

A person is shown in profile, wearing a VR headset and holding a smartphone. The background is a stylized cityscape with digital overlays, including a glowing globe and circuitry. The text "WHERE TO PLAY: GAME-CHANGING TECHNOLOGIES FOR ICT" is prominently displayed in the upper left.

WHERE TO PLAY:
GAME-CHANGING
TECHNOLOGIES
FOR **ICT**

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Introduction

Digital transformation is imperative to doing business today. It enables organizations to increase productivity, streamline operations, and respond to customers' ever-changing needs. It is becoming a requisite for resilience and success in an increasingly uncertain future and the catalyst for economic growth on a global scale. And integral to this digital transformation is the information and communication technology (ICT) industry.

Essentially a collection of technologies that enables the processing, transmission, and display of information electronically, ICT drives digital solutions, strategies, and, indeed, transformation across industries and economic sectors. This positioning makes ICT highly influential and its components, products, and services extremely in demand—no more so than now in the wake of the COVID-19 pandemic.

While, in general, ICT companies largely fared well over the course of 2020 and 2021, the industry faces its share of challenges—from supply chain disruptions and skills shortages to intense competition from new entrants and incumbents alike.

At the same time, opportunities abound; capital-rich ICT companies are looking to augment their technology stacks and talent pools as a wide range of non-ICT companies seek the critical tools and capabilities to digitalize their operations. Consequently, there is significant activity around investments, mergers, and acquisitions as organizations re-evaluate their value chains through the lens of ICT.

In many cases, ICT innovation is outpacing regulators' ability to establish policies and standards and many organizations' ability to adopt and embed new technology into their businesses. This has created an environment that favors speed, agility, and foresight—that is, the ability to predict what technologies will have the greatest impact in the future and on what time scale.

The game-changing technologies presented in this report represent key areas where innovation potential is high for organizations in the ICT industry and, by extension, for all other organizations embarking on their journey of digital transformation. The information contained within this report is interlinked with the ITONICS Innovation Platform to help you visualize the connections between various drivers of change and identify the technologies that align with and enable your strategic innovation goals. Our aim is to inspire decision-makers in ICT—and in the growing number of ICT-reliant industries—to act on the most rewarding innovation opportunities for the future.

An Introduction to Technology Scouting

End2end innovation management begins by asking the fundamental question, **Where to Play**. Answering this question relies on several congruent activities and internal capabilities that primarily fall within the discipline of Foresight and Strategy, as advocated by our distinct **ITONICS COFIM** model. Organizations equipped with strong foresight capabilities can align their strategy with future scenarios and build resilience in an increasingly uncertain and competitive landscape.

Essential in **Foresight and Strategy** is an organization's capacity to scan its business environment comprehensively and continuously—environmental scanning. This is the capability to scan the horizon for weak signals that might indicate larger shifts and influence or disrupt the environment. It begins with the collection of vast amounts of data from which patterns are revealed through sensemaking analysis.

Environmental scanning focuses on control objectives that enhance innovation intelligence, thereby enabling the identification of new opportunities for growth, informing strategic priorities, and shaping future goals. These include capability supervision, competitor watch, trend scouting, and technology scouting.

As the focus of this industry report, **technology scouting** is the process of observing technological shifts and developments by collecting pertinent data, contextualizing change to uncover discernable patterns as weak signals, and identifying emerging technologies that hold both impact and relevance.

Actively screening for shifts in technology adoption, R&D, and patents serves as an early-warning system to help organizations anticipate and respond to changes while also minimizing risk.

Applying an industry lens to the process of technology scouting helps organizations direct their focus and resources more optimally.

And by gaining an understanding of the technological developments and adoption trends that may present future opportunities in their industry, they can equip themselves with the innovation intelligence needed to take decisive, strategic action and ultimately gain a competitive advantage.





The Role of Technologies in Innovation

Emerging, evolving, and disruptive technologies serve as solution drivers, helping innovators connect the dots between their current and future states. These are the tools capable of meeting—and sometimes, creating—new needs, desires, and demands.

Technologies enable new business models, products, and services. They have the potential to meaningfully expand an organization's existing portfolio and transform an entire industry.

The Interplay between Technologies and Trends

Technologies and trends are complementary elements that interact with and influence one another. Trends are expressions of new consumer attitudes, expectations, or behaviors—an indication of market pull; whereas technologies are designed either in response to these shifts or as precursors to nascent demands—representing a market push.

Together this push and pull exert force on the market, driving change forward. It is organizations' ability to pre-empt or respond to this change through innovation that determines their success.

Determining Industry Relevance

Environmental scanning is a divergent exercise; too narrow an approach and important opportunities can easily be missed. And while all elements in the ITONICS portfolio hold relevance—the degree of relevance differs depending on the industry in which your organization operates.

To help provide this industry lens, ITONICS analysts have performed relevance analysis to identify the Technologies and other elements that are most relevant and likely to be game changers in each respective industry.

Our team of analysts monitored the frequency with which each Technology appeared in a given industry. Instances of real-world applications, R&D, patents, and startup activities were tagged with relevant industries through a process combining manual and automated data classification.

This initial mapping of the ITONICS portfolio served as hypotheses of industry relevance. These hypotheses were further validated and enriched through additional quantitative and qualitative industry research to arrive at nine industry packages.

Each industry package, available on the ITONICS Innovation Platform, displays the Technologies, Trends, and Inspirations that represent the most relevant—that is, impactful, disruptive, and transformative—areas in which to play.



Technology Scouting with ITONICS

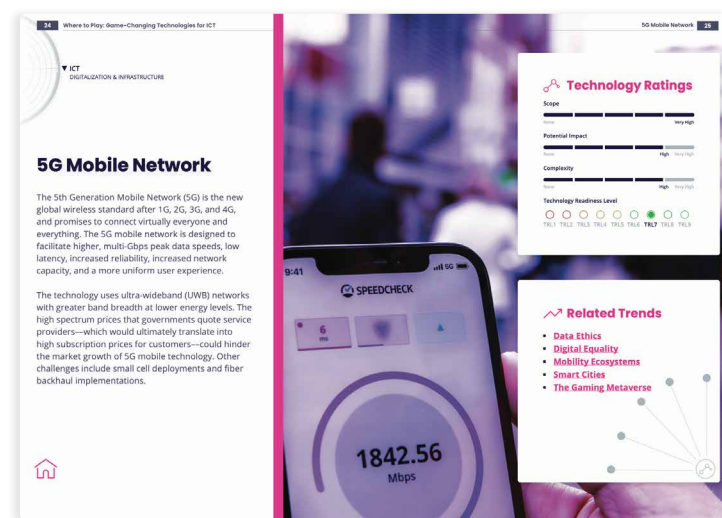
This report provides a starting point from which to embark on your organization's technology scouting. It presents 35 game-changing Technologies for the information and communication technology (ICT) industry. Through a process of relevance analysis, these have been identified as most relevant and impactful to innovation in the industry.

Each can all be explored on the ITONICS [Teaser Technology Radar](#), filtered for ICT. Additionally, our pick of the industry's top five game-changing Technologies is unpacked in further detail in this report.

