

# LTIMindtree CRYSTAL

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Technology Radar 2023 Refresh

**“Beyond-The-Horizon”** Technologies for cross-industry enterprises.



# From CTO's Desk



**Dear All,**

In recent times, the Digitalization March has gained significant momentum, as the pandemic revealed the need for organizations to inculcate a tech outlook. With technology priorities now translating to business priorities, we are experiencing a rise in 'technology-driven value' in business and operating models. Across domains, we are witnessing the formation of digital business platforms, FinOps, Industry 4.0, digital twins, and enterprise metaverse. Enabling monetization of digital assets, such as data, APIs, IP, and virtual objects, in addition to blockchain-based tokenization, leads to an increased revenue contribution from the digital stream. Environmental excellence is at the core of new business streams; for example, predictive maintenance over operational data in industries drives efficiency in the complex manufacturing supply. This enables reinvestment of savings or offering more value to customers through innovation and lower costs. To capitalize on these digital value streams, businesses are opting for agile and open processes. These processes enhance resilience and adapt to emerging opportunities by optimizing IT spending, connecting value chains, and leveraging digital assets.

We have observed that the digital domain has the highest concentration of technologies nearing the mainstream market riding on the success of Generative AI. The data and cloud domains follow close by, but there is no significant change in technologies for the privacy and security domain. Investment in the cloud is changing as organizations move from in-house cloud solutions to vertical-market clouds. These platforms serve specific industries, offering industry-specific data sets from different vendors to help them grow their businesses.

The computing space is flourishing even though edge-powered systems are the norm for the industry. Instead of chasing qubit records, quantum computing aims for practical and long-term outcomes. Efforts and investments are being channeled into Decision Intelligence, Quantum Computing, and Heterogeneous computing. These areas show potential for better computation outputs and players promoting innovation with emerging computation techniques.

The market for Immersive Technologies such as AR, Computer Vision, Digital Twins, MR, and Smart Spaces is expected to increase significantly in the coming years. Virtual experiences, such as the metaverse, are not just for fun anymore and are becoming business tools for many companies. They are tapping into the opportunities of "unbounded and immersive reality" to redefine traditional training programs and create a talent marketplace. The market potential for VR and Metaverse is expected to remain steady due to the dependency on exclusive hardware. This may be addressed once competitive pricing starts with more players entering the space.

We are delighted to present an update on the first edition of the LTIMindtree Crystal - Technology Radar 2022-23. Our journey of technology empowerment began with this publication, and we are now pleased to offer a refreshed view aligned with the current technology landscape. This bird's eye view of the evolving landscape highlights the technology maturity and interdependence across segments. As we move on this journey of technology empowerment and enable newer ways of thinking and reforming, I would love to know what's on the mind of our Solver's Tribe.

Warm Regards,

**Aan Chauhan**  
CTO, LTIMindtree

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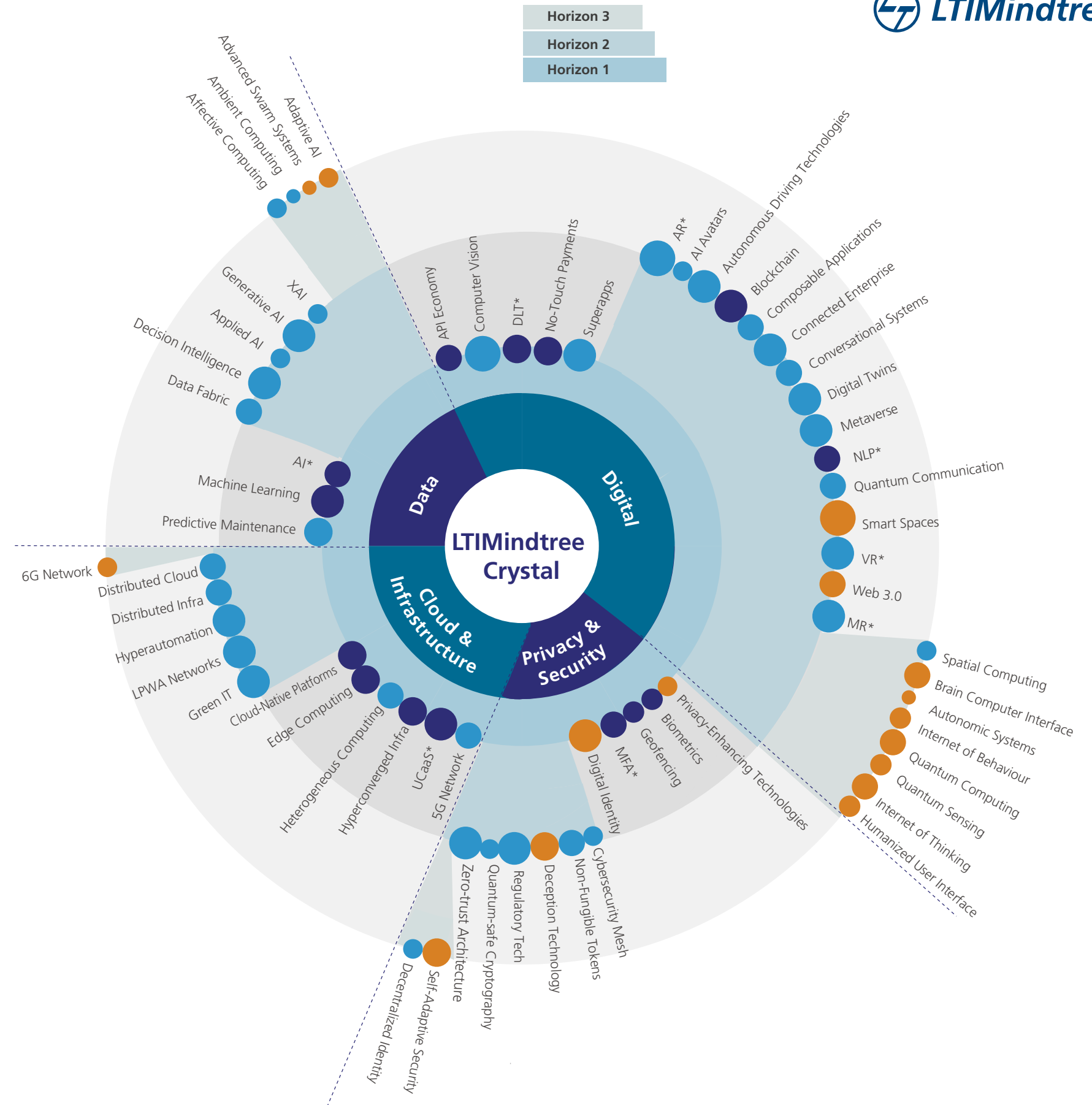
# LTIMindtree Crystal - Technology Radar 2023 Refresh

Market Potential (USD)	Emerging	Improving	Mature
0-100Mn			
100 Mn - 500 Mn			
500 Mn - 1 Bn			
1 Bn - 10 Bn			
10Bn +			

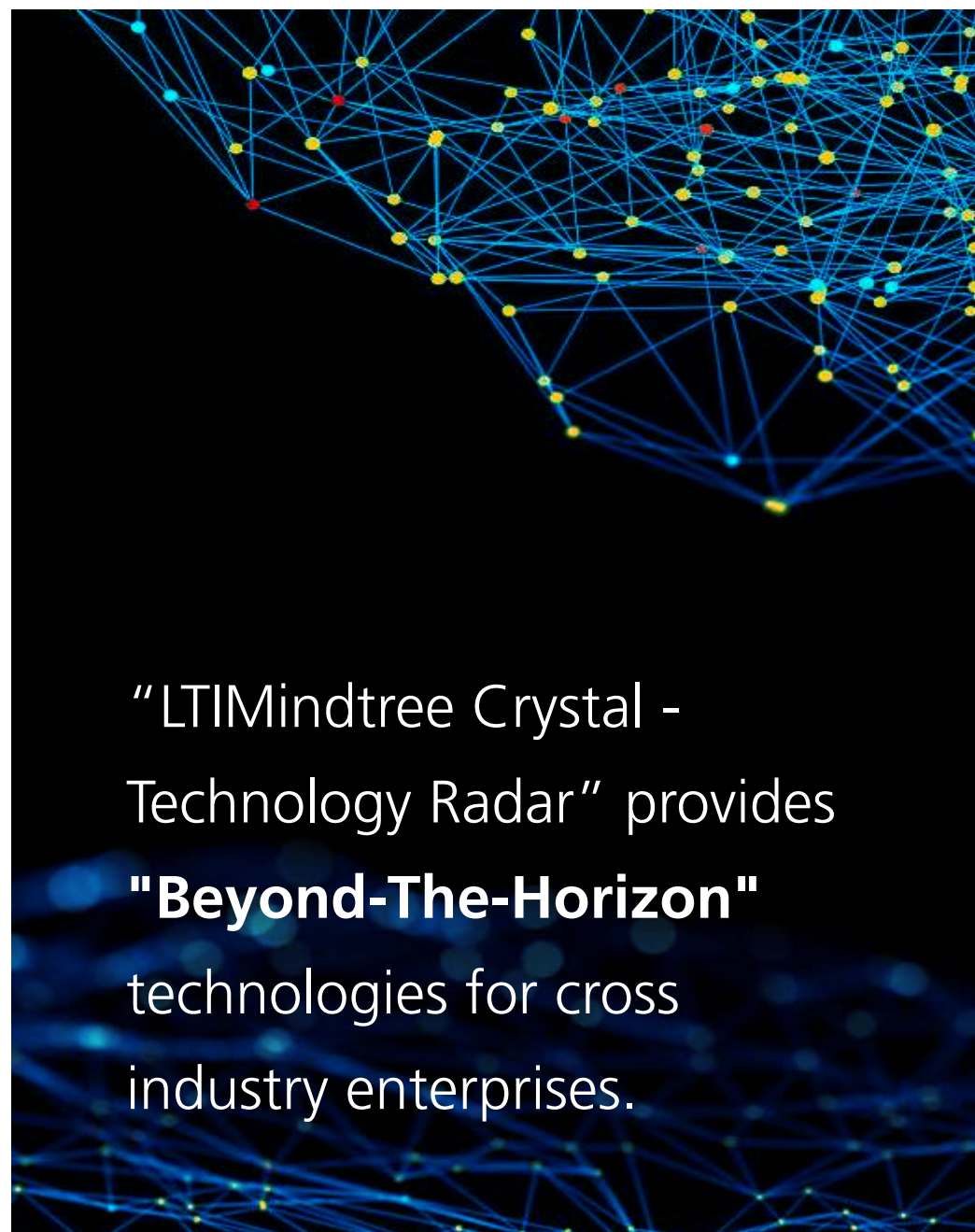
## Abbreviations:

<b>AI</b> – Artificial Intelligence	<b>VR</b> – Virtual Reality
<b>AR</b> – Augmented Reality	<b>MR</b> – Mixed Reality
<b>DLT</b> – Distributed Ledger Technology	<b>XAI</b> – Explainable Distributed Infrastructure
<b>MFA</b> – Multi-Factor Authentication	<b>LPWA Network</b> – Low Power Wide Area Network
<b>NLP</b> – Natural Language Processing	<b>Green IT</b> – Green Information Technology
<b>UCaaS</b> – Unified Communications-as-a-Service	<b>API</b> – Application Programming Interface

Note: Next page entails the corresponding horizon, grouped by their technology segment



# LTIMindtree Crystal – Technology Radar: Ratings Scale



## Horizon

Horizon is defined as the period/ span from the conception of a new idea until it becomes mainstream.

### Horizon 1

The technology will reach the mainstream market within 2 years

### Horizon 2

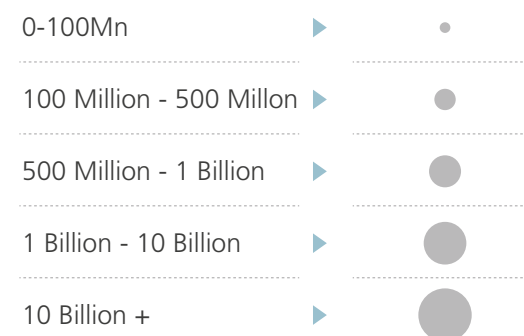
The technology will reach the mainstream market within 2 - 5 years

### Horizon 3

The technology will take more than 5 years to reach the mainstream market

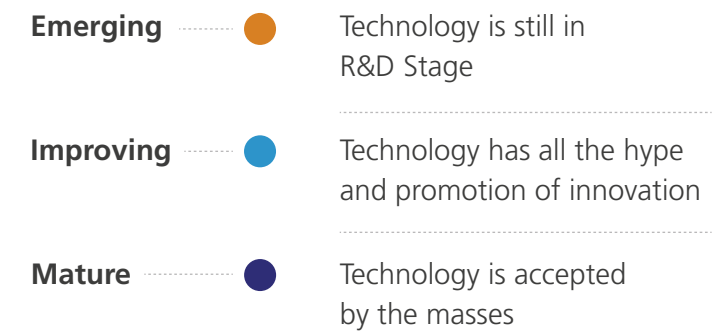
## Market Potential (USD)

The **market potential** of every technology is measured as the expected revenue opportunity of the technology.



## Adoption Phase

Adoption maturity of technology in the market



# LTIMindtree Crystal - Technology Radar Navigation

The technologies listed below are arranged according to their corresponding horizon and grouped by their technology segment. This report consists of the new technologies added as part of the refresh, are hyperlinked below. For information on the other technologies, please refer to [LTIMindtree Crystal - Technology Radar 2022-23](#).

## Horizon 1

### 1. Cloud & Infrastructure

- [5G Network](#) [Horizon Change]
- [Heterogeneous Computing](#) [New]
- Cloud-Native Platforms
- Edge Computing
- Hyperconverged Infrastructure
- Unified Communication-as-a-Service

### 2. Data

- [Predictive Maintenance](#) [Horizon Change]
- Machine Learning
- Artificial Intelligence

### 3. Digital

- [API Economy](#) [Horizon Change]
- [Computer Vision](#) [Horizon Change]
- [Superapps](#) [New]
- No-Touch Payment
- Distributed Ledger Technology

### 4. Privacy & Security

- [Digital Identity](#) [New]
- [Quantum-Safe Cryptography](#) [New]
- Biometrics
- Geofencing
- Multi-Factor Authentication
- Privacy Enhancing Technologies

## Horizon 2

### 1. Cloud & Infrastructure

- [Low-power, wide-area \(LPWA\) network](#) [New]
- [Green IT](#) [New]
- Distributed Cloud
- Distributed Infrastructure
- Hyperautomation

### 2. Data

- [Applied AI](#) [New]
- [Explainable AI \(XAI\)](#) [New]
- [Generative AI](#) [Horizon Change]
- Decision Intelligence
- Data Fabric

### 3. Digital

- [Autonomous Driving Technologies](#) [New]
- [Connected Enterprise](#) [New]
- [Smart Spaces](#) [Horizon Change]
- [Web 3.0](#) [Horizon Change]
- AI Avatars
- Augmented Reality
- Blockchain
- Composable Application
- Conversational Systems

- Digital Twins
- Metaverse
- Mixed Reality
- Natural Language Processing
- Virtual Reality
- Quantum Communication

### 4. Privacy & Security

- [Regulatory Tech](#) [New]
- [Zero-trust architecture](#) [New]
- Cybersecurity Mesh
- Deception Technology
- Non-Fungible Tokens

## Horizon 3

### 1. Cloud & Infrastructure

- [6G Network](#) [New]

### 2. Data

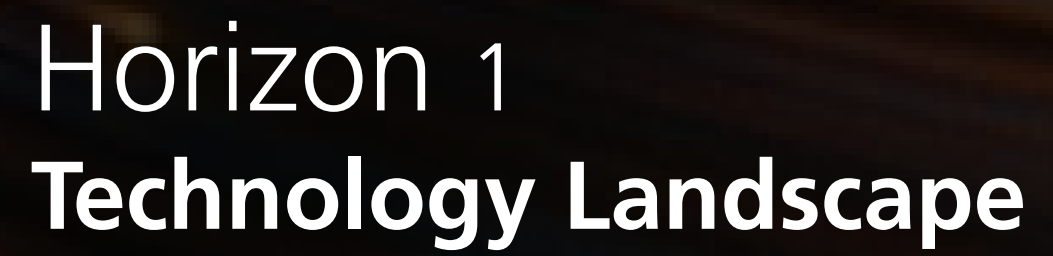
- [Adaptive AI](#)
- Advanced Swarm Systems
- Affective Computing
- Ambient Computing

### 3. Digital

- [Brain Computer Interface](#) [New]
- [Humanized User Interface](#) [New]
- Autonomic Systems
- Internet of Behaviour
- Internet of Thinking
- Quantum Computing
- Quantum Sensing
- Spatial Computing

### 4. Privacy & Security

- Decentralized Identity
- Self- Adaptive Security

A horizontal line above the text 'Horizon 1 Technology Landscape'. The background of the slide is a dark, abstract image with glowing, curved lines in shades of orange, blue, and white, suggesting a digital or technological landscape.

