a challenge on mobile device applications.
- Enterprises will be able to provide better engagement, collaboration and connection to their employees through better immersive workspaces in virtual offices.
- The social media environment will move to the metaverse for more engaging experiences.
- The metaverse will provide innovative new opportunities and business models. This allows businesses the ability to extend digital business that may be persistent, decentralized, collaborative and interoperable.

Recommendations:

- Develop digital business strategies that leverage the built-in infrastructure and participants of the metaverse.
- Lead idea and innovation management that focuses on new opportunities and business models with the metaverse.
- Identify the unique technology risk, privacy and security implications in this new persistent and decentralized environment.
- List the outcomes, opportunities and obstacles the metaverse provides as part of the emerging technology radar and/or in the form of an emerging technology wheel.
- Plan your scenarios for how the metaverse may transform your organization.
- Use the metaverse, along with related technologies (i.e., digital humans) for improving existing processes like onboarding, customer service and training.

Related Research:

Cool Vendors in Immersive Experiences

Three Best Practices to Optimize Digital Commerce for Visual Experiences

Virtual Reality and Augmented Reality for Remote Workers

Maverick* Research: Digital Humans Will Drive Digital Transformation

Toolkit: How to Create an Emerging Technology Wheel

Strategic Planning Assumption: By 2024, 25% of global enterprises will have embraced process mining as a step-up to autonomic business.

Analysis by: Marc Kerremans

Key Findings:

- More organizations are relying on process mining for its proven methods, techniques and tools which, based on available day-to-day operational data, provide an accurate model of the way of working in a format that can be understood by anybody in the organization. This improves visibility and understanding of the actual performance of business operations and processes.
- By discovering the ways of working and using this mined information to automate the sequence and guidance of the different tasks, applications are being scripted and built. Combining this capability with continuous monitoring and rediscovery ultimately leads to the creation of continuously adapting, dynamic operations or autonomous operations.
- A bigger trend is revealing itself if we start adding the recent evolution in AI and ML to these capabilities of autonomous operations. This decision intelligence component would allow the full operational resilience life cycle (sense-monitor-adapt) to be handled in an autonomic way, paving the way for autonomic business.

Market Implications:

Operational resilience is a set of techniques that allow people, processes and information systems to adapt to changing patterns. It is the ability to alter operations in the face of changing business conditions:

- **Operational resilience** — The techniques underlying process mining provide a new and enhanced way to encompass the sense and model capabilities. Based on available day-to-day operational data, process mining continuously seeks and finds the relevant objective operational data. The advanced process mining algorithms then provide an accurate model of the ways of work in a format that can be understood by anybody in the organization. This ensures that everybody can be engaged in the change initiative. Furthermore, it allows for continuous adaptation and improvement because, after the adaptation, the new operational data will give insights into the new adapted way of working.

- **Autonomous operational resilience —** Adding execution or automation capabilities to the discovery or mining allows for an autonomous way of handling this operational resilience. The three different stages of operational resilience (seek, model, adapt) are connected and performed autonomously (i.e., without supervision and minimal or no human intervention). Resulting autonomous operations are one of the building blocks of autonomous business, which is Gartner's holding term for the next distinct macro wave of digital and information technology enabled business.
- **Autonomic operational resilience —** Ultimately through providing learning and awareness capabilities, the full resilience life cycle is handled in an autonomic way — autonomic operational resilience. From a governance perspective, this would require decision intelligence support. The autonomic operations and operational resilience could lead the way to autonomic business by extending the operations to their organizational context within a business operations model.

This multistep journey to autonomic business leads to many opportunities in each of the different stages, such as:

- Making explicit the extensive and expensive set of business processes underpinned by a patchwork of technologies that are often not optimized, lean, connected or consistent.
- Recontextualizing the techniques of process mining (basically sequencing of events) by creating:
  - Client journey maps (events coming from client interactions)
  - Supplier journey maps (events coming from supplier interactions)
  - Product life cycle maps (events coming from milestones in a product life cycle)
  - Service delivery maps (events coming from milestones in, e.g., shared services)
  - System or application interaction maps
  - Journeys of how business capabilities are operationalized to provide value
- Reacting to disruptive internal and external events, whether they are problems or opportunities, in a more organized and more predictable way.