How to Read the Technologies

The **Synopsis** gives a brief overview of the Technology, explaining why it is important, what is required to enable it, how it has evolved, and any current limitations and opportunities.

The **Segmentation** of the Technology is indicated corresponding to the relevant categories that appear on the ITONICS Radar: Chemicals & Materials, Energy & Resources, Engineering, Healthcare & Life Sciences, ICT, and Mobility. Listed below, the **Sub-segmentation** provides a more narrow scope as to the area of technological development.



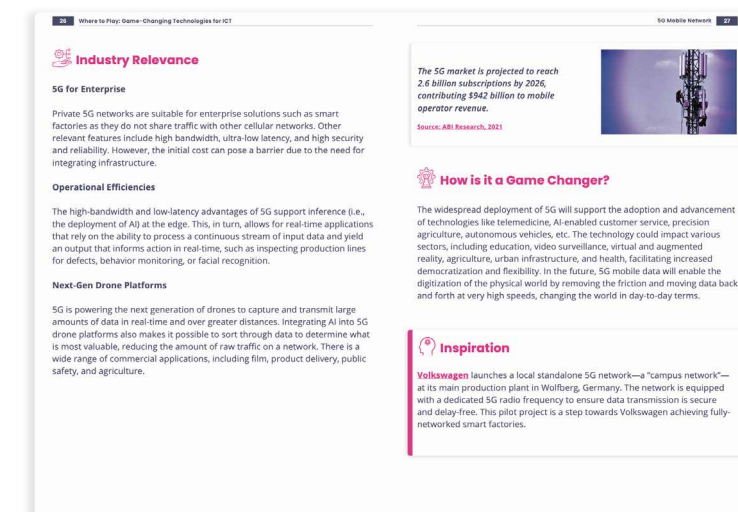
In the navigation bar, the  icon will bring you back to the Table of Contents page. The  button will open up the individual element in the ITONICS **Teaser Technology Radar**. Here you can deep dive into the Implications for Innovation associated with the Technology and view the interconnected elements that influence and impact it, including related Trends, Inspirations, and other Technologies.

 The **Technology Ratings** look at the parameters of Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL).

 **Related Trends** show the elements that are influenced by and have an influence on the Technology, its development, and adoption. This network provides greater context as to the interplay between elements and points to possible opportunities.

 **Industry Relevance** unpacks the industry-specific applications and potential use-cases that are most prominent with regard to the Technology. Each point looks at the strategic advantage gained through adoption of the Technology and the considerations for its future development.

 **How is this a Game Changer?** elaborates on how the Technology may contribute to or influence possible future scenarios. The relationship between the Technology and nascent demands is explored through a future-oriented lens.

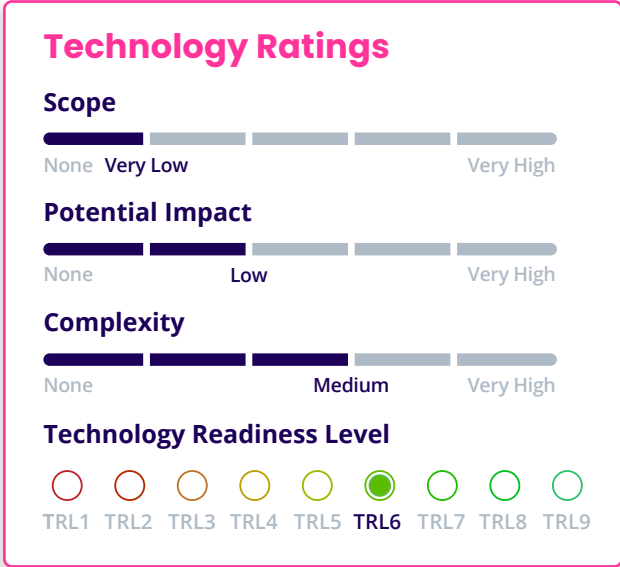


 **Inspirations** provide evidence of how organizations are applying the Technology in the real world. They serve as springboards for ideation, helping innovators look beyond their category, connect information in new ways, and nurture fresh thinking.

ITONICS Ratings

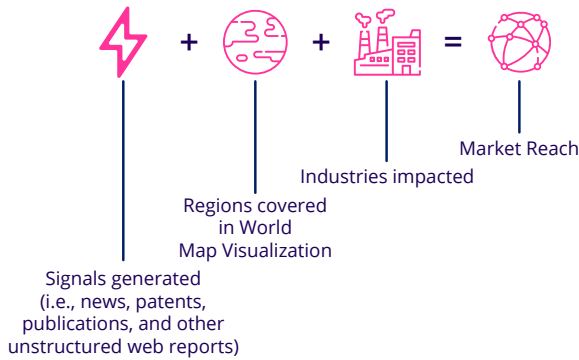
The evaluation of trends or technologies is one of the most important activities in innovation management. The goal is to predict future changes in your industry and whether they are relevant to your organization.

ITONICS Trends and Technologies are presented with ratings that help foresight teams focus their attention and identify relevance based on their unique set of strategic objectives.



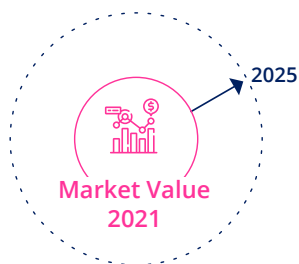
Scope: How far-reaching is the potential influence of this element on this market?

ITONICS Insights tool uses keywords to retrieve data across three dimensions and derive an aggregated mean value to indicate the market reach of each Technology.



Potential Impact: How high is the potential impact of this element on the market?

Market growth data for each Technology is collected from a minimum of 5 verifiable sources, aggregated and extrapolated to 2025.



Scale: Projected market value in 2025 (USD billion):

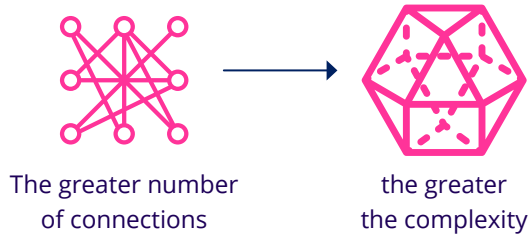
- Very Low: >10 bil.
- Low: 10-50 bil.
- Medium: 50-500 bil.
- High: 500-1,000 bil.
- Very High: >1,000 bil.

Our team of analysts uses advanced query and **ITONICS Insights** to garner the relevant information alongside our research and statistically derive the ratings from quantifiable historical and present data.

Each Technology is rated on Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL) to provide targeted and tailored analysis at your fingertips.

Complexity: How high is the complexity of this element?

A complexity score is derived based on the number of connections each Technology forms with other elements.



Technology Readiness Level (TRL): How mature is this element in the market?

Each Technology is mapped by its Technology Readiness Level (TRL) to determine its relative maturity.