—  
Horizon 1  
**Technology Landscape**

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Heterogeneous Computing (1/2)

## Overview

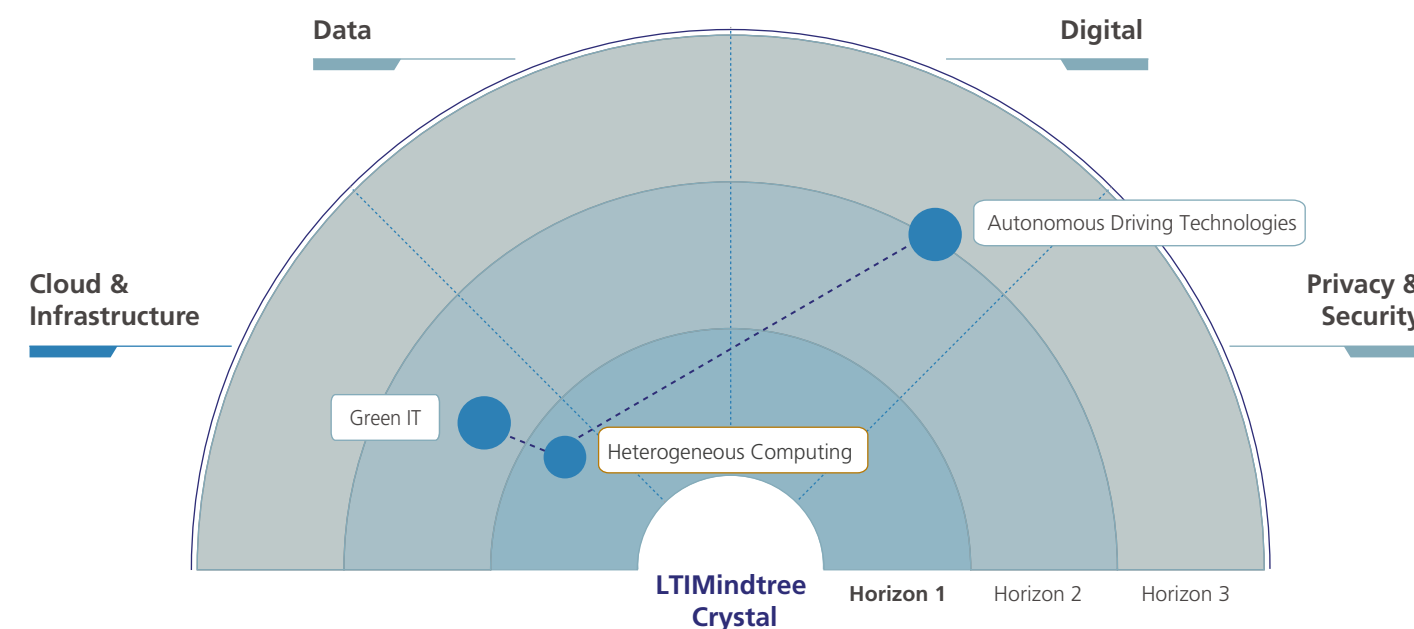
A system that utilizes many types of processing cores, such as CPUs, GPUs, ASICs, FPGAs, and NPUs, is known as **heterogeneous computing**. Performance and energy efficiency are increased by distributing different workloads to processors **built for specific tasks or specialized processing**. The usage of processors with multiple computer architectures is commonly referred to as "heterogeneous compute"; this is a popular strategy when one architecture is more suitable for a specific task due to power efficiency, compatibility, or the number of cores it offers. The combination of a CPU core and a GPU (Graphics Processing Unit), used for graphics-intensive applications, is a widely used kind of heterogeneous computing.

## CRYSTAL Insights

In 2022, the global heterogeneous mobile processing and computing market revenue was **US\$87.8 bn**. Overall, demand in the market is forecasted to rise at **15.8% CAGR between 2022 and 2032**. Accordingly, by the end of 2032, the total market size will touch around **US\$ 382 bn**.

An increase in demand is expected in the industrial sector throughout the forecast period. Growing demand for advanced electronic gadgets and scaled-down GPUs is one of the major components driving the global heterogeneous mobile processing and computing market.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	1Bn-10Bn	Improving

Note: Refer Page 5 to understand the rating parameters



# Heterogeneous Computing (2/2)

## How is it a game changer?

Multiple computing sub-systems can exist within a single system thanks to heterogeneous computing. These processors, which may carry out core instructions in various ways, cooperate to speed up computation and reduce the time needed to finish a task. When building workloads for **artificial intelligence (AI) and machine learning (ML)**, where extensive data needs to be processed and transformed for a consistent user experience.

An example of heterogeneous computing is the total compute strategy, which employs a comprehensive approach to SoC architecture to ensure that solutions can securely and seamlessly manage complex and computation-intensive applications. The overall compute strategy is focused on enhancing developer access to **high-performance software and tools**, increasing security, and speeding compute performance.

### Key Use Cases



#### Telecommunications

Used in large-scale ML experiments for better performance and optimizing complex deep learning models.



#### Technology

Increase the performance of the overall system and decrease energy consumption by optimizing the allocation of the computational load onto processors.

### Featured Story

#### A leading semiconductor company, search giant develop GPU-based accelerator for edge devices

A leading multinational semiconductor company and a search giant developed a **GPU-based accelerator for edge devices**, which can integrate with **Raspberry Pi or other devices**. Thus, more heterogeneous edge devices are deployed to build an edge computing environment for deep learning applications. However, building and maintaining a cluster edge environment with numerous edge devices is a challenge due to the heterogeneity of these devices.

Horizon 1

Cloud & Infrastructure

Data

**Digital**

Privacy & Security

# Superapps (1/2)

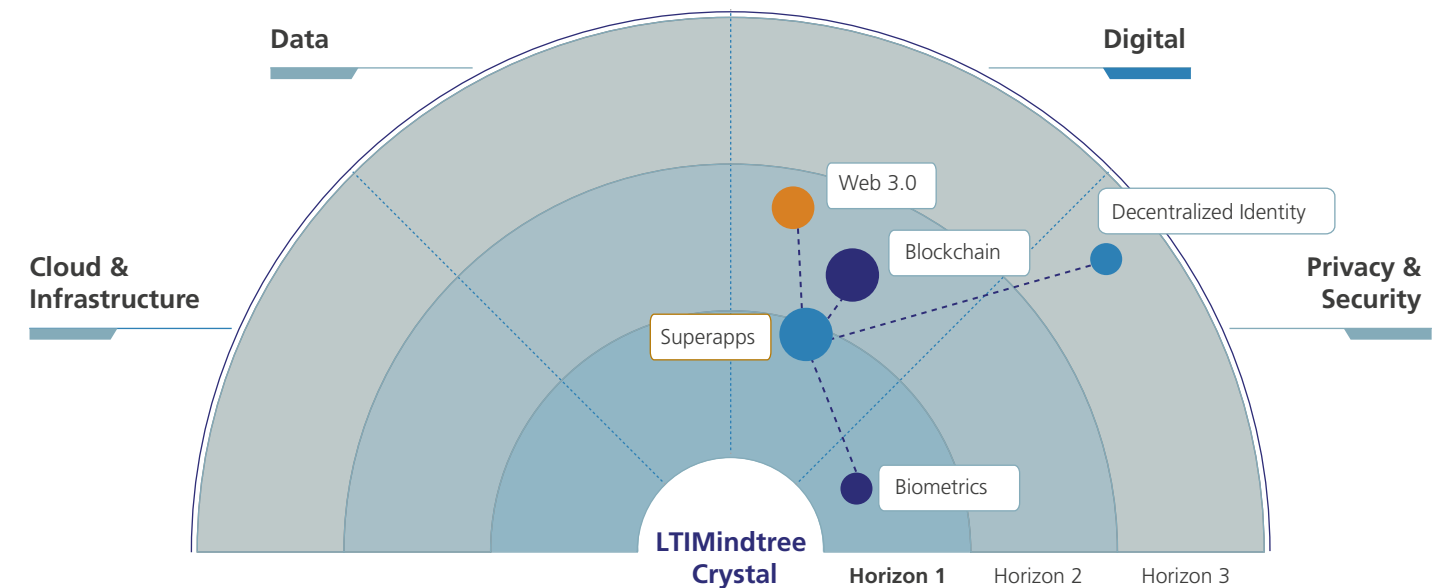
## Overview

Superapps are a relatively new concept in the world of mobile apps. They are mobile applications that offer a wide range of services and features beyond their core functionality. Typically, superapps offer various services such as **messaging, payments, ride-hailing, food delivery, shopping**, and more in a single app. This makes for a more seamless and convenient user experience.

## CRYSTAL Insights

**Superapps** are a growing trend in the world of mobile applications, with the potential to transform the way we use technology in our daily lives. They have gained significant traction in Asia, particularly in China and Southeast Asia. Superapps have become an **attractive option for investors**, as they offer the potential for high growth and profitability. They have the potential to disrupt traditional business models by offering a range of services that were previously offered by separate companies. For example, ride-hailing companies have expanded into e-commerce and financial services.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
<b>1</b>	<b>10Bn+</b>	<b>Improving</b>

Note: Refer Page 5 to understand the rating parameters

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security




## Superapps (2/2)

### How is it a game changer?

Superapps offer a one-stop-shop for various services, simplifying the user experience and saving time. The same app offers access to multiple services, eliminating the need to switch between different apps

It can increase digital inclusion by providing access to various services to users who may not otherwise have access. This promotes economic development and bridges the digital divide. Superapps offer higher engagement and user retention by providing a range of services.

Users are more likely to stay on the app for extended periods, leading to increased user data and potential for monetization.

<h3>Key Use Cases</h3>	 <p><b>Technology</b></p> <p>An intuitive experience for employees with organized company information with a modern, logical flow.</p>	 <p><b>Telecommunication</b></p> <p>A self-contained platform for online communication and commerce</p>	 <p><b>Retail</b></p> <p>Creating a cost-effective business model that positively impacts people's lives in emerging on-demand markets such as food delivery, ride-sharing, eLearning, and financial services.</p>
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<h3>Featured Story</h3>	<p><b>Superapps in China: The apps that let you buy things without leaving the app</b></p> <p>One of the most well-known superapps is a Chinese app featuring e-commerce, messaging, social media, ride-hailing, and financial services. One of the key features of this app is its integration with other services. For example, users can book a ride, order food, or pay bills through the app. It has also become a popular e-commerce platform, allowing users to purchase products from various retailers without leaving the app.</p>
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Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Digital Identity (1/2)

## Overview

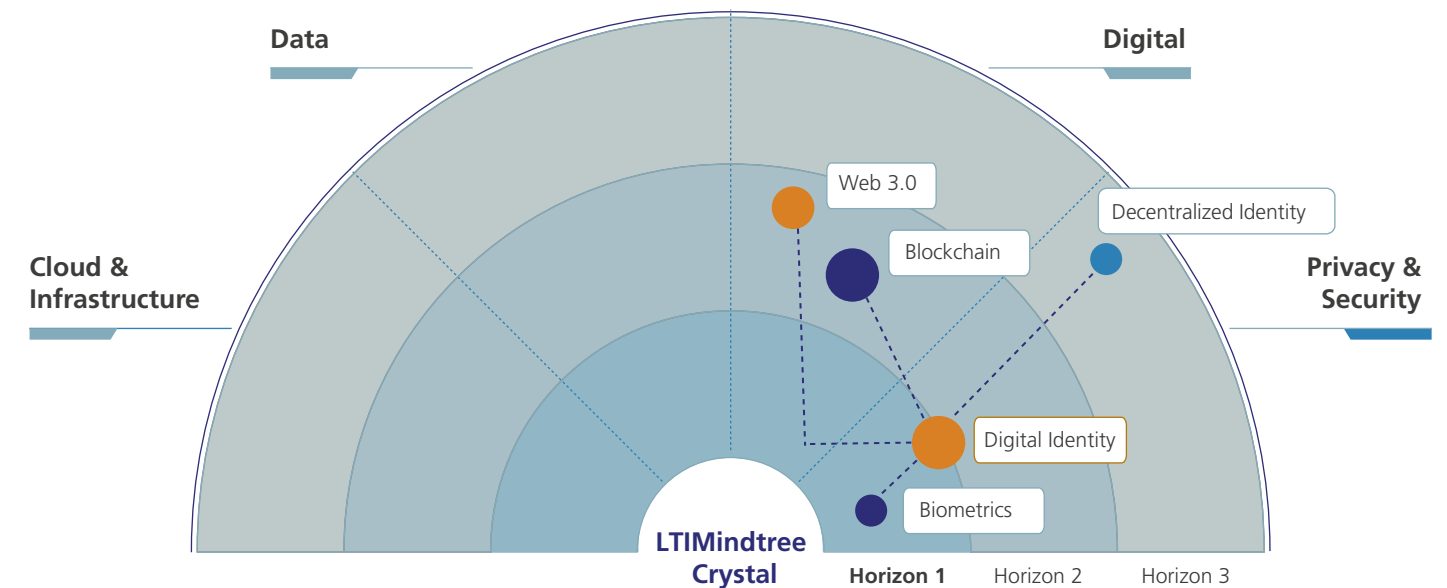
**Digital identity** is a digital mechanism that provides complete information to identify and distinguish individuals, systems, and organizations in the digital space. It is a personal and reusable proof of identification that is non-transferable and convenient for online use. Each entity has only one unique digital ID within a system, which ensures that every system identity corresponds to a single entity. This unique and verifiable representation allows users to **interact and transact in a trustless virtual world**.

## CRYSTAL Insights

The concept of digital trust encompasses the management of digital risks across domains such as **data, cloud, AI, analytics, and risk culture**. Using digital trust technologies such as digital identity, organizations can establish, expand, and sustain the trust of their stakeholders in the use of digital-enabled products and services.

Today's business environment has undergone a significant transformation, driven by the **widespread adoption of cloud technology** and critical applications. Cloud-first initiatives have resulted in notable IT and security risks as companies strive to innovate and gain a competitive edge.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	10Bn+	Emerging

Note: Refer Page 5 to understand the rating parameters

# Digital Identity (2/2)

## How is it a game changer?

The increasing importance of data privacy and control for digital systems has led to the development of digital identity solutions. They are built to provide complete protection from unauthorized access and modifications. Digital identity analytics and orchestration platforms can unlock tangible business benefits such as increased efficiency, security, compliance, and satisfaction.

Such platforms integrate disparate security tools and technologies under one roof, orchestrating automated provisioning, risk management, and dynamic remediation. Digital ID can potentially enable economic and non-economic value creation but also carries associated risks, like unauthorized credential use and exclusion of individuals.

It can help reduce these risks by minimizing the opportunity for manual error or conduct breaches.