- Exploring next steps along the journey through how customer interactions align with internal business operations and processes.
- Enabling organizations to become more resilient through the creation of business operations that exhibit automation, learning and awareness.
- Paving the way to autonomic business by extending the autonomic operations to their organizational context within a business operations model that is product/market/channel-driven.

Recommendations:

- Create visibility and understanding of internal operations and external interactions by discovering exceptions and shadow operations. Process mining identifies the opportunities for process adaptation and improvement initiatives and validates or audits whether actual operations are in conformance with defined operations.
- Support ongoing adaptability by closing the sense-model-adapt loop by showing the actual business outcome and aligned stakeholder value after the implemented actions. Moreover, process mining shows next opportunities, thus becoming a key enabler for continuous adaptation.
- Optimize the benefits of autonomic technologies by piloting them in situations, such as complex and rapidly changing environments, where early adoption will deliver agility and performance benefits in business operations.
- Work together with the business unit and executive leaders on the disruptive potential autonomous and autonomic operations present for the enterprise, and create a roadmap for the needed enterprise skill sets, architectures and governance for how to create the necessary competence center and related fusion teams.
- Support accountability and help reduce political and cultural barriers induced by any change or reconstruction of operations.

Related Research:

Market Guide Process Mining

How Process Mining Can Support Operational Resilience in Times of a Crisis

Top Strategic Technology Trends for 2022: Autonomic Systems

Market Guide for Technologies Supporting a Digital Twin of an Organization

DigitalOps Helps Connect Business Models to the Digital

Top 10 Strategic technology Trends: Autonomic Systems

Top Strategic Technology Trends for 2022: Decision Intelligence

A Look Back

In response to your requests, we are taking a look back at some key predictions from previous years. We have intentionally selected predictions from opposite ends of the scale — one where we were wholly or largely on target, as well as one we missed.

This topic area is too new to have on-target or missed predictions.

Evidence

The 2022 Gartner View From the Board of Directors Survey: This study was conducted to understand how BoDs will address the risk from economic and political volatility and a multipolar world and their intent to convert digital acceleration to digital momentum. The survey also helps understand the impact of the key societal issues that took center stage during the pandemic on BoDs' strategy and investment approaches

The survey was conducted online from May through June 2021 among 273 respondents from the U.S., Europe and Asia/Pacific.

Companies were screened to be midsize, large or global enterprises.

Respondents were required to be a board director or a member of a corporate board of directors. If respondents serve on multiple boards, they answered for the largest company, defined by its annual revenue, for which they are a board member.

The survey was developed collaboratively by Gartner analysts and the Research Data and Analytics team.

Disclaimer: Results of this study do not represent global findings or the market as a whole but reflect sentiments of the respondents and companies surveyed.

Note 1: Von Neumann Architecture

The basic high-level architecture of the majority of computers was first identified as far back as 1945 by John Von Neumann and colleagues and is hence known as a “Von Neumann” architecture. It identified the key components of a computing device including a processor, a control unit that schedules instructions to execute, memory that stores data and instructions, mass storage, and I/O mechanisms.

Note 2: Extreme Parallelism

We use the phrase “extreme parallelism” to refer to computing architectures with very large numbers of processors or cores operating in parallel. In 2021, this can range from thousands to hundreds of thousands of processor units.

Recommended by the Authors

Some documents may not be available as part of your current Gartner subscription.

Leadership Vision for 2022: Technology Innovation

Quick Answer: How to Use Combinatorial Innovation to Identify Opportunities From Trends and Emerging Technologies

Maverick* Research: World Order 2.0: The Birth of Virtual Nations

Emerging Technologies and Trends Impact Radar: Compute and Storage, 2021

Maverick* Research: Climate Change Needs a Digital Drug Against Delusion

Quick Answer: What Is a Digital Twin of an Organization?