PHASE	TRL	DEFINITION
RESEARCH	1	Basic principles observed
	2	Concept formulated
	3	Experimental proof of concept
DEVELOPMENT	4	Validated in lab
	5	Validated in relevant environment
	6	Demonstrated in relevant environment
DEPLOYMENT	7	System prototype demonstrated in operational environment
	8	System complete and qualified
	9	Actual system proven in operational environment

Exploring the ITONICS Radar

Having the right tools to manage innovations, technologies, projects, and opportunities is vital to act on your organization's innovation strategy in an increasingly uncertain and dynamic world. After all, what you can't manage, you cannot change.

Get started by exploring the ITONICS [Teaser Technology Radar](#) and [Teaser Trend Radar](#), displaying the elements that are most relevant

to your industry. Here you will find a read-only overview of each Technology and Trend.

Beyond what's available in the Teaser, the full content on the ITONICS Innovation Platform provides deeper insight into each Technology. It allows users to interact with and configure different elements to derive greater meaning and prompt informed decision-making.

The screenshot displays the ITONICS Innovation Platform interface. The main area shows a grid of 16 elements, each with a thumbnail image, a title, and a brief description. The elements are categorized by 'Trend, Inspiration and more...' and 'Status: Published'. The 'Advanced Filtering' sidebar on the right allows users to refine their search. It includes a 'Saved Filters' section with 'ICT' selected. The 'What element types do you want to show?' section has 'Trend', 'Technology', and 'Inspiration' selected. The 'What do you want to filter by?' section has 'Tags' selected. The sidebar also shows filters for 'Trend', 'Tags', 'Technology', and 'Inspiration', each with a search bar and a dropdown menu.

The ITONICS Innovation Platform provides access to:

- The full portfolio of **175+ Trends and Technologies**, each with detailed explanations of how they have developed, where they are currently having an impact, and how they could evolve into the future.
- **7,000+ Inspirations**, continually updated to illustrate how Trends and Technologies are being activated and brought to life by innovators, businesses, and consumers.
- The ability to set **Internal Ratings** such as Business Relevance, Strategic Fit, Internal Know-How, and Need for Action. Undertaken as a collaborative evaluation exercise within your organization, these ratings help build the consensus and commitment needed in the innovation journey.
- Interactive **Network Graph** visualizations that display first- and second-level relations for a selected element. New relations that hold strategic relevance to your organization can also be added to any network graph.
- Various **Tags** attributed to each element to help users focus their searches. A **Tag Filter** function allows advanced searching by tags and gives suggestions for related tags. To view the Trends, Technologies, and Inspirations that are most relevant to ICT, use **Advanced Filtering** and select the **Saved Filter: ICT**.

For full access to this content and functionality, register an account on ITONICS Cloud for free today.

REGISTER

Forces Shaping the Future of ICT

Context of Change

Defining the objectives and scope of environmental scanning activities like technology scouting requires a clear understanding of the context of change in your industry. Context provides a foundation for identifying and assessing the driving forces shaping the future. It points to evidence of where we see change happening in social, technological, economic, environmental, and political spheres and where the change will expand to next. It is the landscape upon which trends and technologies play out; the ability to navigate this landscape is the ability to adequately prepare for possible futures.

Forces Shaping the Future

Around the globe, several driving forces are impacting the information and communication technology (ICT) industry. The imperative for digitalization across all sectors has pushed the ICT industry to develop new technologies, products, and services at an unprecedented pace while attracting new investment, talent, and players to the market. Demand for flexibility, affordability, and accessibility of ICTs continues to rise while there is a persistent need for greater computing power and cybersecurity. These forces drive innovation and new approaches to value chains and business models in the industry. Moreover, with the potential to shape the future of work, bridge the digital divide, and spark economic development, ICT is itself a driving force.

Here we'll discuss some of the forces shaping the future of the ICT industry.

DIGITALIZATION DEMANDS

will continue to drive ICT innovation.

Demand for ICTs is at an all-time high as digital transformation becomes a requisite for success across industries, especially in the wake of the pandemic. This has created an ICT landscape replete with opportunities for investment, R&D, and M&A. With the industry's seemingly boundless market potential, new players are emerging to challenge big tech firms' collective dominance. With competition from capital-rich startups willing to push tech boundaries and cross-category businesses developing internal digital toolboxes, ICT innovation is increasingly fast-paced and prolific.

THE GLOBAL CHIP SHORTAGE

will prompt the re-evaluation of value chains.

Supply chain disruptions due to the pandemic have resulted in a global shortage of semiconductor chips. As such, demand is surging for these essential ICT components that power everything from smartphones and game consoles to automobiles and medical devices. With the chip shortage expected to persist through 2022, manufacturers, large and small, are leveraging their new market power to form lucrative partnerships and expand production. Meanwhile, chip buyers in ICT and several other industries are racing to introduce agility and transparency throughout their supply chains to prevent prolonged disruption.

III THE SHIFT TO HYBRID CLOUD

will create new ICT business models.

More organizations are adopting a cloud infrastructure, drawn to the cost savings, flexibility, and scalability that cloud-based technologies offer. Hybrid cloud strategies, in particular, promise the best of both worlds, with a combination of anything-as-a-service (XaaS) applications and on-premise data centers. Hybrid cloud gives organizations the ability to work across multiple computing environments and manage exponential data growth while also ensuring security, privacy, and compliance. Large public cloud providers are pouring investments into hybrid solutions, and new business models are emerging, such as content-as-a-service, AI-as-a-service, and IoT-as-a-service.

IV THE FUTURE OF WORK

will be powered by the ICT industry.

The future of work and the ICT industry have converged. The result is increasingly virtual, remote workforces, real-time operations, and process automation. These are shifts enabled by ICTs like artificial intelligence and machine learning, IoT, predictive analytics, and advancements in connectivity and computing power. Across industries, there is a drive to build internal ICT capabilities and automate work to keep pace with digitalization. In response, interest is growing in cloud-based XaaS solutions and partnerships with ICT companies to improve workplace operations and resource allocation.

V DEMOCRATIZATION OF TECHNOLOGY

will support grassroots innovation.

The democratization of technology is underway as the knowledge and capabilities surrounding high-tech platforms become more accessible. ICT tools like low- and no-code platforms, robotic process automation, and open-source AI applications give rise to citizen developers and empower non-technical individuals to design solutions that incorporate their unique perspective or expertise. This helps bridge the skills gap many organizations face as they increasingly digitalize their processes and product offerings. Democratizing technology creates an environment that supports grassroots innovation, practically and culturally, throughout an organization.

VI ISSUES OF DIGITAL PARITY

will require ICT companies to take action.

Despite many ICTs becoming more accessible, the effects of digital parity are sharper than ever. These are the tools that enable digital transformation—and without them, businesses, economies, and society are at a disadvantage. Enhancing ICT access and capabilities is especially important for developing economies where there are opportunities to leapfrog industrial-age infrastructure. The ICT industry must play a role in investigating new technologies and services that address the digital divide by, at minimum, improving internet penetration and, at best, providing practical hardware, software, and skills training.



Use this context to help better understand the strategic importance and innovation opportunities associated with the game-changing technologies identified for the ICT industry.

Game-Changing Technologies for ICT

Technology Navigation

Through a process of qualitative and quantitative industry research, our team of analysts conducted relevance analysis in order to identify the Technologies within our portfolio that are **most relevant and influential in the ICT industry**.