<h3>Key Use Cases</h3>	<h4>Telecommunications</h4> <p>Build digital identity services on next-generation networks.</p> <p>Extend services to third-party partners on networks.</p>	<h4>Healthcare</h4> <p>Set up a "single source of truth" for medical records and better coordination</p>	<h4>Education</h4> <p>Protect students' digital identities and data while ensuring access to educational resources.</p>	<h4>BFS</h4> <p>Digital identity helps enable decentralized finance (DeFi) applications.</p> <p>Reduce friction in customer journeys.</p>
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<h3>Featured Story</h3>	<h4>Global technology consulting to redefine identity-based security</h4> <p>▶</p>	<p>A global technology consulting and digital solutions company partnered with an industry-leading cloud solutions provider to redefine identity-based security with their Digital Identity Orchestration platform. It offers uninterrupted delivery of identity and access governance to enterprises, helping companies move away from fractured IAM processes and experiences to achieve-</p>	<ul style="list-style-type: none"> <li>• Integrated processes</li> <li>• Efficient and scalable systems</li> <li>• Continuous compliance</li> <li>• Operational efficiency</li> <li>• Faster application onboarding and gain the true value of a "service economy."</li> </ul>
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Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Quantum-Safe Cryptography (1/2)

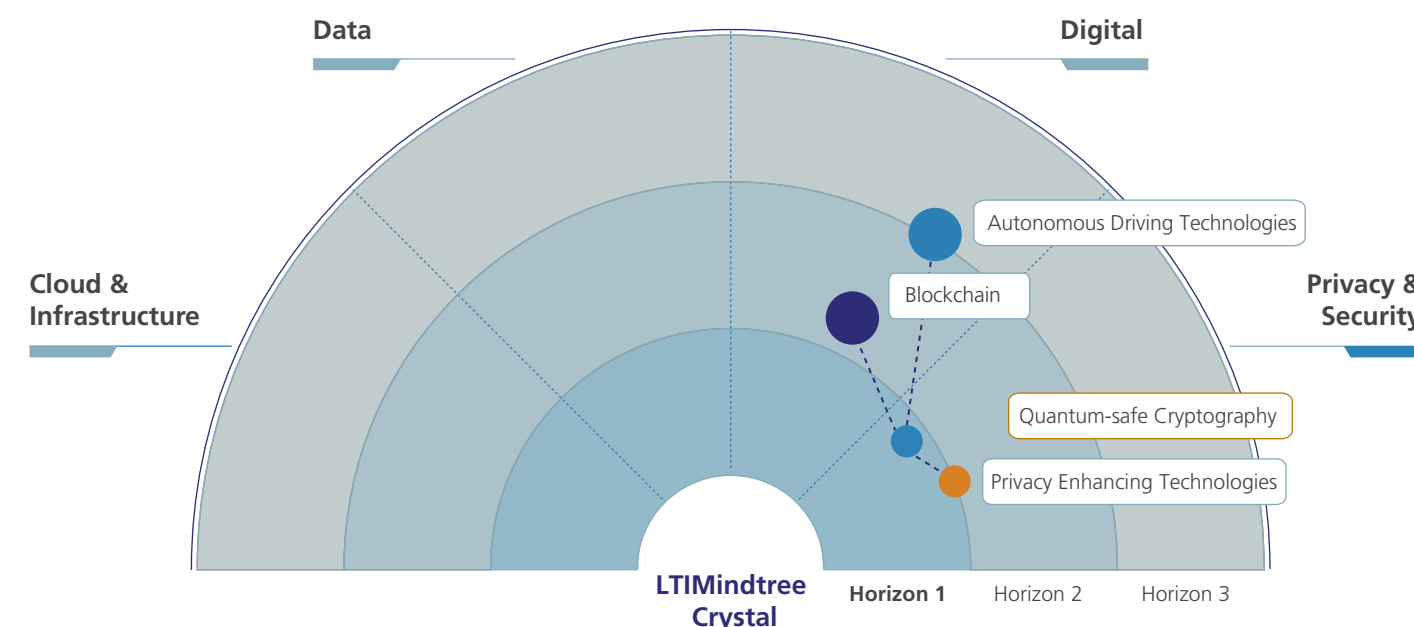
## Overview

**Quantum-safe cryptography** is a field that seeks to create and implement secure encryption methods against quantum attacks or make existing methods resistant to quantum threats. **RSA and ECC** are public-key algorithms widely used to secure data on the internet. They depend on mathematical problems that are difficult to solve with classical computers, such as finding the factors of large numbers or finding discrete logarithms. These problems can be solved faster by quantum computers using Shor's algorithm, which can break these algorithms and endanger data security.

## CRYSTAL Insights

Developing and **testing quantum-safe cryptography solutions** is required to achieve interoperability and standardization among different quantum-safe algorithms and protocols and with existing cryptographic systems. Various organizations, like the National Institute of Standards and Technology (NIST), the European Telecommunications Standards Institute (ETSI), the Internet Engineering Task Force (IETF), and IBM Research, are working on developing these solutions. NIST announced the first four quantum-resistant cryptographic algorithms to become part of its post-quantum cryptographic standard.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	500Mn - 1Bn ●	Improving ●

Note: Refer Page 5 to understand the rating parameters

# Quantum-Safe Cryptography (2/2)

## How is it a game changer?

Making a complete inventory of all the assets and technology that rely on cryptography, finding out which ones are connected to sensitive data, and designing and executing a change to post-quantum cryptography.

This will be a huge project that will span several years and impact every aspect of IT infrastructure. Quantum-safe cryptography can provide security for cloud computing, e-commerce, e-government, e-health, and e-voting.

This technology is a game changer because it will demand a massive shift from the current cryptographic systems and protocols to the new ones. This will entail a lot of challenges and opportunities for enterprises, governments, and individuals.

<h3>Key Use Cases</h3>	<p><b>Telecom</b> Secured B2B communications</p>	<p><b>Public Sector Undertaking</b> Secured supply chain networks   E-Voting</p>	<p><b>Automotive</b> Secure vehicle-to-everything (V2X) communications</p>	<p><b>BFS</b> Enhanced Data privacy &amp; security   Quantum-safe card tokenization</p>
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<h3>Featured Story</h3>	<p><b>Joint Quantum-safe Secure Systems deploys large-scale encryption</b></p>	<p>A leader in quantum-safe cryptography products and solutions collaborated with the Armed Forces maritime branch to procure large-scale quantum-based encryption systems. They deployed these systems in Hub &amp; Spoke configuration across multiple locations, underscoring the maritime forces' determination to stay at the forefront of emerging security technologies. The rapid development of quantum computers and the increasing vulnerability of conventional encryption systems necessitated a response. The deployment will secure communication networks against potential threats and position maritime forces as a pioneer in the field of quantum secure communication within the country.</p>
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The background of the slide is a dark blue space filled with small white stars. Overlaid on this are several large, wavy, grid-like structures in shades of blue, green, and purple, creating a sense of depth and movement.

# — Horizon 2 Technology Landscape



Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Green IT (1/2)

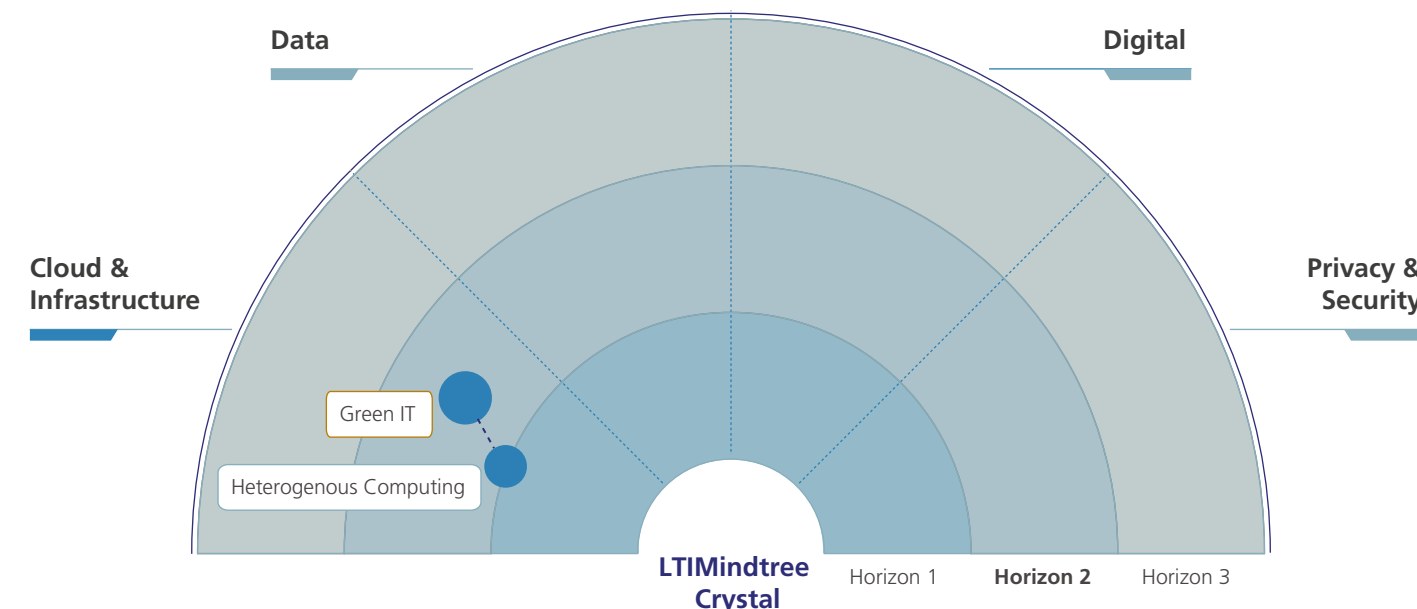
## Overview

**Green IT** refers to the use of IT products, services, and infrastructure that minimize environmental impact and promote sustainability. This involves **eco-friendly IT solutions** that lead to lower energy consumption and reduced greenhouse gas emissions. It covers a diverse range of companies, including hardware manufacturers, telecommunications companies, internet providers, and logistics suppliers. The future of Green IT is likely to be characterized by a continued **focus on energy efficiency, sustainable infrastructure, and the use of renewable energy sources**. Organizations will likely invest in green technologies and practices to reduce their carbon footprint.

## CRYSTAL Insights

The growing need for computers and IT infrastructure is accompanied by a decline in resources used to power them. However, advancements in computing technology can also provide solutions for businesses to adopt a greener approach to save power and protect the environment. According to Gartner, by 2025, carbon emissions will be a crucial factor for hyper scalers when it comes to making cloud purchase decisions. With the rise of ESG priorities and reporting, more than **90% of organizations** have increased their investments in sustainability programs. Gartner reports significant growth since the beginning of the pandemic compared to their investments in 2017.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+ ▶ ●	Improving ●

Note: Refer Page 5 to understand the rating parameters

Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

## Green IT (2/2)

### How is it a game changer?

The IT industry plays a crucial role in the sustainability program. The sector consumes a significant amount of energy, generates considerable electronic waste, and needs proper methods to dispose of or recycle hazardous waste. While there are challenges to overcome, proactive steps towards a greener and more sustainable future are necessary, and **Green IT is a vital first step**. Companies that prioritize sustainability and environmental responsibility might have a competitive edge over others.

Cost savings are a huge reason behind the increased acceptance of Green IT. Companies' motivation to go green is to reduce equipment, energy, paper, and ink costs. Environmental regulations enacted to combat climate change require companies to assume green-friendly measures.

To join the **green IT revolution** and grow revenue, businesses must adopt green technology by providing and maintaining energy-efficient equipment. Consumers also want to engage with companies that are committed to green initiatives and are committed to **fighting climate change and global warming**.

### Key Use Cases



#### Telecommunication

Green Networks with low power consumption and energy efficiency



#### Technology

Use virtualization to reduce the number of servers, power, and disposal requirements of desktops

### Featured Story

#### A German software leader takes steps toward 'green ledger' for carbon accounting

A German software leader is expanding the capabilities of the Sustainability Footprint Management tool in its ready-to-run cloud ERP and new tools to enable companies to share detailed greenhouse gas emissions data with associates in a common format. As consumers and regulators demand more accurate and timely information about the impact of their products on the climate, new tools and capabilities in the company's ERP solution will help companies keep account of carbon emissions across their supply chains.

Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Low-power WAN (LPWAN) (1/2)

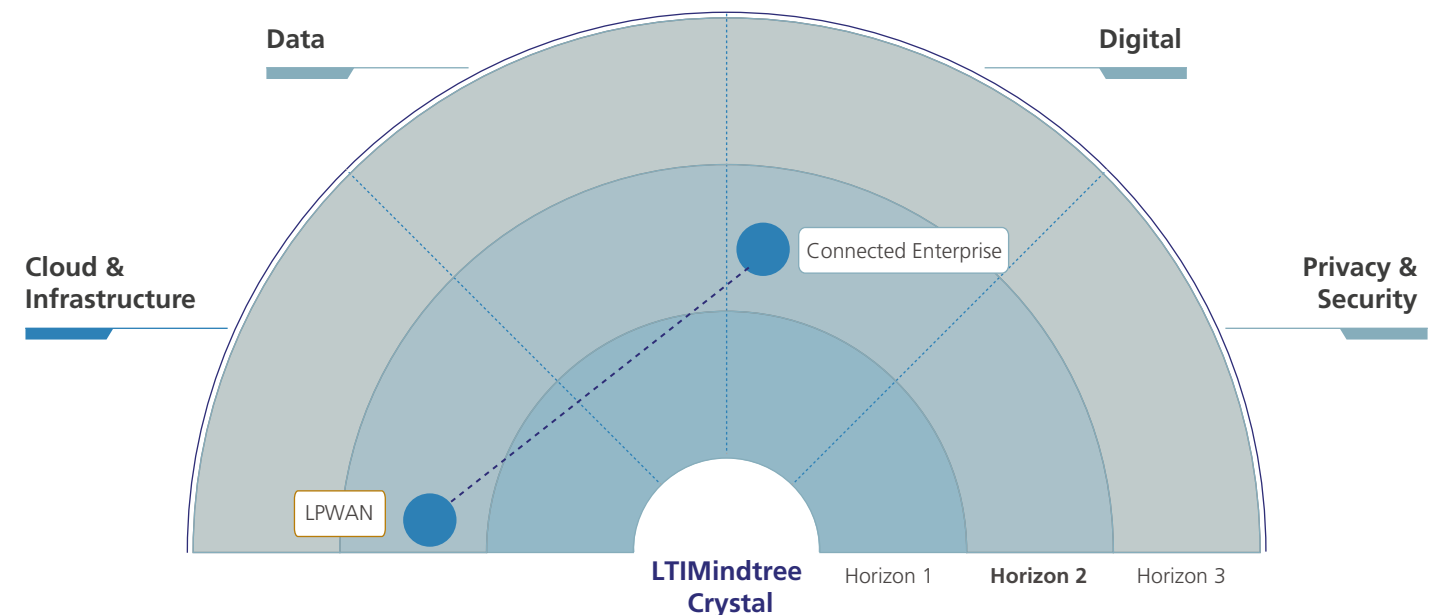
## Overview

**Low-power WAN (LPWAN)** connects low-bandwidth, battery-run devices at low bit rates over large distances. LPWANs are created for **machine-to-machine (M2M) and Internet of Things (IoT) networks**. They can adjust more linked devices across a wider area, including battery-powered sensors. The gap between cellular and short-range communication technologies is filled by LPWAN when a longer range at lower power for delivering sparse data is sought. It is a collection of many low-power, wide-area network technologies that can take on many different forms rather than being a single technology.

## CRYSTAL Insights

According to a report by Vantage Market Research, the global low-power vast area network (LPWAN) market is expected to grow from **US\$19.76 bn in 2022 to US\$1069.61 bn in 2030**, with forecasts of the average annual growth rate during the period being **64.70%**. The transmission method, the quantity of IoT devices connected, the available data speeds, and other variables all affect coverage. Environmental obstacles, for example, impact LPWAN coverage and transmission. Using LPWAN costs less than using a traditional WAN. Some types typically boast a maximum range of around 25 miles, while others offer a low-cost connectivity solution.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn +	Improving

Note: Refer Page 5 to understand the rating parameters

# Low-power WAN (LPWAN) (2/2)

## How is it a game changer?

The functionality of LPWANs depends on their low power characteristics. LPWANs facilitate numerous M2M (Machine-to-Machine) and IoT applications.

Unlike traditional mobile networks, LPWANs offer advantages such as lower power requirement, extended range, reduced costs, making them beneficial for applications constrained by budget and power consideration. LPWANs are more suited for applications that require occasional uplink messaging of smaller messages. Many LPWANs have a downlink capability.

The functionality of LPWANs depends on their low power characteristics. IoT devices frequently run on batteries and have modest energy requirements. Furthermore, most IoT devices only communicate small amounts of data at low bit rates. LPWANs are, therefore, perfect for tying these devices together over long distances while consuming the least amount of electricity.

They mostly employ unlicensed radio frequencies. This eliminates the requirement for licensing and lowers expenses. LPWAN type determines how the data is encoded and sent. However, a modulation method created to carry data over great distances with little interference is at the core of each type.

### Key Use Cases



#### BFS

Facilitate direct data exchange without any third-party involvement to expedite fund transfers securely and effectively while maintaining the confidentiality of the entire transfer process.



#### Technology

Scale IoT data collection cost-effectively

Increase AI technology deployment, smart cities, smart metering, etc

### Featured Story

**A Serbia-based telecom operator rolled out a new NB-IoT network alongside its public LoRaWAN network.**

A Serbia-based telecom operator rolled out a new NB-IoT network alongside its public LoRaWAN network. It was meant to provide services to cities, municipalities, industrial firms, energy providers, and retail and facilities operators. A system integrator based out of Serbia was responsible for upgrading LTE networks. The day-to-day functioning of licensed and unlicensed LPWA-gear IoT networks was conducted by drafting Activity for its wireless service management platform as a single web-based dashboard. A smart energy management provider described its evolving infrastructure as a “national scale, carrier-class, multi-technology public IoT network.” The operator’s 360-degree IoT strategy provides connectivity for each use case, including those that require 10-15 year battery life, such as water and gas meters. ”

Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Applied AI (1/2)

## Overview

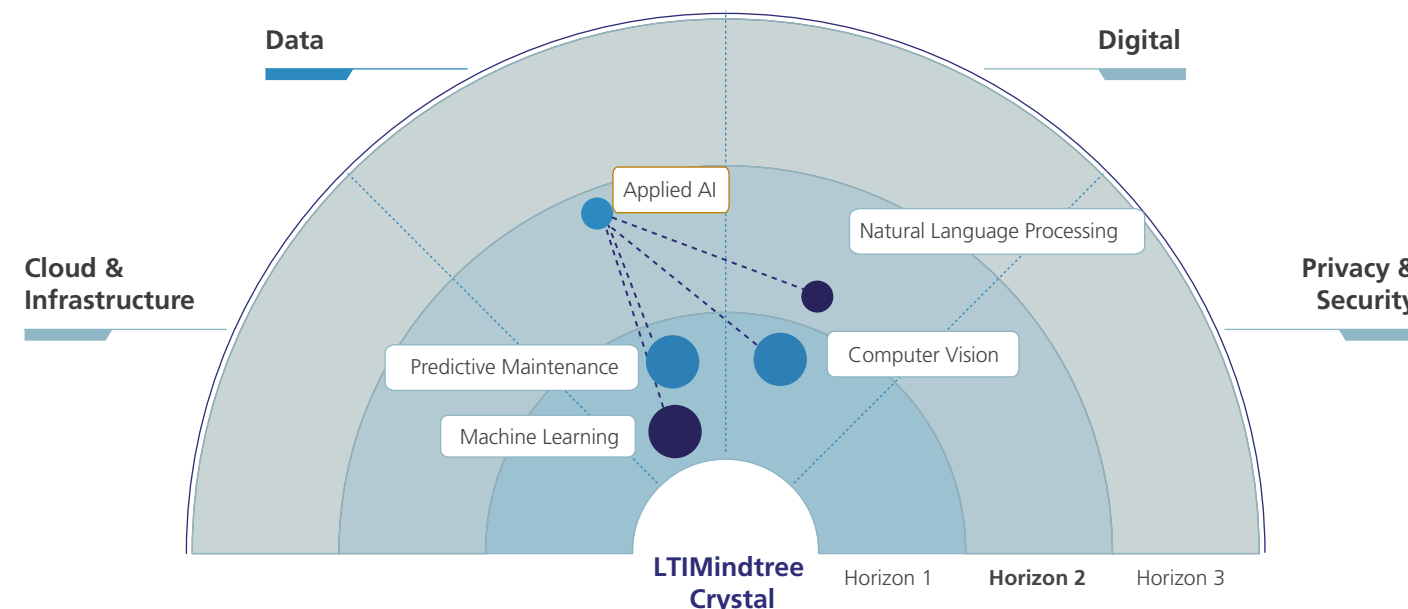
**Applied AI** includes artificial intelligence applications that resolve problems related to classification, prediction, and mitigation. This helps automate, add, or augment real-world business use cases. Applied AI helps solve real-world problems using underlying AI technologies like **Natural Language Processing (NLP), Machine Learning, Computer Vision, predictive analytics, etc.**

## CRYSTAL Insights

Applied AI aims at the practical implementation of **artificial intelligence (AI) technology**. It creates intelligent systems that can learn from data, make predictions, and take actions that improve efficiency, accuracy, and productivity.

To develop **applied AI systems**, data scientists and AI engineers use machine learning methods like data pre-processing, feature engineering, model evaluation, supervised learning, unsupervised learning, reinforcement learning, and deep learning.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	500Mn - 1Bn	Improving

Note: Refer Page 5 to understand the rating parameters

## Applied AI (2/2)






### How is it a game changer?

Applied AI has the potential to provide insights and predictions that were previously impossible for humans to generate. It leverages machine learning algorithms to study huge amounts of data.

Lately there have been tremendous developments in many Applied AI areas. **No-code ML platforms, API-based ML services (MLaaS)**, easy-to-use ML programming libraries, and dedicated hardware for training and running ML models continue to mature and adopt.

At the same time, the underlying data storage technology for ML services has become more flexible, interoperable, and scalable. Some enterprise AI companies have also started offering ML solutions for financial services, oil and gas, and retail sectors.

Applied AI can improve industries and make our lives better. As technology continues to upgrade and gains wide acceptance, we can expect the emergence of even more revolutionary applications.

<h3>Key Use Cases</h3>	 <h4>Manufacturing</h4> <p>Optimize production processes and improve quality control</p>	 <h4>Healthcare</h4> <p>Assess medical images, diagnose diseases, and create personalized treatment plans</p>	 <h4>Transportation</h4> <p>Optimize traffic flow, improve public transportation systems, and develop self-driving vehicles</p>	 <h4>Education</h4> <p>Develop personalized learning experiences</p>	 <h4>Agriculture</h4> <p>Optimize crop yields and reduce waste</p>
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<h3>Featured Story</h3>	<p><b>Development of an AI-powered diagnostic tool to detect diabetic retinopathy, a leading cause of blindness in adults.</b></p> <p>The tool was developed by one of the world's largest tech firms in collaboration with an Eye Hospital in London. It uses deep learning algorithms to check retinal scans and look for signs of diabetic retinopathy. An enormous dataset of retinal images was used to train the algorithm and then tested on new images to evaluate its accuracy. In a study published in the journal Nature Medicine, researchers found that the AI algorithm was able to detect diabetic retinopathy with an <b>accuracy of 94%</b>, which was equivalent to that of human ophthalmologists. The algorithm was also able to detect other types of eye diseases, such as glaucoma and age-related macular degeneration, with high accuracy.</p>
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# Explainable AI (XAI) (1/2)

## Overview

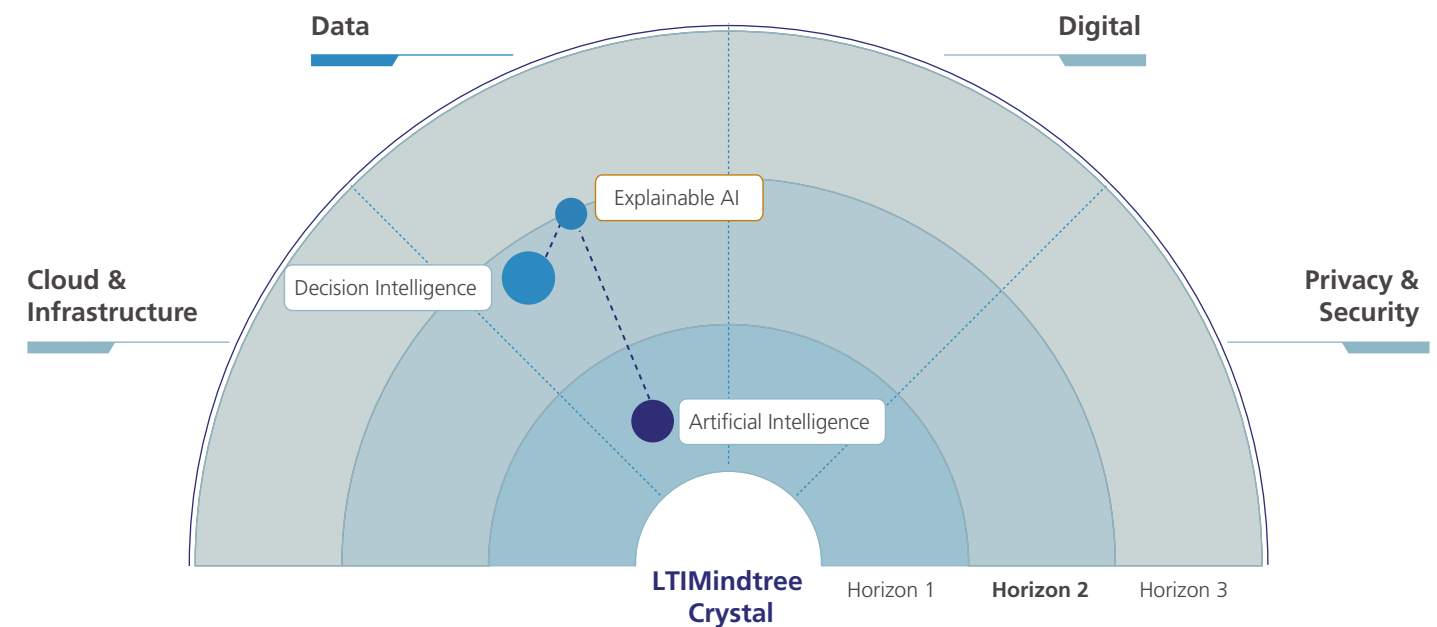
**Explainable AI (XAI)** refers to an approach to creating artificial intelligence (AI) systems that are curated to be transparent and easy to understand. The goal of XAI is to create AI systems that can explain their decision-making processes and provide clear, easily understandable reasons for why they make certain decisions.

## CRYSTAL Insights

One of the problems of traditional machine learning algorithms is that they can often be seen as black boxes. The internal processes that lead to the outputs are opaque and difficult to interpret. The lack of interpretability can be an obstacle to the **adoption of AI systems**. XAI seeks to address these issues by explaining their rationale, characterizing their strengths and weaknesses, and conveying an understanding of their future behavior.

These models will be merged with **world-class human-computer interface methodologies** with the power to make them easy to understand and use explanative dialogues for the final users.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	500Mn - 1Bn	Improving

Note: Refer Page 5 to understand the rating parameters

# Explainable AI (XAI) (2/2)


## How is it a game changer?

XAI can help to **increase the trust and acceptance of AI systems**. When people understand the AI system's decision-making process, there is more trust and comfort while using it. People can work with the system to make informed decisions and attain good results.

It can also assist in increasing the exactness and effectiveness of AI systems. Explaining their decisions can make auditing and testing of AI systems easier. This can help with identifying and correcting errors and biases in the system.


Transparent decision-making processes of AI systems, enabled by XAI, can help identify and mitigate biases and other ethical concerns. Overall, XAI can transform human interactions with AI systems, making them more transparent, trustworthy, and effective. It can enable new forms of collaboration between humans and machines.

Key Use Cases




**Healthcare**

Understand the reasoning behind AI decisions



**Finance**

Understand the factors that contribute to creditworthiness



**Autonomous vehicles**

Understand how the vehicle is making decisions and identify potential safety concerns

Featured Story

Explainable deep learning for Pulmonary Disease Diagnosis project

The project used a convolutional neural network (CNN) to classify medical images as healthy or diseased. Then it used a technique called "**Grad-CAM**" to generate visual explanations of CNN's decision-making process. Grad-CAM highlights the regions of the image that were most important in CNN's decision, giving doctors a clear understanding of why CNN made a particular diagnosis. The system was tested on a dataset of chest X-rays and achieved high accuracy in diagnosing diseases like pneumonia and tuberculosis. The **XAI system was able to provide clear, interpretable explanations** for its diagnoses, which helped doctors understand the reasoning behind the system's decisions and identify potential errors or biases.



# Autonomous Driving Technologies (1/2)

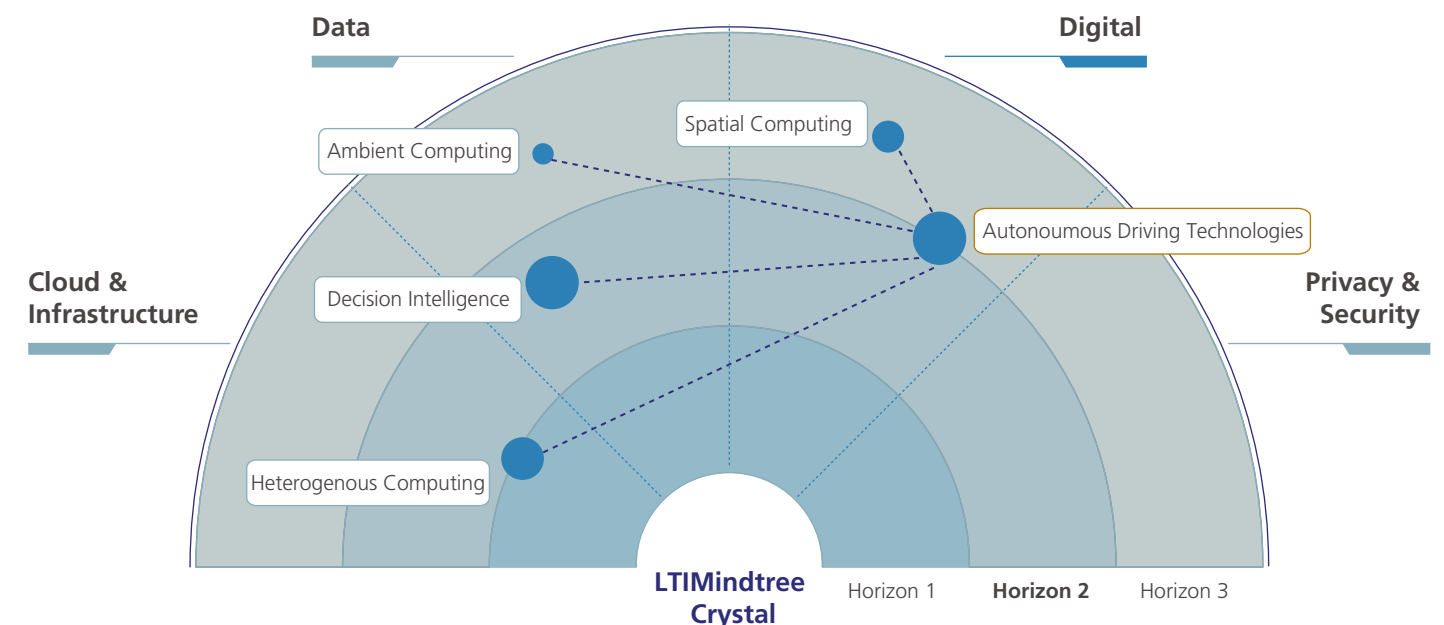
## Overview

**Autonomous driving technologies** involve a range of technologies that enhance the capabilities and safety of self-driving cars, such as sensors, actuators, powerful processors, and deep learning systems. Leveraging deep learning neural networks, autonomous vehicles can detect obstacles better, interpret signals from other drivers and pedestrians, and make more informed decisions. Tasks like **facial recognition, image classification, and object detection**, which require computer vision, benefit from deep learning. However, developing and training neural networks can be challenging. These networks rely on large datasets, which may be more demanding than those required by other AI algorithms.

## CRYSTAL Insights

**Autonomous vehicles (AVs)** help cut transportation costs, enhance productivity, and improve safety. Using these vehicles specifically benefits industries that rely heavily on vehicles operating in structured environments, such as construction, agriculture, and mining. Intelligent speed assistance in AVs minimizes speeding-related road accidents by limiting and adjusting speed based on different conditions. As per McKinsey, by **2035, ADAS and AD could raise between US\$300 bn and US\$400 bn** in the passenger car market. Beyond technological considerations, the widespread acceptance of AVs is a remaining challenge, alongside the need for concrete regulations around usage and liability in the case of accidents.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+	Improving

Note: Refer Page 5 to understand the rating parameters

# Autonomous Driving Technologies (2/2)

## How is it a game changer?

Autonomous driving technologies are advancing rapidly, with the **automotive and ICT industries** converging to develop, test, and bring to market vehicles with enhanced levels of autonomy. This industry, however, continues to **overcome technological barriers**. The underlying deep learning and computer vision systems required for AVs to navigate their route accurately and safely are continuously improving.

The infrastructural and regulatory systems will likewise need to **evolve alongside AV development**. The transportation systems of the future, dominated by AVs, will be safer and more efficient.

The technology has the potential for an even broader impact on society—the notion of car ownership and where people live and work—and several industries.