Game-Changing Technologies for ICT

Explore the selection of Technologies at play in the ICT industry. **Click on the Technology** below to view it in the ITONICS [Teaser Technology Radar](#):

- [3D Memory Chip](#)
- [5G Mobile Network*](#)
- [Affective Computing](#)
- [AI Avatars](#)
- [AI for Everybody](#)
- [API Economy](#)
- [Brain-Computer Interfaces](#)
- [Citizen AI](#)
- [Conversational Systems](#)
- [Deception Technology](#)
- [DevSecOps](#)
- [Digital Twins*](#)
- [Distributed Cloud](#)
- [Distributed Ledger Technology](#)
- [DNA Data Storage](#)
- [Edge Computing](#)
- [Extended Reality](#)
- [Eye-tracking Technology](#)
- [Facial Recognition and Biometrics](#)
- [Fintech](#)
- [Hyper Converged Infrastructure](#)
- [Internet of Thinking*](#)
- [Low-Code No-Code Platforms*](#)
- [Machine Learning](#)
- [Multi-Factor Authentication](#)
- [Nanosatellites](#)
- [Natural Language Processing](#)
- [No-touch Payments](#)
- [Privacy Enhancing Technologies](#)
- [Programmatic Advertising](#)
- [Quantum Computing*](#)
- [SD WAN](#)
- [Self-adaptive Security](#)
- [Self-writing Software](#)
- [Unified Communications Services](#)

*These Technologies make up ITONICS' pick of the ICT industry's top 5 game-changing Technologies. These are unpacked in further detail in this report.



ITONICS Top 5 Game-Changing Technologies for ICT

Click below to read more about the industry potential of these Technologies and examples of how organizations are applying them as solutions:

1. [5G Mobile Network](#)
2. [Digital Twins](#)
3. [Internet of Thinking](#)
4. [Low-Code No-Code Platforms](#)
5. [Quantum Computing](#)

▼ ICT

DIGITALIZATION & INFRASTRUCTURE

5G Mobile Network

The 5th Generation Mobile Network (5G) is the new global wireless standard after 1G, 2G, 3G, and 4G, and promises to connect virtually everyone and everything. The 5G mobile network is designed to facilitate higher, multi-Gbps peak data speeds, low latency, increased reliability, increased network capacity, and a more uniform user experience.

The technology uses ultra-wideband (UWB) networks with greater band breadth at lower energy levels. The high spectrum prices that governments quote service providers—which would ultimately translate into high subscription prices for customers—could hinder the market growth of 5G mobile technology. Other challenges include small cell deployments and fiber backhaul implementations.



Technology Ratings

Scope



Potential Impact



Complexity

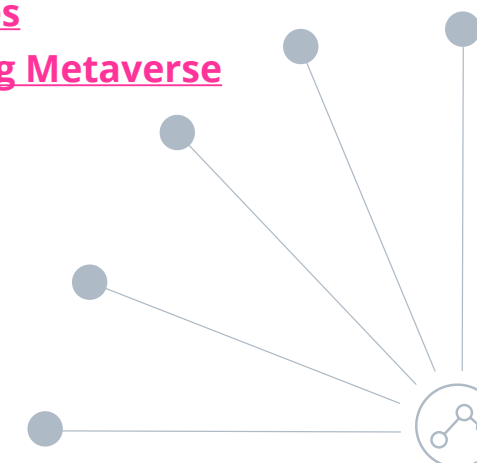


Technology Readiness Level



Related Trends

- [Data Ethics](#)
- [Digital Equality](#)
- [Mobility Ecosystems](#)
- [Smart Cities](#)
- [The Gaming Metaverse](#)





Industry Relevance

5G for Enterprise

Private 5G networks are suitable for enterprise solutions such as smart factories as they do not share traffic with other cellular networks. Other relevant features include high bandwidth, ultra-low latency, and high security and reliability. However, the initial cost can pose a barrier due to the need for integrating infrastructure.

Operational Efficiencies

The high-bandwidth and low-latency advantages of 5G support inference (i.e., the deployment of AI) at the edge. This, in turn, allows for real-time applications that rely on the ability to process a continuous stream of input data and yield an output that informs action in real-time, such as inspecting production lines for defects, behavior monitoring, or facial recognition.

Next-Gen Drone Platforms

5G is powering the next generation of drones to capture and transmit large amounts of data in real-time and over greater distances. Integrating AI into 5G drone platforms also makes it possible to sort through data to determine what is most valuable, reducing the amount of raw traffic on a network. There is a wide range of commercial applications, including film, product delivery, public safety, and agriculture.

The 5G market is projected to reach 2.6 billion subscriptions by 2026, contributing \$942 billion to mobile operator revenue.

Source: ABI Research, 2021



How is it a Game Changer?

The widespread deployment of 5G will support the adoption and advancement of technologies like telemedicine, AI-enabled customer service, precision agriculture, autonomous vehicles, etc. The technology could impact various sectors, including education, video surveillance, virtual and augmented reality, agriculture, urban infrastructure, and health, facilitating increased democratization and flexibility. In the future, 5G mobile data will enable the digitization of the physical world by removing the friction and moving data back and forth at very high speeds, changing the world in day-to-day terms.



Inspiration

Volkswagen launches a local standalone 5G network—a “campus network”—at its main production plant in Wolfberg, Germany. The network is equipped with a dedicated 5G radio frequency to ensure data transmission is secure and delay-free. This pilot project is a step towards Volkswagen achieving fully-networked smart factories.

Digital Twins

A Digital Twin is a virtual replica used to run simulations to predict how a process or product may perform in real life. Digital Twins technology also allows users to continually optimize a product or service even after its physical counterpart has been built.

Digital Twins are reducing operational costs and increasing service efficiency in a variety of industries. Machine Learning and the Internet of Things (IoT) are just two of the technologies enabling Digital Twins. A limitation of this technology is that to be truly effective, digital replicas must be in place throughout the value chain.



Technology Ratings

Scope



Potential Impact



Complexity

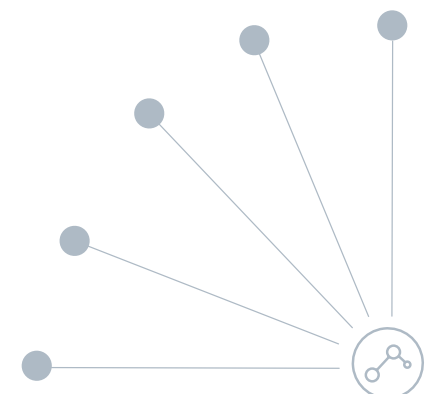


Technology Readiness Level



Related Trends

- [Automating a Greener World](#)
- [Distributed Manufacturing](#)
- [Green and Lean](#)
- [Smart Cities](#)



Industry Relevance

Closing the Value Chain Loop

Digital Twin technology revolutionizes the end-to-end value chain by establishing a unique, traceable 'digital fingerprint' for physical products. It enables iterative improvement by incorporating real-time feedback from various stakeholders at every step from product design through to end-of-life, ultimately creating the potential for a closed-loop, circular value chain.