<h3>Key Use Cases</h3>	<p><b>Defense</b> Autonomous reconnaissance and surveillance</p>	<p><b>Healthcare</b> Autonomous emergency response vehicles Transporting medical supplies or providing rapid transportation for patients</p>	<p><b>Utility</b> AVs for public transportation</p>	<p><b>Mining</b> AVs can be used for mining and construction</p>	<p><b>Agriculture</b> Autonomous tractors and other farming vehicles to automate tasks such as planting, harvesting, and fertilizing crops</p>
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<h3>Featured Story</h3>	<p><b>A London-based developer of autonomous driving technology relies on a camera-first approach to sensor technology and an end-to-end deep learning system</b></p>	<p>Its computer vision technology accurately simulates the real world by learning to represent the <b>semantics, motion, and geometry of a scene</b>. It then builds intermediate outputs with multitask perception using planning and control techniques. The technology teaches motion planning for driving using surround cameras and recent advancements in policy learning. This approach allows it to build an autonomous driving system that can adapt to driving in new cities, making it a more scalable and adaptable solution for commercial fleet operators.</p>
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# Connected Enterprise (1/2)

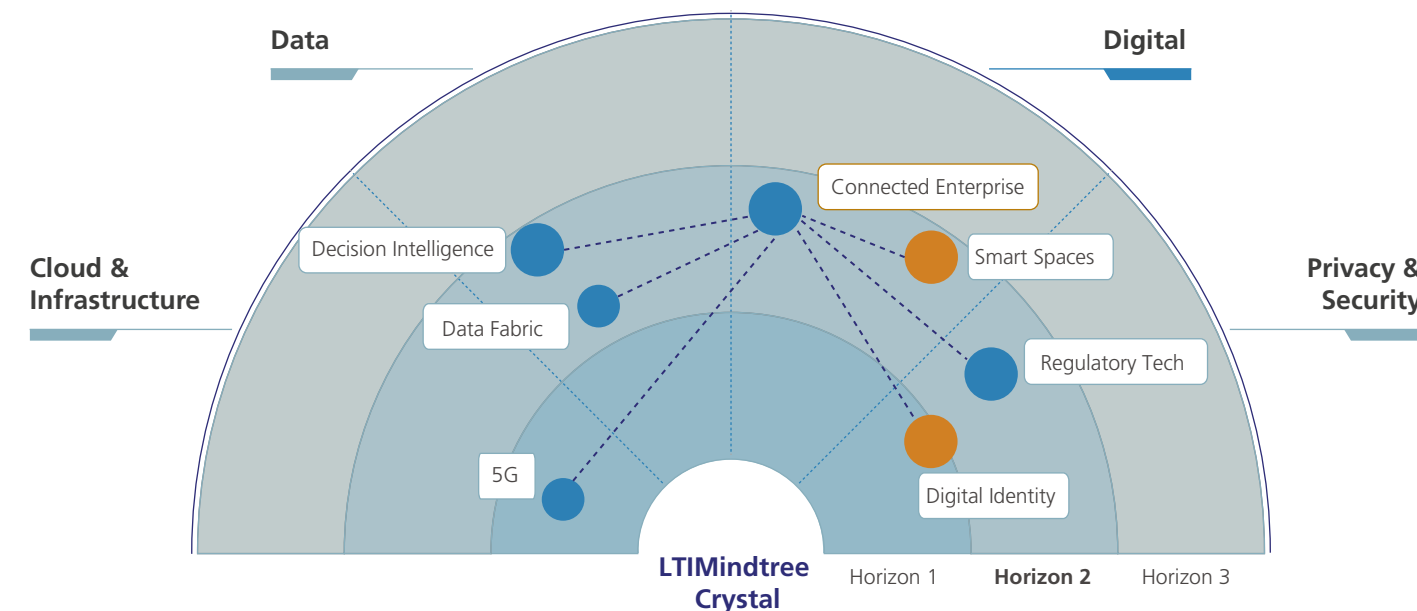
## Overview

**Technologies such as 5G**, edge computing, AI, and the cloud make new value chains and digital touchpoints. Together, these technologies make a connected enterprise. Value stream mapping (VSM) is crucial for keeping the process transparent and identifying the pain points. Data integration and harmonization through a data lakehouse lead to contextualized decision-making. The process leverages **unstructured, structured, diverse, and distributed data**. This approach improves awareness and generates value at scale while also supporting ESG initiatives. Connected governance is an upcoming organizational response to the growing complex governance challenges across enterprises and geographies.

## CRYSTAL Insights

In a digitized enterprise, **connectivity is the key to success**. This means connecting systems to systems, humans to systems, and internal systems to external partners, such as suppliers and customers. APIs are a key enabler of digital connectivity. However, the **limits of legacy technology structures** and the challenges of adopting modern architectural elements allow organizations to process only a fraction of the data from connected devices in real-time. As a result, data lakehouses have become a popular solution for data integration and analysis, but their security must be a top priority. Finally, **network-driven digital platforms** like blockchain are becoming increasingly important for scaling quickly as more partners are onboarded.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+ ▶ ●	Improving ●

Note: Refer Page 5 to understand the rating parameters

# Connected Enterprise (2/2)

## How is it a game changer?

**Connected enterprise** extends beyond IoT and encompasses all the aspects of an organization's operations. Most companies invest heavily in cloud platforms, digital systems, and technology. However, a higher ROI can be achieved by leveraging data lakehouses that offer enterprise connectivity, greater speed, storage, and operational efficiencies. Analytics tools built over **data lakehouse** help in providing real-time insights. Connected data can be used to assess credit ratings and promote socially conscious collaboration with business partners.

Using a single data storage system provided by data lakehouses lowers the amount of data that travels to multiple systems from the pipelines. This can simplify business data demands and streamline data observability. Data lakehouses support **business intelligence**, **data visualization workstreams**, and even more complex data science ones.

This approach to data management can optimize business operations, drive innovation, and support positive outcomes for both businesses and society within the connected enterprise context.

<h3>Key Use Cases</h3>	<p><b>BFS</b> Store and analyze data from financial transactions, and risk management systems, to make better investment and risk management decisions</p>	<p><b>Healthcare</b> Study the data extracted from medical devices, electric health records, and other mediums</p>	<p><b>Retail</b> Assess data from point-of-sale systems and customer interactions to understand user behavior</p>	<p><b>Manufacturing</b> Optimize production and supply chain to reduce costs</p>	<p><b>Government</b> Increased transparency in government programs</p>
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<h3>Featured Story</h3>	<p><b>An industrial automation provider adopted the connected enterprise approach resulting in significant benefits</b></p>	<p>An American provider of industrial automation and digital transformation technologies adopted the connected enterprise approach resulting in significant benefits. Unifying the IT and OT systems allowed the company to access, monitor, and capitalize on operational, business, and transactional data across the enterprise. Their new network infrastructure approach lowered the total cost of ownership, reduced inventory days, and resulted in <b>30% annual capital avoidance</b>. The supply chain deliveries grew to 96%, lead times were reduced by 50%, and the provider could achieve a faster time-to-market. They estimated a <b>4-5% improvement in annual productivity</b>, showcasing the game-changing benefits of the Connected Enterprise for better decision-making using enterprise data.</p>
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Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Regulatory Technology (1/2)

## Overview

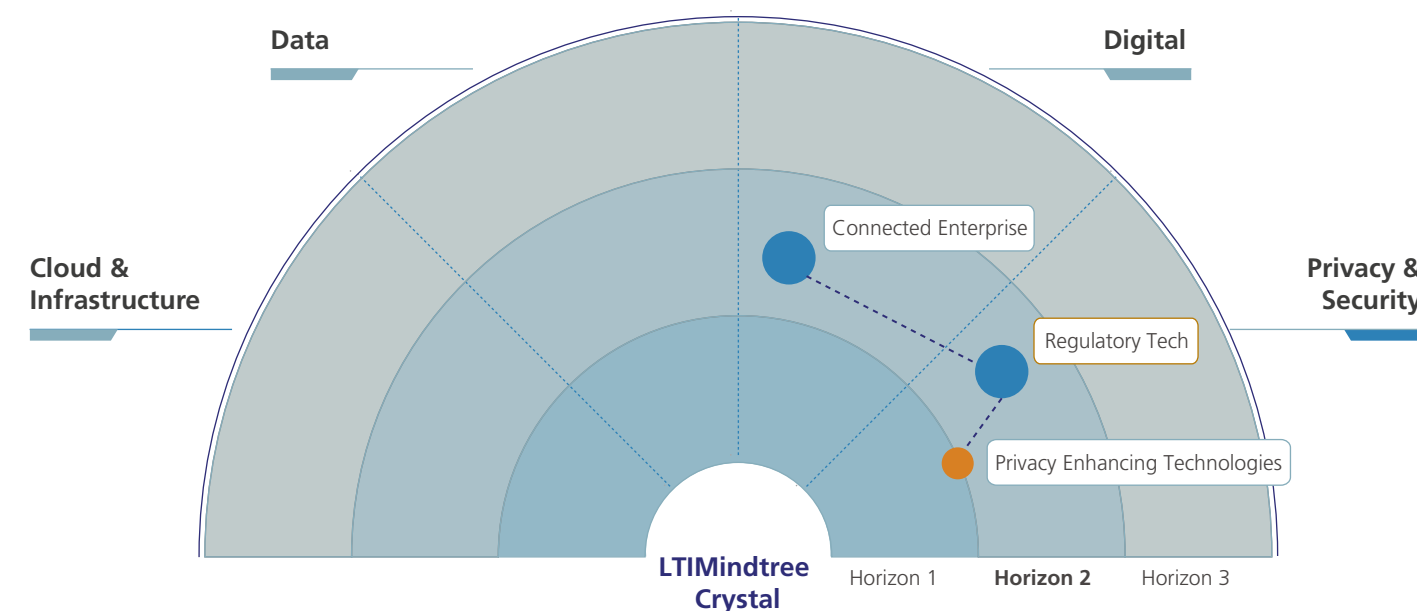
**Regulatory technology, or RegTech,** refers to the use of technology, particularly software and data analytics, to help organizations comply with regulatory requirements. **RegTech solutions** are designed to streamline and automate compliance processes, reduce the risk of non-compliance, and lower the cost of compliance.

## CRYSTAL Insights

Regulatory compliance can be **complex and time-taking**, especially for organizations in regulated industries such as healthcare, finance, and energy.

RegTech solutions can help organizations overcome compliance challenges by automating compliance processes, offering real-time monitoring and reporting, and leveraging data analytics to identify potential risks. This can help organizations reduce the risk of non-compliance, avoid costly penalties, and improve their overall compliance posture.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+	Improving

Note: Refer Page 5 to understand the rating parameters

# Regulatory Technology (2/2)

## How is it a game changer?

RegTech is a game changer in many ways because it can automate many of the compliance processes that were previously done manually, saving organizations time and money.

By leveraging data analytics and other technologies, RegTech solutions can help organizations detect and mitigate potential risks before they become a problem.

can also help organizations reduce compliance costs by reducing the need for manual processes and streamlining compliance efforts.

### Key Use Cases



#### Healthcare

Comply with regulations related to patient data privacy, electronic health records, and billing and coding



#### Energy and Utility Compliance

Automate compliance processes, monitor energy usage and emissions, and generate required reports



#### Transportation Compliance

Automate compliance processes, monitor vehicle performance and generate required reports.



#### Insurance Compliance

Automate compliance processes, monitor policyholder data and generate required reports.

### Featured Story

#### KYC and AML Compliance in Banking

A large multinational bank faced increasing regulatory pressure to improve its Know Your Customer (KYC) and Anti-Money Laundering (AML) compliance processes. The bank used a manual process to perform customer due diligence, which was time-consuming, error-prone, and costly. It implemented a RegTech solution that used artificial intelligence and data analytics to automate the KYC and AML compliance processes.

As a result, the bank significantly improved its KYC and AML compliance processes. The resolution lessened the time and cost related to manual compliance processes and improved the accuracy and effectiveness of risk assessments. The bank could also adapt to changing

# Zero Trust Architecture (1/2)

## Overview

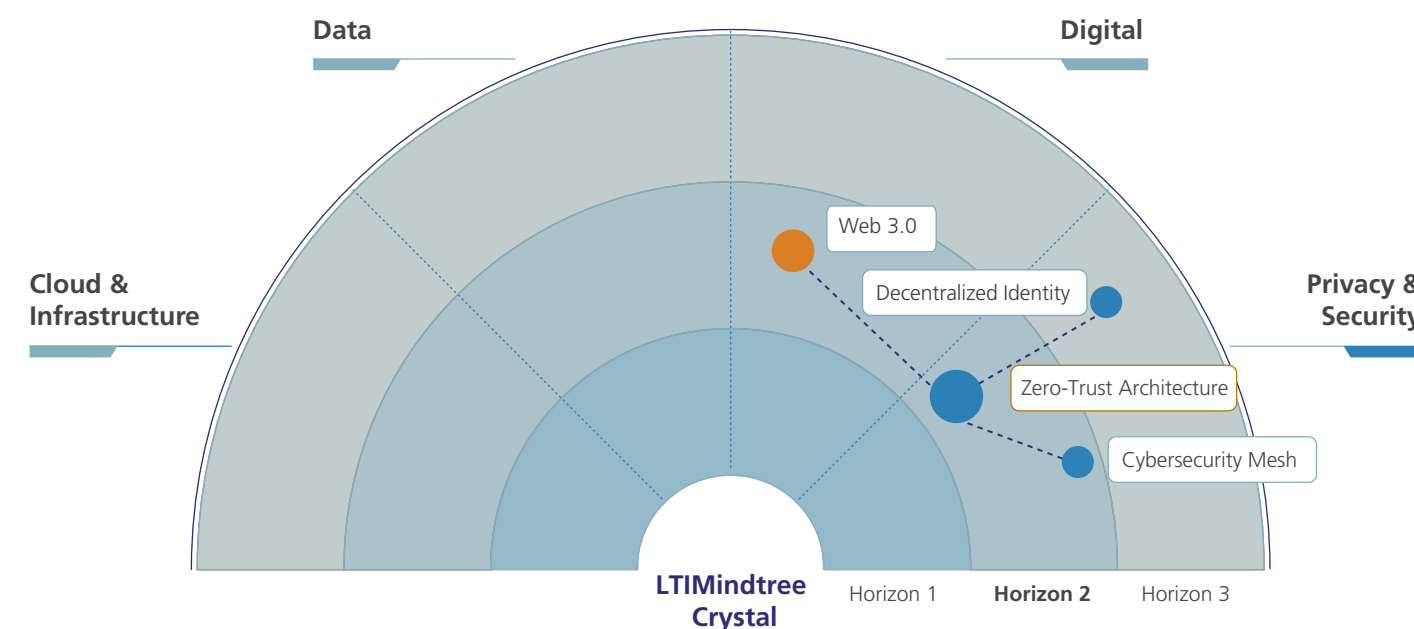
**Zero Trust (ZT)** is a cybersecurity approach that shifts the focus from network-based perimeters to users, assets, and resources. These principles are used to plan industrial and corporate infrastructures and workflows, assuming no implied trust is placed in assets or user accounts because of their physical or network location or ownership. Discrete authentication and authorization functions are performed before establishing a session with an enterprise resource. It also addresses network trends such as remote users, **BYOD**, and **cloud-based assets** beyond an enterprise-owned network boundary.

## CRYSTAL Insights

ZTA will become increasingly adopted by organizations as the need for more robust and adaptable security solutions continues to grow. Remote work and a shift to cloud-based services are expected to drive further adoption.

ZTA integrates with other security frameworks, such as **Secure Access Service Edge (SASE)** and **Identity and Access Management (IAM)**, to provide a more extensive and unified approach to security. ZTA will continue to evolve and become more critical as organizations seek more effective and adaptable security solutions to solve the problems of the modern enterprise environment.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+ ▶ ●	Improving ●

Note: Refer Page 5 to understand the rating parameters

# Zero Trust Architecture (2/2)

## How is it a game changer?

By 2026 Gartner expects that only 10% of large enterprises will have a mature and quantifiable ZTA program. This increases significantly from the current figure in 2022 of less than 1%. In other words, while ZT is top of mind for many organizations, most are still in the process of implementing it.

It is a game changer in cybersecurity because it represents a fundamental shift in how security is approached and implemented


It moves away from the historic perimeter-based security model, focusing on protecting the data and resources, regardless of their location within the network. ZTA is a game changer because it provides a more comprehensive and effective security strategy better suited to the modern enterprise environment.

With the advent of mobile devices, increased cloud computing, and remote workers traditional security model based on perimeter defense is no longer enough. It also addresses these challenges by providing a more granular approach to security based on user and device identity and trust.

<h3>Key Use Cases</h3>	<p><b>Telecom</b></p> <p>Ensure IoT devices are securely authenticated and authorized</p> <p>Ensure secure access to cloud services and protect against unauthorized access</p>	<p><b>Hi-Tech</b></p> <p>Protecting intellectual property</p> <p>Secure and restricted access to development environments</p>	<p><b>Manufacturing</b></p> <p>Implementing network segmentation to protect critical systems such as Supervisory Control and Data Acquisition (SCADA)</p>	<p><b>BFS</b></p> <p>Ensure secure remote access to banking systems and data</p> <p>Securing payment processing systems</p>
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<h3>Featured Story</h3>	<p><b>A US-based security leader expands relationship with a global tech giant, makes industry-leading zero trust security tools easier than ever to deploy</b></p> <p>A US-based security provider expanded its relations with the tech giants to help the users to position, automate, and strengthen their company's Zero Trust security easily. This new integration will enable organizations to deploy consistent Zero Trust security without altering the code. Mutual customers can deploy Zero Trust security tools without complex code changes within minutes. It also allows adding industry-first features, such as the security provider's Remote Browser Isolation technology.</p>
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**Horizon 3**  
**Technology Landscape**

Horizon 3

Cloud & Infrastructure

Data

Digital

Privacy & Security

# 6G Network (1/2)

## Overview

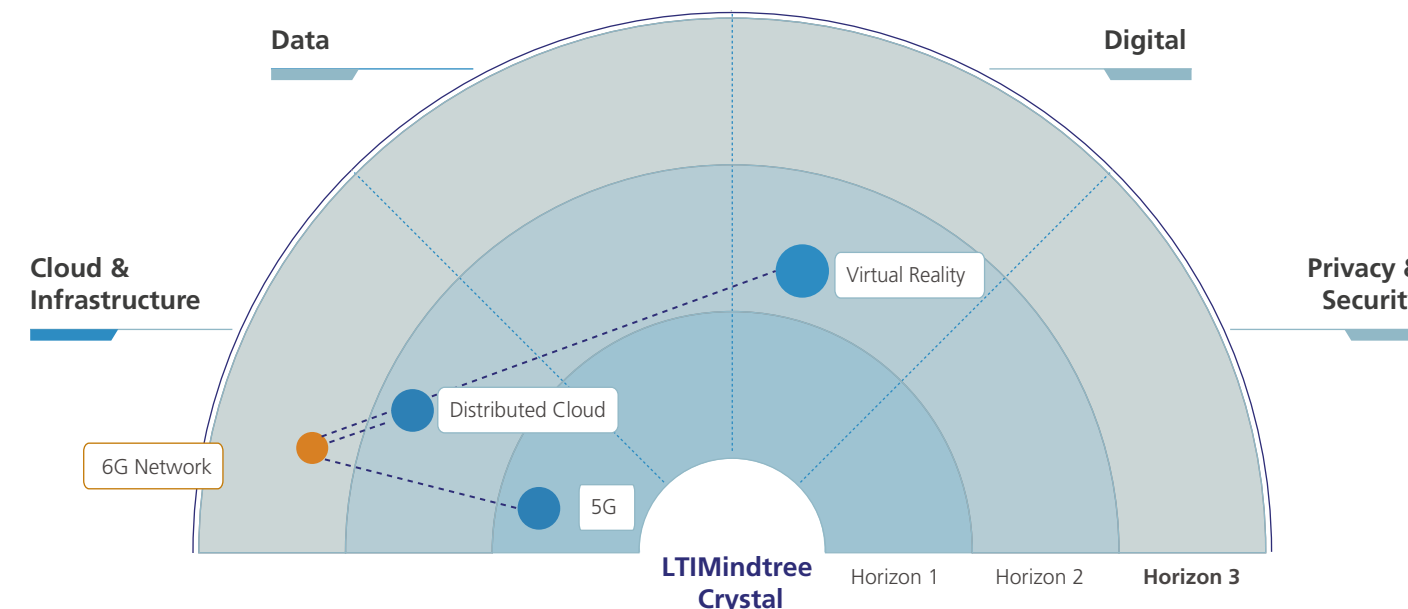
Cellular technology is the predecessor to 6G . 6G networks require higher frequencies than 5G networks and offer relatively higher bandwidth with lower latency. The time taken by data to reach from a source to the end user is called latency, and the amount of data that travels through the network is called bandwidth. 6G Network has the potential to **deliver omnipresent wireless intelligence** and is expected to become available early in the 2030s and will likely be **100 times faster than 5G**. An essential goal of the 6G network internet is to assist one-microsecond latency communications. **It is 1,000 times faster** than a millisecond output.

## CRYSTAL Insights

The global 6G market is predicted to rise considerably in the coming years due to the rising demand for high-speed internet connectivity and the rise in machine-to-machine communication. By 2030, the market for 6G is anticipated to **reach USD\$129 bn with a 4.8% CAGR.**

Application and Type segmentation is expected to drive a pivotal role in its expansion and gain significant momentum in the coming years.

## Crystal Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
<b>3</b>	<b>500Mn - 1Bn</b> ●	<b>Emerging</b> ●

Note: Refer Page 5 to understand the rating parameters

Horizon 3

Cloud & Infrastructure

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Privacy & Security

# 6G Network (2/2)

## How is it a game changer?

Communication among consumers, devices, and the environment will improve with 6G network

6G network support will change the way companies handle information, communicate, decide, and train employees. However, the advantages go far beyond quickness.

It is anticipated to be a completely integrated system that enables immediate communication between gadgets, users, and the environment.

### Key Use Cases



#### Healthcare

Deliver ultra-high-speed network connections

Always available and even telepresence tools to patients



#### Industry 4.0

Implementation of Digital Twins, both in factory and consumer settings, augmented reality, autonomous transportation



#### Telecommunication

In combination with multi-sensory technologies, create new ways for people to interact with one another and with their surroundings, with the help of not just sight and sound but also touch, smell, and taste



#### Entertainment

Advanced gaming experience

### Featured Story

#### The world's first 6G network satellite

6G network still a decade away from reality; however, several countries have started innovating to develop and patent 6G network, which could be called the next big industrial revolution. To test the technology, China has successfully launched what has been dubbed "the world's first 6G network satellite" into orbit. It will be several years before the telecom sector agrees on the requirements for 6G network. Therefore, it still needs to be determined whether the technology being tested will be incorporated into the ultimate standard. It uses high-frequency terahertz waves to transmit data at times faster rates than 5G network is likely capable of.

Horizon 3

Cloud & Infrastructure

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Privacy & Security

# Adaptive AI (1/2)

## Overview

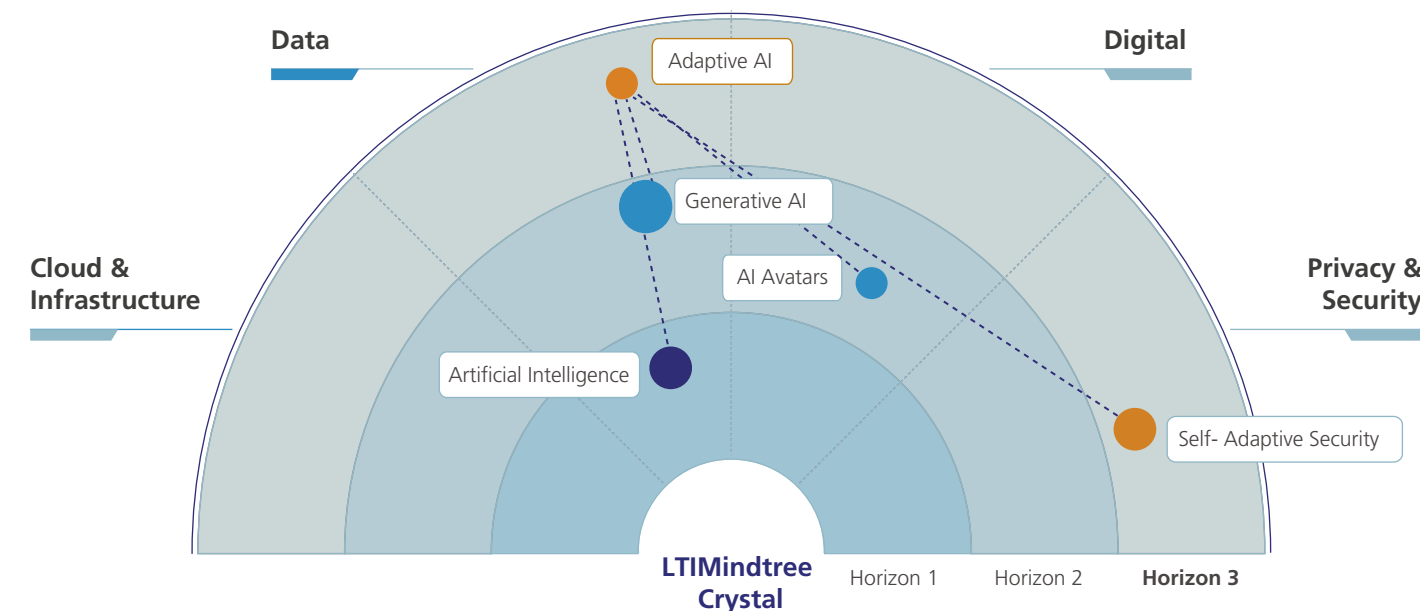
**Adaptive AI** refers to artificial intelligence systems that can adapt to environmental or input changes. These systems are designed to learn from their experiences and adjust their behavior to enhance performance progressively over time.

## CRYSTAL Insights

**Adaptive AI** adapts to complex business situations and analyzes large real-time data clusters to detect patterns and trends. The insights can be leveraged for **forecasting opportunities in the market** and future needs and improve operational efficiency

Such insights may be difficult for a human to gather. Gartner has identified adaptive AI as the top strategic technology of 2023. As per the study, organizations embracing adaptive AI will outperform competitors by up to **25% by 2026**.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
3	500Mn - 1Bn	Emerging

Note: Refer Page 5 to understand the rating parameters

# Adaptive AI (2/2)

## How is it a game changer?

Its ability to continuously learn and improve can provide personalized experiences and enhance user engagement.

Adaptive AI actively learns from previous transactions and promptly identifies abnormal patterns in real time, effectively assisting in the detection of fraudulent activities like credit card fraud.

<h3>Key Use Cases</h3>	<h4>Healthcare</h4> <p>Individualized treatment plans are developed by leveraging the patient's medical history and genetic data.</p>	<h4>Manufacturing</h4> <p>Optimize production levels based on changes in demand</p> <p>Improve efficiency and reduce waste</p>	<h4>Finance</h4> <p>Developing investment strategies based on an individual's financial goals, risk tolerance, and other contextual factors</p>	<h4>Transportation</h4> <p>Optimize transportation routes based on traffic patterns and weather conditions</p>
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<h3>Featured Story</h3>	<h4>American streaming service uses adaptive AI algorithms to analyze user data</h4> <p>An example of adaptive AI in action is the personalized recommendation engine used by a popular American streaming service. It uses adaptive AI algorithms to analyze user data, including past viewing history, search queries, and ratings, to make personalized content recommendations for each user. One of the key benefits of its adaptive AI recommendation engine is that it improves user engagement and retention. Providing personalized recommendations helps the media company to keep users engaged and interested in the platform, reducing the likelihood of churn. Another benefit is that it can improve the quality of content recommendations.</p>
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Horizon 3

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Brain-Computer Interface (1/2)

## Overview

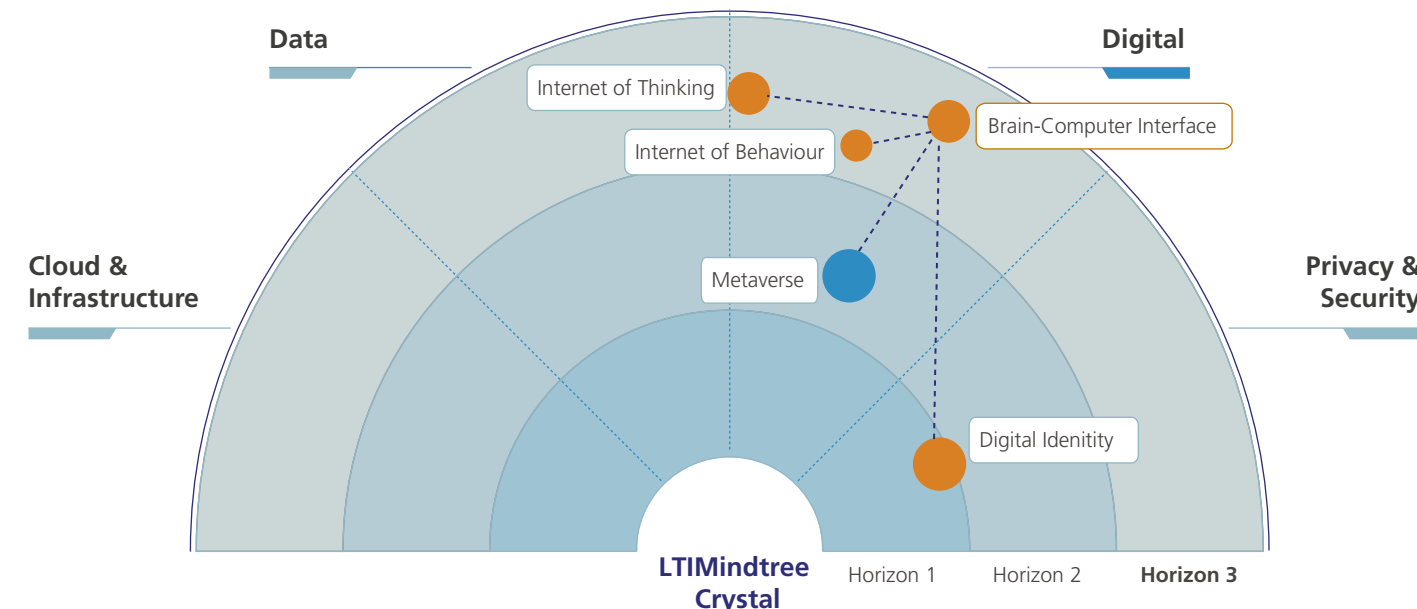
A **brain-computer interface (BCI)** is a technology that captures brain activity and converts it into signals or commands. These signals of commands control external devices such as a prosthetic limb, a computer, or a robotic system. The technology can be applied to treating neurological disorders, enhancing human abilities, or providing new forms of communication and entertainment.

## CRYSTAL Insights

BCIs involve connecting the brain to an external device, which users can control with their thoughts. Users act on objects through brain signals instead of their thoughts via this technology.

BCIs through direct interface with the nervous system can be **life-changing for individuals** with debilitating disorders of the brain, spine, limbs, and sensory organs.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
3	1Bn - 10Bn	Emerging

Note: Refer Page 5 to understand the rating parameters

# Brain-Computer Interface (2/2)


## How is it a game changer?

BCIs have the power to change the lives of paralytic people. Inculcating this technology into their homes will be a game changer and a gradual adoption curve.

Subjects wear an EEG headset in brain-computer interface gaming. The headset used while playing VR games controls virtual objects.

Instead of a game controller, the subject creates movement-based actions using mental commands such as **“push,” “pull,” or “jump.”**


### Key Use Cases



**Entertainment**

Create more immersive experiences.

Control video games using brain signals.




**Healthcare**

Control prosthetic limbs

Help people with spinal cord injuries regain some movement.

Help people with communication difficulties.



**Defense**

Enhance infantry performance.

Control unmanned vehicles and other equipment

### Featured Story

**The "BrainGate" system** ▶

An interesting case study of a BCI is the "BrainGate" system. It was done by a team of researchers at a leading, nonprofit research university and the third-oldest general hospital in the United States. This system enables people with paralysis to use their thoughts to control a computer cursor or robotic arms. A small sensor is placed into the motor cortex of the brain. The sensor records the electrical activity of neurons in the motor cortex. The activity is then translated into commands that can be used to control a computer cursor or robotic arm.

Horizon 3

Cloud & Infrastructure

Data

**Digital**

Privacy & Security

# Humanized User Interface (1/2)

## Overview

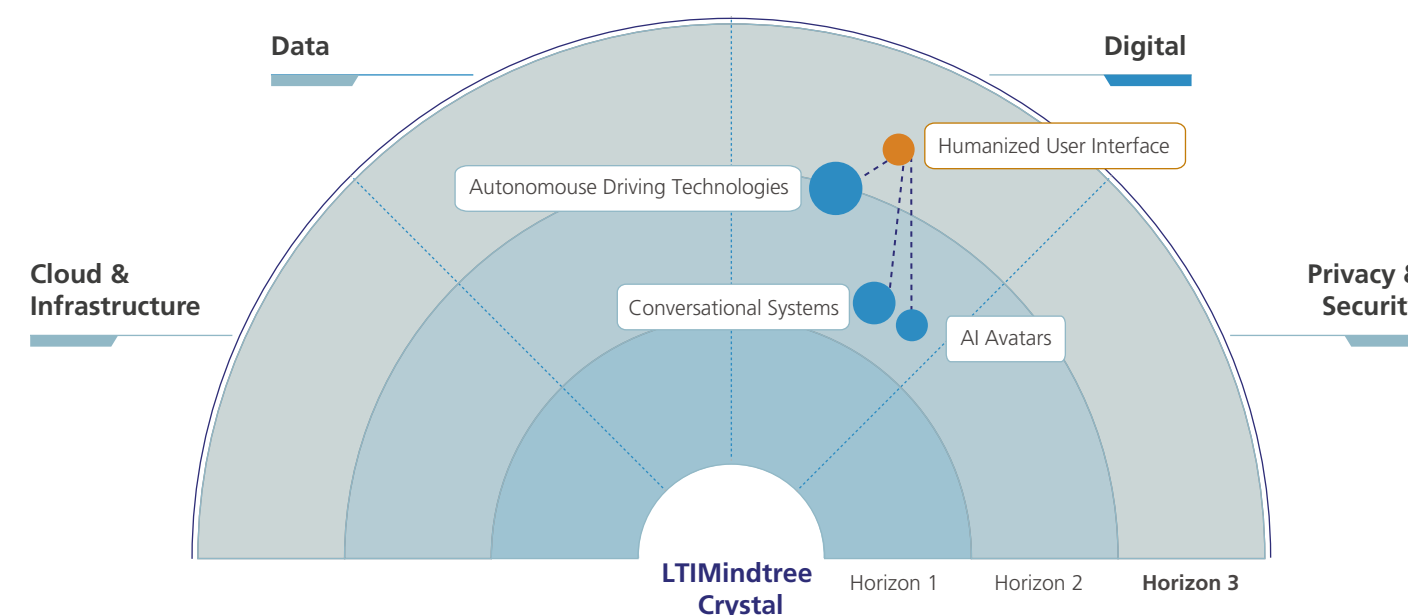
A humanized and intuitive UI takes into account human tendencies and expectations. This is achieved using plain language, visual cues such as colors and icons, and helpful prompts. The goal is to make the experience **less mechanical and natural**, increasing engagement and satisfaction and decreasing frustration and errors.