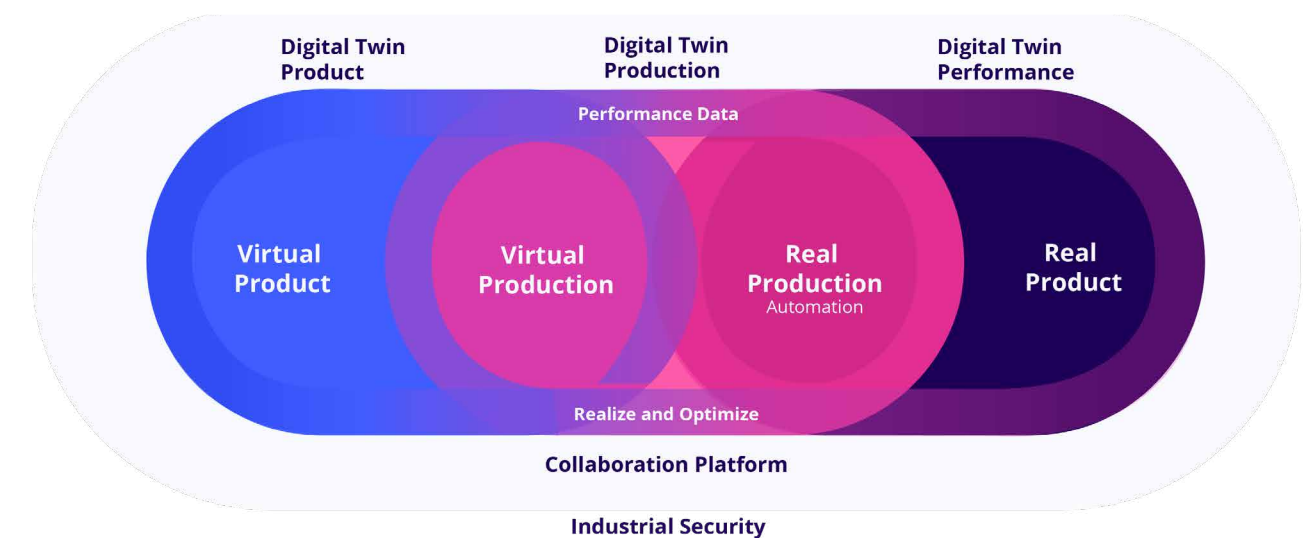
Predicting Maintenance Needs

Digital Twins enhance predictive analytics to estimate product life cycles based on diverse variables in addition to real-world data from sensors. Companies can perform preemptive maintenance, especially when there are uncertain or changing variables in the system. This ability to generate multiple outcomes goes beyond the conventional applications of predictive analytics.

Virtual Training Environments

Immersive field simulators (IFS), powered by digital twin technology, provide mixed reality-based training solutions to help them close the industrial skills gap. Workers can interact with complex equipment and gain valuable technical instruction by engaging with an accurate replica of the real-world environment. This is shown to be significantly more effective than traditional classroom training or e-learning.

Digital Twin Continuous Optimization Loop



Source: Adapted from Siemens, 2020



How is it a Game Changer?

Digital Twin technology takes the process of designing a product or service and revolutionizes it by making implementation iterative and adaptive, allowing for ongoing optimization.

The Internet of Behavior and the imminent proliferation of 5G technology will further empower Digital Twins. Valued at \$3.1 billion in 2020 and projected to grow to \$48.2 billion by 2026, this technology's importance lies in its multi-industry applicability. As specialists in this technology grow, expect its adoption across numerous value chains.



Inspiration

Connected product innovator **EON** uses Digital Twin technology to create a unique digital ID for clothing items. Power by a QR code and hosted on the cloud, this digital passport traces every item through the value chain, offers customers product-level impact reporting, and enables greater circularity.

Internet of Thinking

The Internet of Thinking refers to systems that can process and analyze the data collected by IoT devices closer to the origin of the data without relying on a central cloud server. This technology is focused on maximizing the capabilities of hardware by harnessing a mixture of IoT and edge computing.

By implementing analytics capabilities near the data sources, this technology helps stakeholders gain real-time insights, allowing them to make immediate operational adjustments. To be adequately leveraged, this technology requires physical infrastructural overhauls across the supply chain, a process associated with high costs.



Technology Ratings

Scope



Potential Impact



Complexity

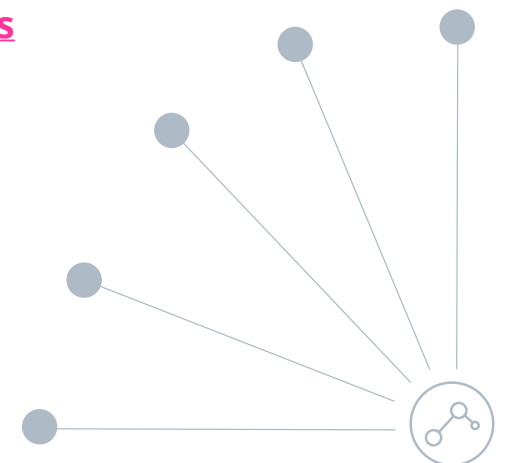


Technology Readiness Level



Related Trends

- [Automating a Greener World](#)
- [Me Commerce](#)
- [Mobility Ecosystems](#)
- [Smart Cities](#)



Industry Relevance

Automated Asset Management

Automating asset tracking through the Internet of Thinking streamlines workflows, saving time and resources while reducing the likelihood of error. By collecting data on the performance and use of equipment or inventory over time, companies can maintain assets with greater precision and efficiency. However, there are privacy and security hurdles to overcome as well as a lack of standardization across devices and platforms.

Conscious Cameras

Cameras equipped with Internet of Thinking capabilities can process images and perform analytics at the source. This approach removes the need to send potentially sensitive data to a central cloud, uses less bandwidth, reduces lag time, and improves data security. IoT-infused cameras can monitor people, spaces, and items with uses in smart cities, commerce, and homes.

Training Manufacturing Robots

The Internet of Thinking enables smart factories that use deep learning to train manufacturing robots on the job. These robots can continuously optimize operations by learning complex tasks like product customization, anomaly detection, and predictive maintenance. This raises the level of transparency, improves worker safety, and facilitates remote monitoring and management.

"Artificial Intelligence can act as the brains to the body of an IoT solution, synthesizing new algorithms to react and even become proactive about addressing potential problems."



Source: Barbara IoT, 2021



How is it a Game Changer?

Intelligent infrastructure and interconnected systems with analytical and real-time data transmission capabilities will transform many industries. The unique selling point of this technology is its ability to manage change autonomously to optimize work processes, reducing costs and increasing productivity. This generation of intelligent solutions will transform physical environments, and companies will need to invest in infrastructural development and edge computing to fully take advantage of this technology's capabilities.



Inspiration

Edge computing embedded solutions provider **SMART Wireless Computer** has developed a new system on module (SoM) that enables several advanced visual computing applications. It equips connected cameras with on-device AI and ML capabilities for fast data analysis and decision making. It is also power-efficient and cost-effective.