## CRYSTAL Insights

Designing a **humanized UI** is essential for preparing engaging and effective products and services. The usability and accessibility of interfaces can be enhanced based on the understanding and expectations of human users.

Natural language is a significant aspect of humanized UI design, as most users prefer interfaces with simple language rather than technical jargon. Additionally, **incorporating visually appealing and meaningful cues**, including icons, colors, and animations, can help users navigate the interface more easily and feel more confident.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
<b>3</b>	<b>500Mn - 1Bn</b>	<b>Emerging</b>

Note: Refer Page 5 to understand the rating parameters



# Humanized User Interface (2/2)

## How is it a game changer?

A humanized UI prioritizes user needs, resulting in greater engagement and loyalty in businesses. Using natural language and visual cues, the UI reduces frustration and errors, simplifies complex information, and increases customer retention and brand reputation.

It lowers the demand for training and customer support, saving costs and improving efficiencies.

Overall, a humanized UI creates intuitive and engaging products and services that build long-lasting customer relationships, leading to greater success and growth.

<h3>Key Use Cases</h3>	<h4>Healthcare</h4> <ul style="list-style-type: none"> <li>Patient monitoring through mobile apps</li> <li>Electronic health record (EHR) systems with intuitive interfaces</li> </ul>	<h4>Retail</h4> <ul style="list-style-type: none"> <li>AR and VR shopping experiences</li> <li>Chatbots to assist customers with product information and ordering</li> </ul>	<h4>BFS</h4> <ul style="list-style-type: none"> <li>Personalized finance management apps with intuitive interfaces</li> <li>Chatbots for routine banking tasks</li> </ul>	<h4>Manufacturing</h4> <ul style="list-style-type: none"> <li>User-friendly interfaces for robotic process automation</li> <li>AR and VR training tools to improve employee training and reduce errors</li> </ul>
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<h3>Featured Story</h3>	<h4>KYC and AML Compliance in Banking</h4> <p>▶ A leading language learning app successfully implemented a humanized UI with natural language and visual cues to make the learning process intuitive and engaging. The app features clear and concise instructions, colorful icons, and animations. They help users understand grammar concepts and learn a new language in an interactive and fun way. With more than <b>US\$300 mn users around the world</b>, the success of the company demonstrates the strength of a humanized UI.</p>
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# Change Analysis

## Horizon 2 to Horizon 1

Demystifying the technologies which show increased mainstream maturity driven by **Innovation, Potential and Investments.**

- 5G Network
- Predictive Maintenance
- API Economy
- Computer Vision

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# 5G Network

The 5th Generation Network (5G) is the latest global wireless standard after 1G, 2G, 3G, and 4G, which promises to connect virtually with everyone and everything. 5G networks are designed to deliver higher peak data rates of several Gbps and low latency. Its added advantages include improved reliability, increased network capacity, and a more consistent user experience. 5G Advanced systems, with AI/ML, will support immersive technologies and reduced capability devices and improve network energy efficiency.

## Innovation



By tracking user actions and device activities in real time, 5G networks enable improved customer experiences and also support new business models that leverage data analytics, AI and ML.

## Investment



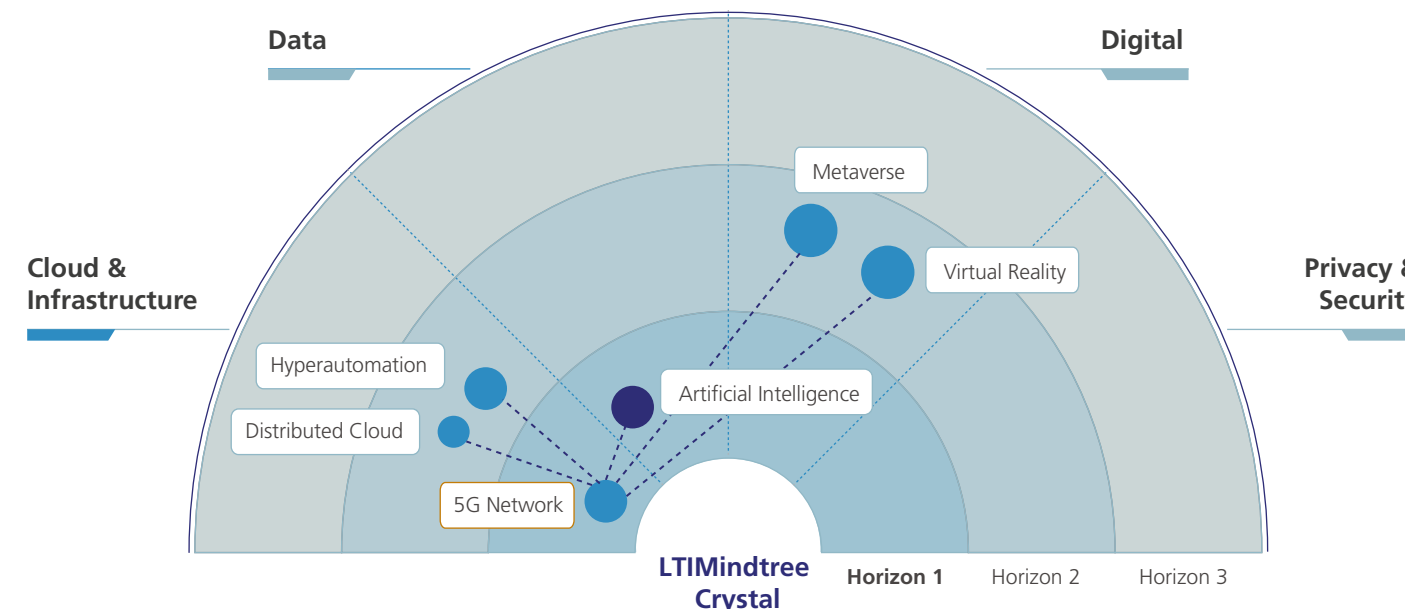
Telecom companies are benefiting from pay-per-use 5G strategies. Multiple Hong Kong telcos have increased ARPU among high-paying customers by 20-30% by creating differentiated tariff structures, driving expected revenue growth of 5% in the next three years.

## Potential



Many organizations have introduced 5G Lab-as-a-Services, promoting innovation in edge computing, remote monitoring, enhanced video, augmented reality, security, AI, and NLP.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	1Bn - 10Bn	Improving

Note: Refer Page 5 to understand the rating parameters

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Predictive Maintenance

Predictive Maintenance (PdM) is a system that uses condition-monitoring techniques and predictive analytics to detect anomalies in machine operation and flag issues before they fail. This is achieved through real-time data evaluation from smart sensors and IoT-connected machines. This AI-based predictive model minimizes machine downtime, saving costs and maximizing equipment lifespan.

## Innovation



With AI, IoT, digital twins, and immersive technologies going mainstream, the need for predictive maintenance as a service is driven by the ability to predict patterns by integrating data from heterogeneous channels.

## Investment



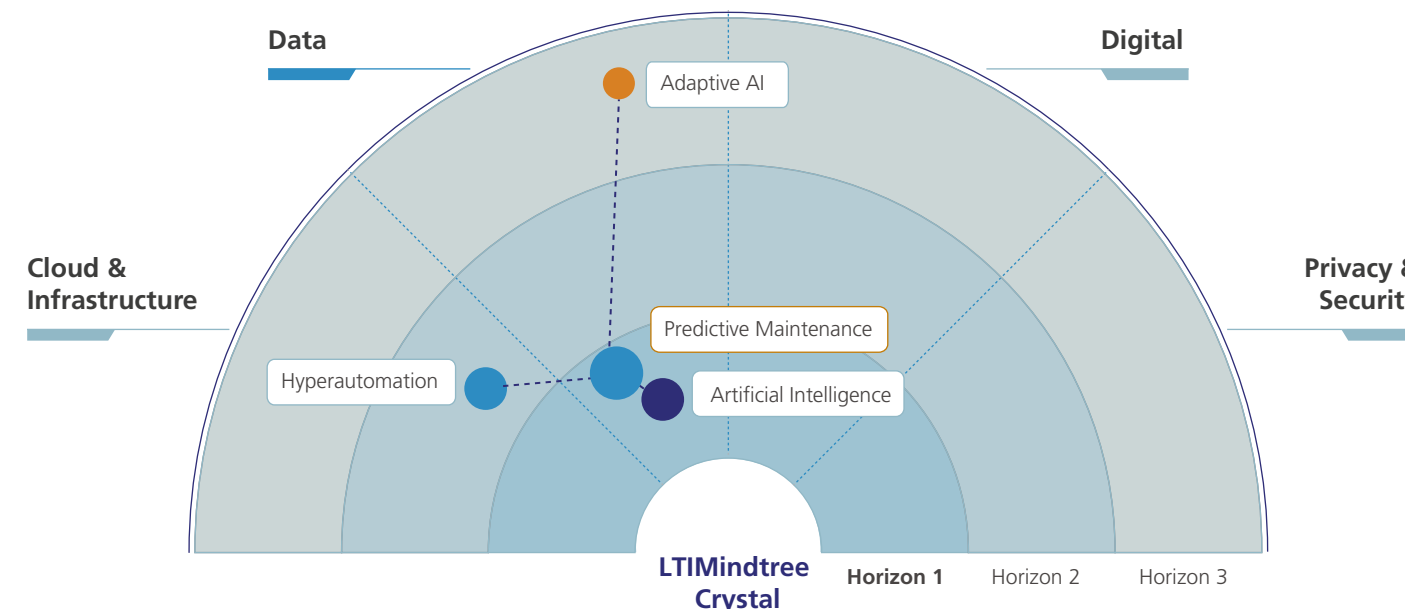
In a Deutsche Messe AG and Roland Berger survey, 81% of companies are devoting resources to predictive maintenance, with 40% already practicing it. The US leads investments in predictive maintenance, with California-based C3.ai investing US\$360 mn in collaborations with Microsoft and Baker Hughes.

## Potential



The accessibility and low price of digital technologies and the increased digital supply network have enabled predictive maintenance to scale across facilities and companies.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	10Bn+	Improving

Note: Refer Page 5 to understand the rating parameters

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# API Economy

The API Economy is a business model built around the use of APIs in the digital economy. APIs refer to application programming interfaces made available to third-party data and services. APIs work as a bridge to connect data extracted from one software application to the next application securely and accurately so that the two can communicate and share data seamlessly. The API Economy is vital because it creates new business models and allows companies to profit by selling their features as Software-as-a-Service (SaaS) products.

## Innovation



Many businesses have built successful models using APIs, such as Uber, Slack and Google. As applications require more agility and inter-operability, the innovations are driven by the demand for a comprehensive framework and methods to create a robust API economy.

## Investment



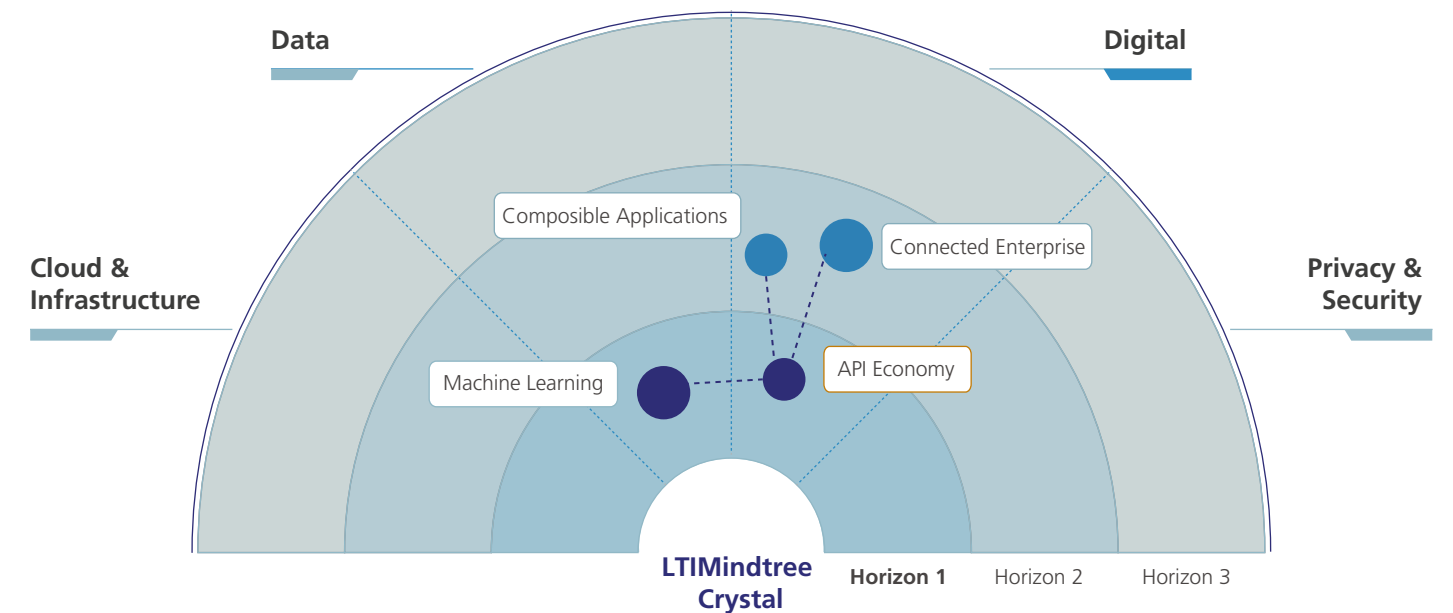
Developers from financial services, technology, telecommunications, and healthcare reported above-average API monetization, with a marked increase in monetization from organizations using over 10 APIs

## Potential



The API economy is proliferating, with 63% of developers using more APIs in 2022. In 2023, Telecom, finance, and technology sectors are expected to use more APIs.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	1Bn - 10Bn	Mature

Note: Refer Page 5 to understand the rating parameters

Horizon 1

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Computer Vision

AI has a branch named computer vision which enables systems and computers to obtain relevant information from videos, digital images, and other visual inputs and perform or suggest actions based on that obtained data. Similar to how AI empowers computers to think, computer vision empowers them to observe and comprehend. Computer vision encompasses various tasks such as capturing, processing, analyzing, and understanding digital images and enabling extraction of high-dimensional data from the real world to generate analytical or symbolic information.

## Innovation



With the incubation of computer vision algorithms for specific tasks gaining momentum in big tech, the number of immersive experience use cases across domains is rising.