Low-Code No-Code Platforms

Low-Code and No-Code Platforms are software development environments in which users are able to build applications using visual user interfaces. These platforms typically include features such as visual modeling and drag-and-drop menus that allow users to build websites or applications with zero to minimal actual coding.

This can significantly reduce development time, time-to-market, and expenses associated with software development. Technologies such as AI, big data, and API-based microservices are often used in low- and no-code platforms. Despite being a highly efficient means of building simple products, these platforms are insufficient for complex or highly customized products or features, which still require manual coding.



Technology Ratings

Scope



Potential Impact



Complexity

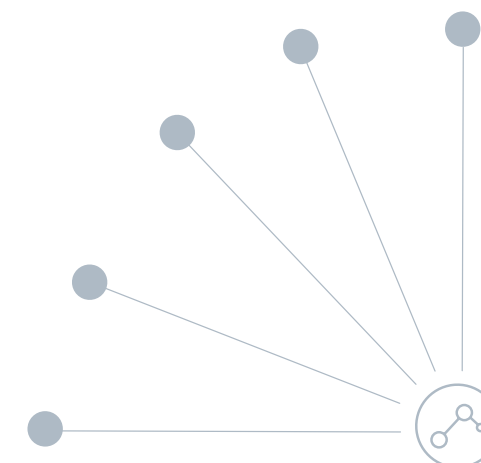


Technology Readiness Level



Related Trends

- [Democratization of Education](#)
- [Digital Equality](#)
- [Product-as-a-Service](#)





Industry Relevance

Efficient Resource Allocation

Low- and no-code platforms allow teams to manage internal resources better, allocating them to more productive, impactful activities. In addition to removing the need to write code line by line, this modular approach allows developers to focus on more critical and complex tasks. Non-IT teams can also build prototypes without expending the capacity of development teams.

Agility and Resilience

Low- and no-code platforms reduce development cycles and time-to-market. Organizations can keep pace with market changes by quickly pivoting to new initiatives and responding to customers' nascent needs. This agility translates to greater resilience in the face of disruptive and abrupt changes like those experienced during the pandemic.

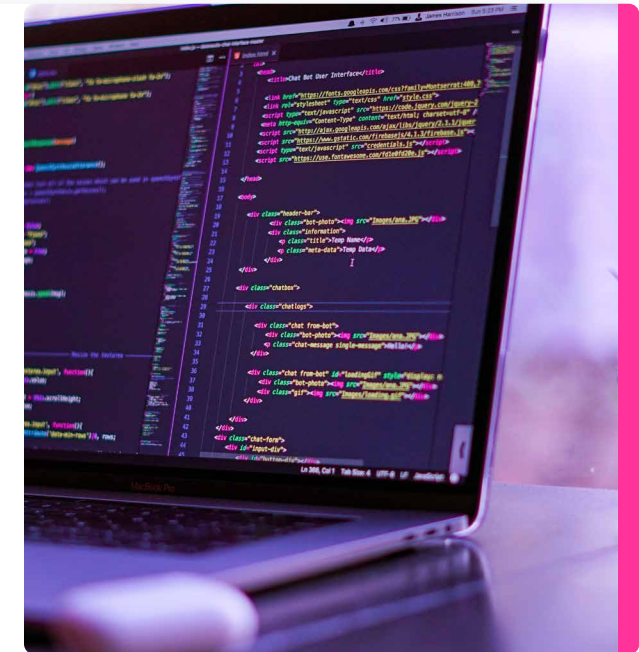
Representing Diverse Knowledge

Low- and no-code platforms democratize software development allowing for more diverse perspectives and knowledge to be represented in technology. For instance, subject matter experts who lack coding skills can design and build bespoke solutions that specifically cater to a specific end-user. This opens the door for citizen developers and a new generation of software entrepreneurs.

"I think the next generation of founders and business owners aren't going to be people with a ton of engineering experience. They're probably going to be teachers building software for teachers, marketers building software for marketers. We're going to see some really exciting innovation coming from that."

— Andrew Ofstad, Airtable Co-Founder

Source: [VentureBeat, 2021](#)



How is it a Game Changer?

Low-Code No-Code Platforms can disrupt the software industry as they enable individuals with no coding expertise to build and deploy their own websites and applications. In organizations, this means that less tech-savvy employees can use low- and no-code platforms to build useful applications without being limited by developer resource availability and bottlenecks. This shifts the control of the product development from software developers to the people who actually use the software.



Inspiration

Customer engagement company **Verint** launches its Intelligent Virtual Assistant Professional (IVA Pro) Package™ that can automatically turn conversation data into self-service experiences. The low-code conversational AI package allows businesses to quickly deploy production-ready customer support chatbots.

▼ ICT

DIGITALIZATION & INFRASTRUCTURE

Quantum Computing

Quantum Computing is the process of leveraging quantum mechanics as a means of processing information. This technology utilizes atoms, ions, photons, or electrons instead of binary code, allowing information to be processed in a very different way from traditional computers.

The capabilities of Quantum Computing include solving problems involving complex variables with a multitude of potential outcomes. Uses of Quantum Computing range from redefining risk assessment in the finance industry to optimizing supply chain management for large corporations. Challenges include scalability, fault tolerance, and a shortage of skills needed to map problems to the quantum space—which differ significantly from knowledge of classical computers.



Technology Ratings

Scope



Potential Impact



Complexity

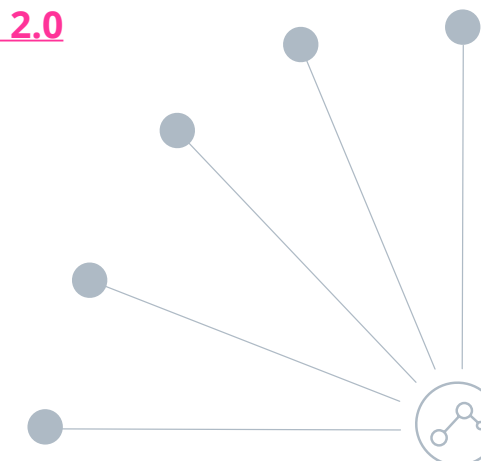


Technology Readiness Level



Related Trends

- [Automating a Greener World](#)
- [Data Secure by Design](#)
- [Green and Lean](#)
- [Space Race 2.0](#)





Industry Relevance

Unprecedented Computational Power

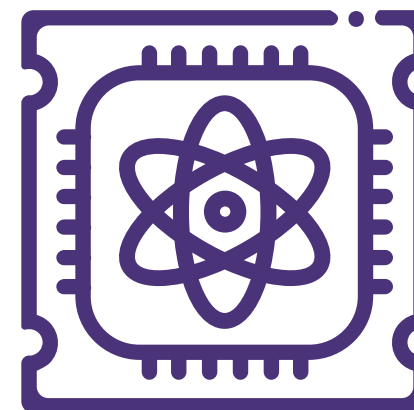
Quantum computers open up new possibilities for data science with the ability to process huge, complex, and live data sets. This allows for advanced mathematical modeling that can perform parallel calculations almost instantaneously. Going far beyond conventional computational power, quantum-based modeling can consider a theoretically limitless number of variables.

Secure Communication Network

Quantum communication creates a theoretically tamper-proof communication network, resulting in more secure and reliable data transfer. It relies on techniques like quantum key distribution (QKD) that protect encryption keys from being altered, copied, or intercepted without detection. QKD adoption is currently limited by the need for expensive transmitters and receivers.

Quantum Sensing

Quantum sensors use subatomic particles that are highly sensitive to external variables such as rotation, acceleration, time, and electric, magnetic, and gravitational fields. This raises the accuracy of sensing and measurement. When combined with imaging capabilities, quantum sensors can also enhance the sensitivity of high-resolution microscopy or macroscopy.



Quantum Computing is expected to become a **\$1 trillion industry** over the next three decades.

Source: Honeywell, 2021



How is it a Game Changer?

A quantum computer can solve a complex problem in only a matter of minutes, whereas a supercomputer may take thousands of years to arrive at the same solution.

This technology can disrupt many industries and work effectively alongside technologies such as machine learning and the IoT. With investments pouring into R&D for quantum computing and its commercial applications, the technology is expected to usher in the next age of large-scale combinatorics and problem-solving.



Inspiration

Fintech firm **Ally** is joining Microsoft's Azure Quantum program to explore quantum computing in the banking and finance sector. The two companies will test several potential use cases ranging from optimizing business processes to powering complex financial models.

Conclusion

Closing Remarks

Innovation, development, and collaboration in the information and communication technology industry are driven, in part, by the demands arising from the growing imperative for digital transformation across sectors. And, in turn, advancements in ICT accelerate digitalization efforts and create new possibilities for capturing the true value of digital transformation. In a sense, the ICT industry and the digital economy are locked in a positive feedback loop—where progress in one amplifies and hastens progress in the other.

The deployment of ICTs like the **5G Mobile Network**, **Distributed Cloud**, and **Edge Computing** are evidence of this relationship. These core technologies provide the infrastructure to enhance connectivity and computational capacity. They facilitate the further adoption of emerging technologies, including **Digital Twins** and **Internet of Thinking**, to lead the transformation to digital, automated, connected, and data-centric.

The COVID-19 pandemic forced many organizations to expedite their ICT agendas, urgently implementing the tools and building the capabilities to enable remote workforces, real-time operations, and process automation. Indeed, the future of work will rely heavily on the ICT industry.

As demand for ICT components, products, and services surges, amidst a global shortage of semiconductor chips, many organizations must re-evaluate their value chains. ICT companies are in an advantageous position to secure investment and partnerships, expand production, and advance R&D into less mature areas like **Quantum Computing** and **Affective Computing**.

Meanwhile, a growing number of ICT-reliant industries are seeking ways to bridge the gaps in their current ICT capabilities. This has many organizations exploring M&A opportunities, talent acquisition, and open-source and modular tech solutions like **Low-Code No-Code Platforms**, **API Economy**, and **AI For Everybody**.

Within this context of change, we provide a set of questions for organizations in ICT to consider in the hope of nurturing fresh thinking about the future they wish to be a part of, and play an active role in helping to create.

- What if influential ICT organizations, governments, and other key stakeholders form coalitions to improve digital literacy and access to technology?
- What if the global chip shortage persists longer than predicted and further deepens the digital divide?
- What if the high demand for ICTs enables new, more agile entrants to gain market share and challenge incumbents in the industry?
- What if regionally disparate and lagging ICT regulations, standards, and security issues impede innovation and the adoption of emerging technologies?
- What if the democratization of ICT tools and capabilities allows for the representation of more diverse perspectives and a new generation of entrepreneurs in ICT?
- What if advancements in connectivity and computing power converge with new cloud-driven and XaaS ICT business models?

There are countless questions to be asked about what the future holds for ICT. Finding possible answers to these questions requires a systematic approach and a structured innovation strategy.

The Way Forward

Create a future competitive advantage tomorrow by defining your strategic direction today.

Making better decisions for tomorrow relies on an organization's ability to collect, understand, and act on innovation intelligence—the multitude of building blocks that make up an organization's innovation process.

Scouting the trends, technologies, startups, and other forces of change that are shaping your industry is a crucial first step in this process. But turning this information into innovation intelligence, and subsequently into action, requires additional steps and capabilities that fall within Foresight and Strategy.

Taking Trends & Technologies to Opportunities



1. Discover ITONICS Trends



2. Build Internal Consensus



3. Develop Pictures of the Future

1. Discover ITONICS Trends

Supplement the insights gained in this industry-relevant technology report with an immersion into the trend landscape.

Get started by exploring the ITONICS [Teaser Trend Radar](#) displaying the elements that are most relevant to your industry.

For a full view of the trend landscape, our [Where to Play 2021+ Trend Report](#) contains the complete ITONICS Trend portfolio, presenting 90+ Trends with real-life inspirations and rich analysis.



DOWNLOAD NOW

2. Build Internal Consensus

In establishing **Where to Play**, it is essential to gain consensus and raise alignment within your organization. This can be achieved through a process of collaborative evaluation. Invite internal stakeholders and experts to participate in rating elements—trends, technologies, scenarios, opportunities, etc.—based on unique industry- and company-specific parameters.

When undertaken in the environmental scanning stage, an internal rating exercise helps empower teams with the consensus needed to ensure strategic relevance, strengthen buy-in, and act decisively.

ITONICS has provided the following internal rating criteria for organizations to consider for trends and technologies:

Technologies

- Technology Attractiveness: How high is the potential value of the technology?
- Internal Know-How: How much internal know-how does your business possess with regard to this element?
- Need for Action: How important is it that your organization take action with regard to this element?

Trends

- Business Relevance: How relevant is this element to your business?
- Strategic Fit: How well does this element fit into your organization's overall strategy?
- Need for Action: How important is it that your organization take action with regard to this element?

The ratings above are pre-set in the ITONICS Showroom. However, organizations can tailor rating criteria to align with their own set of needs and workflows.

3. Develop Pictures of the Future

It's not enough to identify the trends, technologies, disruptive startups, and other drivers of change that are relevant to your industry and organization. To develop an innovation strategy that remains effective beyond the time horizon of key drivers, organizations need to develop realistic and plausible pictures of the future in which these various drivers will unfold. This is done through a process of **scenario planning** and is the basis for discovering future opportunities upon which to act.

Scenario planning is a strategic tool commonly used by key decision-makers, innovation leads, and strategists to find focused foresight, grounded in dependable analysis. This equips them to anticipate exposures appropriately, evaluate innovation opportunities, and inform proactive responses.

What is a scenario?

In the context of business planning and strategy, a scenario is a postulated sequence or combination of events projected to take place that could hold relevance to an organization's future state.

Developing plausible, actionable scenarios requires a systematic approach and organizational participation. It builds on the internal rating exercise, which serves to identify those trends and technologies that hold the greatest strategic relevance and potential. From here, your organization must derive the underlying drivers that are influencing its business environment and extrapolate the different trajectories each driver could take.