## Investment



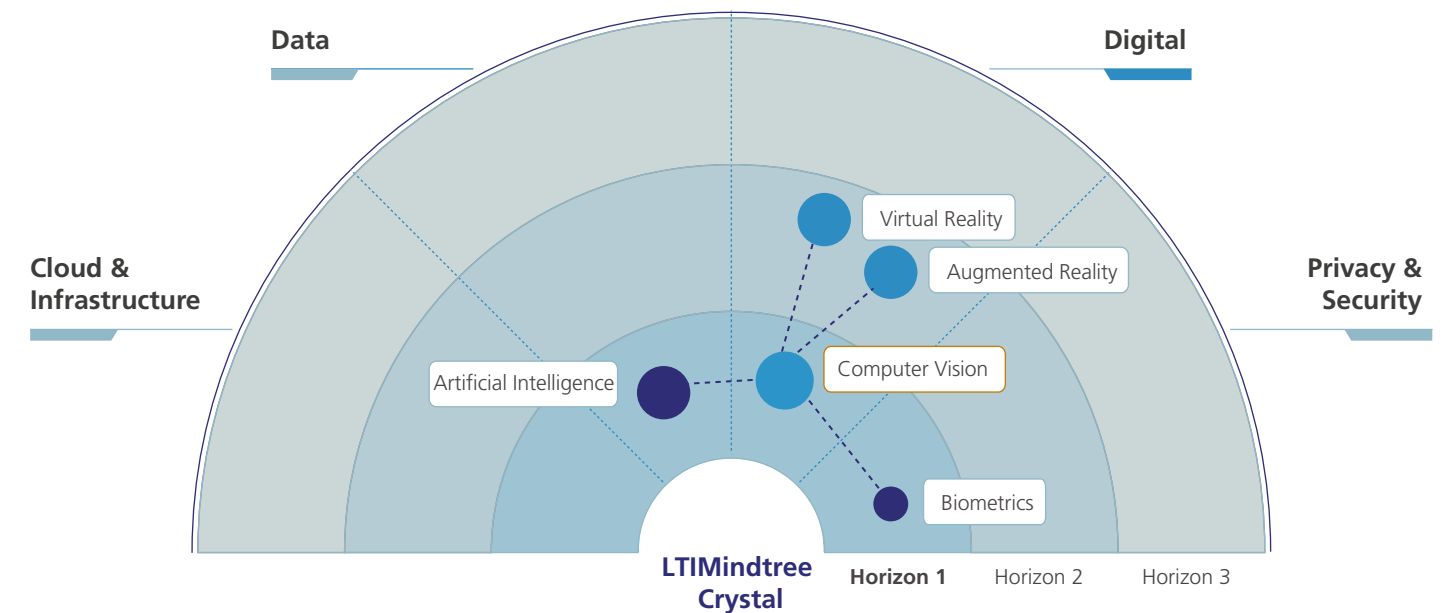
The BFSI sector is an early adopter of computer vision, optimizing operations, increasing security, and mitigating fraud through customer experience metrics and sentiment analysis, automating processes such as KYC and insurance documentation.

## Potential



The average number of Artificial Intelligence-based capabilities that the companies use, for example- natural language generation and computer vision, has increased by 2X, i.e., from 1.9 in 2018 to 3.8 in 2022.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
1	10Bn+	Improving

Note: Refer Page 5 to understand the rating parameters



# Change Analysis

## Horizon 3 to Horizon 2

Demystifying the technologies which show increased mainstream maturity driven by **Innovation, Potential and Investments.**

- **Generative AI**
- **Smart Spaces**
- **Web 3.0**

Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Generative AI

Generative AI is a type of AI that employs unassisted learning algorithms to create new images, videos, sounds, content, or codes. AI is often trained to generate conclusions, yet genuinely impactful force-multiplying technologies possess the ability to innovate independently. Generative AI is a type of AI that learns digital representations of artifacts from sample data and uses them to create new realistic artifacts that retain similarities but do not duplicate them. As a result, generative AI can potentially become the engine of rapid innovation in companies

## Innovation



Large language models and foundation models are driving advancements in generative AI, with businesses eager to incorporate them into strategic processes to boost productivity and generate new ideas.

## Investment



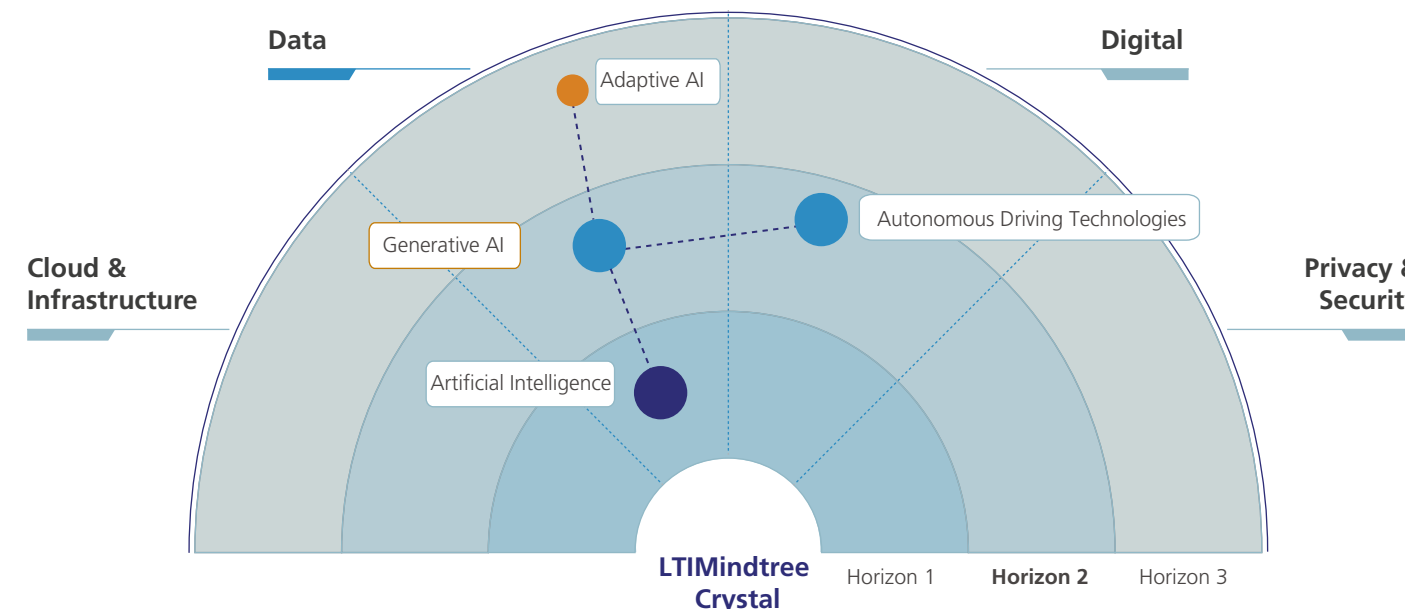
Angel and seed deals have grown, with 107 deals and US\$358.3 mn invested in 2022 compared to 41 and US\$102.8 mn in 2018. VC deals worth US\$1.69 bn materialized in Q1 2023, with US\$10.68 bn announced in the following two months.

## Potential



GPT as a generative AI implementation has sparked interest, with Chat GPT becoming the fastest growing platform with the highest user base within a week of launch and many products/services leveraging OpenAI's GPT.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+	Improving

Note: Refer Page 5 to understand the rating parameters



Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Smart Spaces

A smart space is a physical environment packed with technology. A smart space is an interactive setting where people and technology can communicate openly in a physical or digital environment. This enables “more interactive, immersive and automated experiences for targeted audiences and industry scenarios.” Smart cities, smart homes, and smart factories are examples of smart spaces. Smart Space leverages modern technologies like sensors, high-speed internet, and IoT platforms to create a more dynamic and intelligent environment.

## Innovation



Ambient computing, developments in digital twin algorithms, and technologies like IoT and edge computing, capitalizing on advanced networks such as 5G, have empowered smart, connected ports, roads, and trains.

## Investment



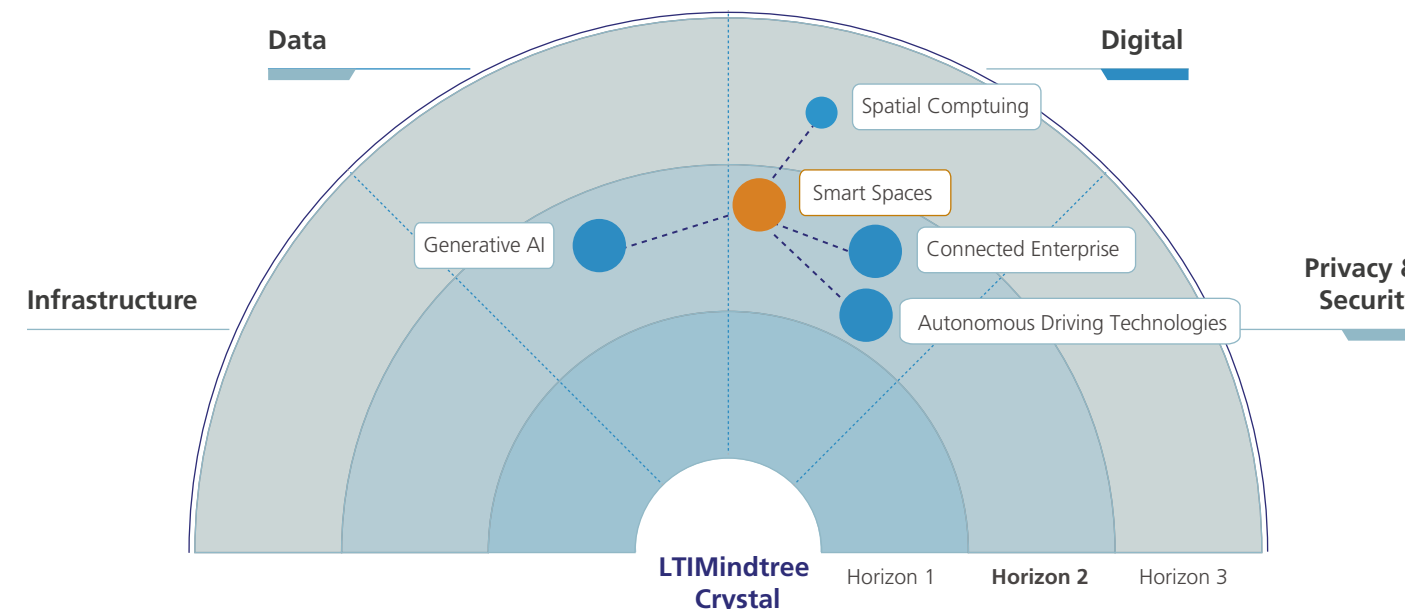
With interconnected workplaces and integrating IoT sensors with humanized experiences gaining traction, organizations are expected to invest in bridging the gap between physical and digital by building smart infrastructure for adaptivity, resilience, and creativity.

## Potential



Advanced device & sensor technologies transform various entities such as homes, offices, industrial complexes, townships into independent and self-sufficient units with the help of improved 5g/wireless connectivity, cloud computing and hybrid, distributed, decentralized cloud deployments.

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	10Bn+	Emerging

Note: Refer Page 5 to understand the rating parameters

Horizon 2

Cloud & Infrastructure

Data

Digital

Privacy & Security

# Web 3.0

Web 3.0 represents the next iteration or stage in Web/Internet development, is potentially disruptive, and portrays a paradigm shift. The fundamental concepts of Web 3.0 included decentralization, openness, and increased user value. It can bring greater value to users beyond social media, streaming, and online shopping. Capabilities such as Semantic Web, AI, and ML are central to Web3. They have the power to increase applications in new areas and improve user interaction.

## Innovation



Decentralization in technical, economic, and legal/fiduciary areas will ensure the realization of the alternate internet with creator/ownership.

## Investment



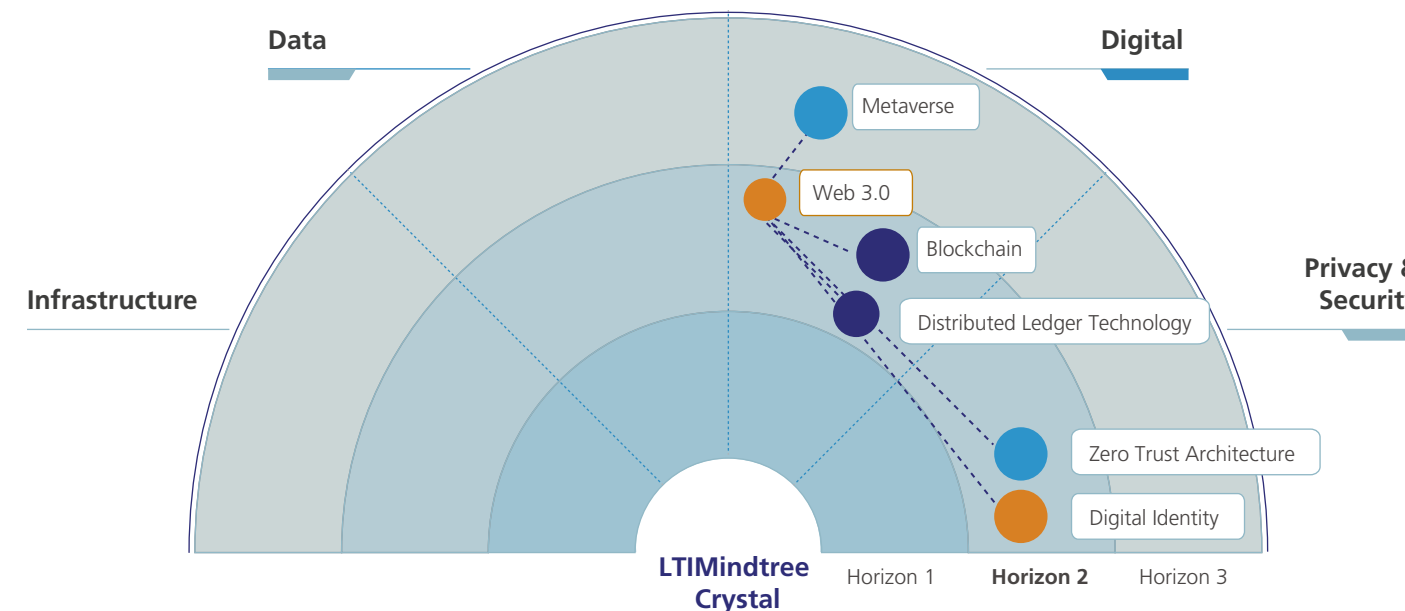
The largest Web3 lending platforms disbursed over US\$200 bn in loans in 2021, with a cumulative bad debt of roughly US\$1 mn despite significant volatility.

## Potential



The first applications that have found product-market fit and gained consumer adoption are Cryptocurrencies, Decentralized Finance (DeFi), and Non-fungible tokens (NFTs)

## Radar Positioning & Related Technologies



## Technology Rating

Horizon	Market Potential (USD)	Adoption Phase
2	1Bn - 10 Bn	Emerging

Note: Refer Page 5 to understand the rating parameters

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# Acknowledgement

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# Glossary

<b>5G</b>	5th Generation Network
<b>AD</b>	Autonomous Driving
<b>ADAS</b>	Advanced Driver Assistance Systems
<b>AML</b>	Anti-Money Laundering
<b>APIs</b>	Application Programming Interface
<b>AR</b>	Augmented Reality
<b>ARPU</b>	Average Revenue Per User
<b>ASICs</b>	Application-Specific Integrated Circuit
<b>AVs</b>	Autonomous Vehicles
<b>BCI</b>	Brain-Computer Interface
<b>BFSI</b>	Banking, Financial Services and Insurance
<b>BYOD</b>	Bring Your Own Device
<b>CAGR</b>	Compounded Annual Growth Rate
<b>CNN</b>	Convolutional Neural Network
<b>CPUs</b>	Central Processing Unit
<b>DeFi</b>	Decentralized Finance
<b>ERP</b>	Enterprise Resource Planning
<b>ESG</b>	Environmental, Social, and Governance
<b>FinOps</b>	Financial Operations
<b>FPGAs</b>	Field Programmable Gate Arrays
<b>GPUs</b>	Graphics Processing Units
<b>HUI</b>	Humanized User Interface
<b>IAM</b>	Identity and Access Management
<b>ICT</b>	Information and Communications Technology
<b>IoT</b>	Internet of Things
<b>IP</b>	Internet Protocol

<b>KYC</b>	Know Your Customer
<b>LoRaWAN</b>	Long Range Wide Area Network
<b>LPWAN</b>	Low-Power WAN
<b>GPS</b>	Global Positioning System
<b>LTE</b>	Long Term Evolution
<b>M2M</b>	Machine-to-Machine
<b>ML</b>	Machine Learning
<b>MLaaS</b>	Machine Learning as a Service
<b>MR</b>	Mixed Reality
<b>NB-IoT</b>	Narrow Band-Internet of Things
<b>NFTs</b>	Non-Fungible Tokens
<b>NLP</b>	Natural Language Processing
<b>NPU</b>	Neural Processing Unit
<b>OT</b>	Operational Technology
<b>PdM</b>	Predictive Maintenance
<b>RegTech</b>	Regulatory Technology
<b>ROI</b>	Return on Investment
<b>RPA</b>	Robotic Process Automation
<b>SaaS</b>	Software-as-a-Service
<b>SASE</b>	Secure Access Service Edge
<b>SCADA</b>	Supervisory Control and Data Acquisition
<b>SoC</b>	Security Operations Center
<b>VR</b>	Virtual Reality
<b>VSM</b>	Value Stream Mapping
<b>XAI</b>	Explainable AI
<b>ZTA</b>	Zero Trust Architecture

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# THANK YOU

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