Plotting these trajectories against one another and engaging your team's collective and creative input reveals multiple scenario narratives. While each narrative represents a possible future for which your organization may need to prepare, internal consistency and strategic objectives point to those scenarios that should be prioritized.

Your team should prioritize the scenarios they feel hold the most strategic relevance by asking the following two questions:

- Is this a future we hope to play an integral role in creating and shaping?
- Is this a future we hope to mitigate and avoid through thoughtful tactics?

The selected scenarios form a foundational springboard from which your organization can best derive and define clear opportunities—i.e., possible solutions or responses to the various scenario narratives. Use the **ITONICS Roadmap** to plot critical scenario events and develop a timeline of innovation activities required to explore the various opportunities ahead of the horizon in which they are set to occur.

In this way, scenario planning provides organizations with the information required to act on opportunities timeously—as well as the evidence needed to develop appropriate capabilities and assets, actively shape our world, and influence outcomes as they steer towards the future.

To further your innovation journey, all the Trends, Technologies, and Inspirations selected as most relevant to ICT can be found on the ITONICS Innovation Platform using the saved filter: **ICT**.

The ITONICS solution supports end2end innovation management, from environmental scanning and trend and technology management to building internal consensus and roadmapping.

REGISTER



About ITONICS

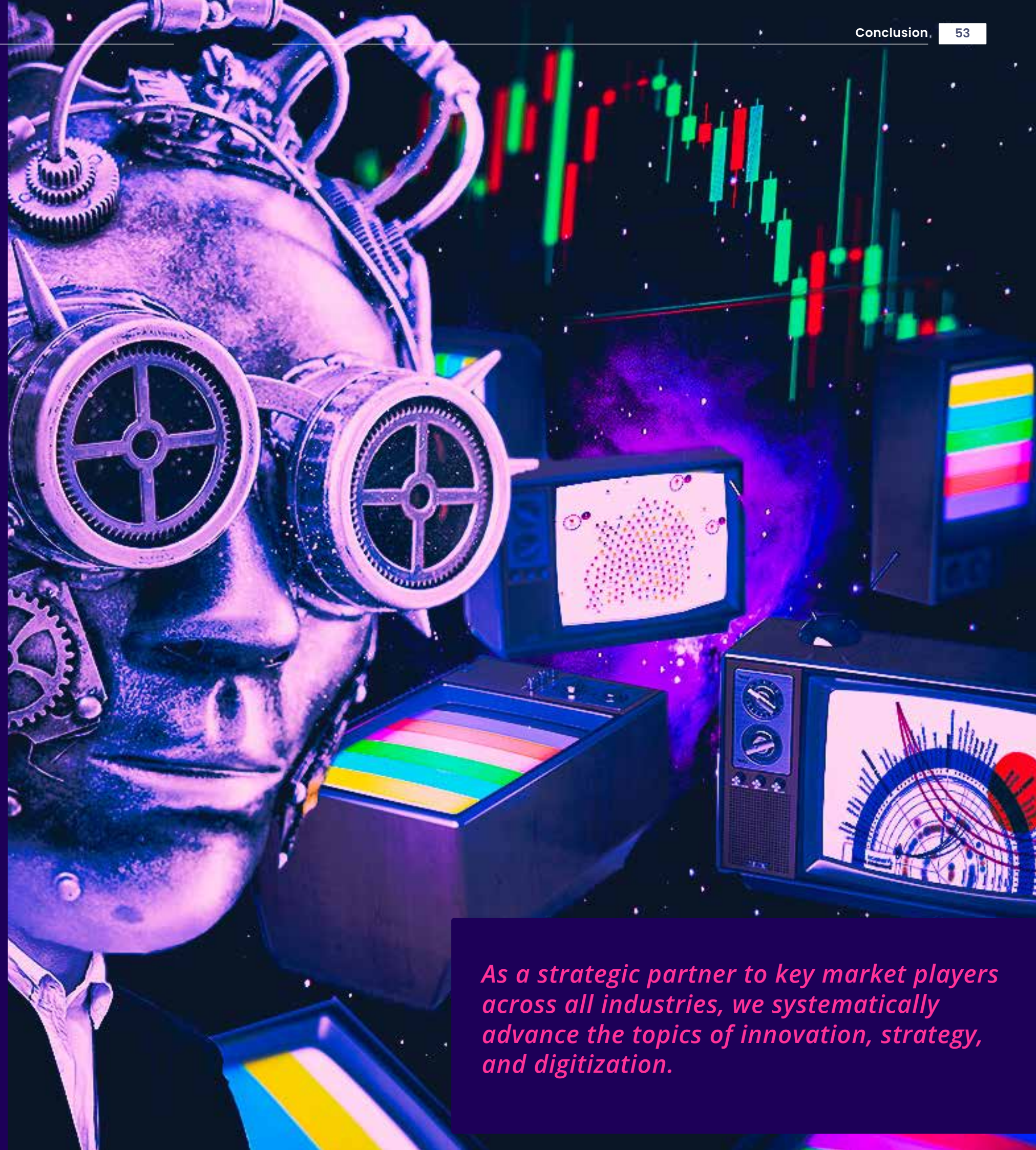
We build AI-powered SaaS to innovate, grow, and disrupt.

Our data-driven software platform helps organizations around the globe to identify emerging technologies, trends, and market potentials and translate them into powerful growth strategies.

Supported by artificial intelligence, companies can manage their entire innovation process in a modular software suite to efficiently achieve their business goals and remain future-proof.

Working with global teams to innovate new products, services, and business models, ITONICS professional services inspire, guide, and accompany organizations on their innovation journey. With more than 115 experts on four continents, we support innovation leaders such as adidas, AUDI, CISCO, Intel, Johnson & Johnson, and SAP.

As a strategic partner to key market players across all industries, we systematically advance the topics of innovation, strategy, and digitalization.



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What's Next

Turn Innovation Intelligence into Action

Your digital toolbox for game-changing innovation ▪ Industry-specific Trend and Emerging Technology Radars ▪ Strategic Roadmaps that guide you into the future ▪ Lean Portfolios to manage ideas, technologies, projects, and opportunities	Free access to inspiring insights & content updates ▪ Access to 6 million+ signals to uncover insights at large scale ▪ 90+ Trends, 85+ Emerging Technologies updated annually ▪ 7,000+ freshly curated inspirations maintained	Dependable thought leadership & advisory services ▪ Free innovation maturity assessment ▪ Exclusive access to COFIM Masterclass content ▪ Access to our international innovation community
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You can find us around the globe



ITONICS is a leading SaaS provider of systematic innovation management. The ITONICS Innovation OS combined with a systematic framework to steer innovation efforts helps companies to identify emerging technologies, trends, and market potential and to translate them into customized growth strategies.

With more than 150 experts worldwide, we support innovation leaders such as adidas, AUDI, BMW, CISCO, Intel, Johnson & Johnson, and KPMG.

Get a Demo

Let's Chat

Discover more at www.itonics-innovation.com



EMPOWER EVERYBODY TO INNOVATE



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