LTIMindtree

LTIMindtree CRYSTAL

Technology Radar 2022-23

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

From **CTO's Desk**

Dear All,

In this ever-changing landscape of exponential technologies, LTIMindtree is pioneering solutions in a converging world through initiatives that will form the gateway for radical thoughts.
I am proud to launch our **"LTIMindtree Crystal - Technology Radar"** to help push the frontiers of innovation by bringing **"Beyond-The-Horizon"** technologies to your doorstep.

LTIMindtree Crystal is curated by an inclusive team of technology experts and Crystal scouts ensuring that the trends and emerging technologies that look daunting are demystified. The Crystal is an output of rigorous research by our team of next-gen technology experts and meticulously rated by our Technology Council across parameters that range from the **horizon** to **market potential** and their **adoption phase.** With disruptions and uncertainties ruling our past, present, and future, LTIMindtree Crystal becomes a vital instrument in ensuring that we are well equipped with this precise ability to predict the future technology elements.

As we contemplate challenges faced by clients, we have built a **Horizon-to-Mainstream** Incubation and **Industrialization** funnel to build solutions to solve them. LTIMindtree's Crystal is the first phase of this funnel. This is followed by a deep point-of-view built in collaboration with academics, partners, and industry experts. The Crystal plays a critical role in building our Incubation and Industrialization pipeline.

As we move on this journey of technology empowerment and enable newer ways of thinking and reforming, we would love to know what's on the mind of our Solver's Tribe.

Warm Regards,

Sandeep Deb
CTO, erstwhile LTI

LTIMindtree Crystal – **Introduction**

At LTIMindtree, we have always been at the forefront of an evolving technological landscape and deploying our expertise in nurturing capabilities. With our spirit of **Ubuntu** and our culture of **Shoshin**, we strive to be at the forefront of the new world order. The emergent business world is experiencing an unprecedented degree of interventions and technologies that act as enablers. It's imperative for us to strengthen our technology landscape for developing ingenious solutions and providing business outcomes to our clients. This first edition of **"LTIMindtree Crystal - Technology Radar"** will act as a catalyst to drive thought leadership and amplify **"Beyond-the-Horizon"** capabilities.

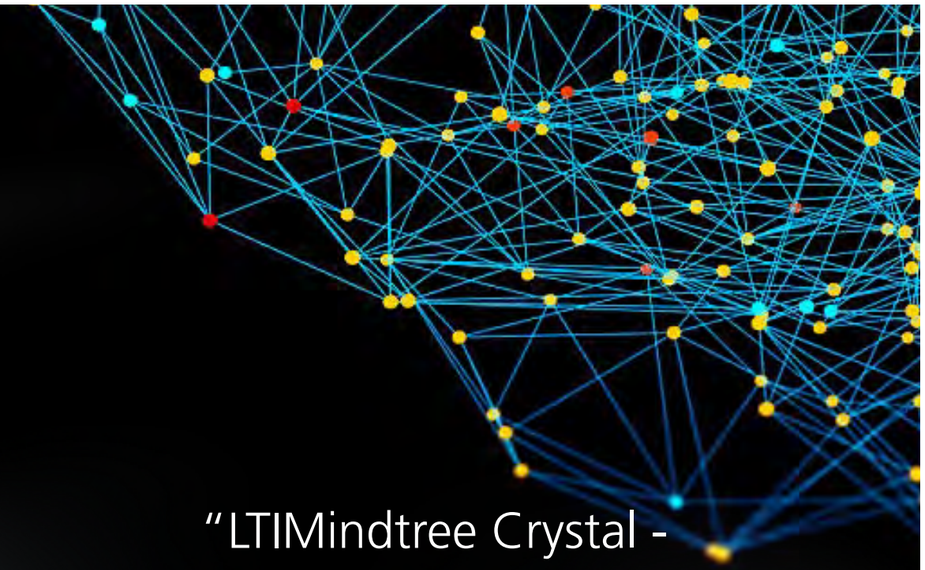
Some of the key envisaged benefits of the Technology Radar are:

- Proactive identification and evaluation of trends related to business, technologies, skills, tools, etc.
- Future-driven growth strategies with an early-warning system
- Opportunity spaces for future research and consideration
- Dynamic, intuitive, and comprehensive visualizations for strategic analysis
- Strategy and innovation combined centrally to create game-changing growth opportunities

There are overall **56** technology elements across **4** segments and each one of them have been rated on **3 parameters** as explained ahead. **Each technology element covers our insights, technology element relationships, key use cases, why this can be a game changer and a featured story.** I request and encourage you to take some time to go through the elements in detail hoping it will inspire, enlighten and take you one step closer to the desired future.

Sachin Jain
Head, LTIMindtree Crystal

LTIMindtree Crystal – **Technology Radar: Ratings**



"LTIMindtree Crystal - Technology Radar" provides **"Beyond-The-Horizon"** technologies for cross industry enterprises.

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.

0 - 100Mn	●
100 Mn - 500 Mn	●
500 Mn - 1 Bn	●
1 Bn - 10 Bn	●
10Bn +	●

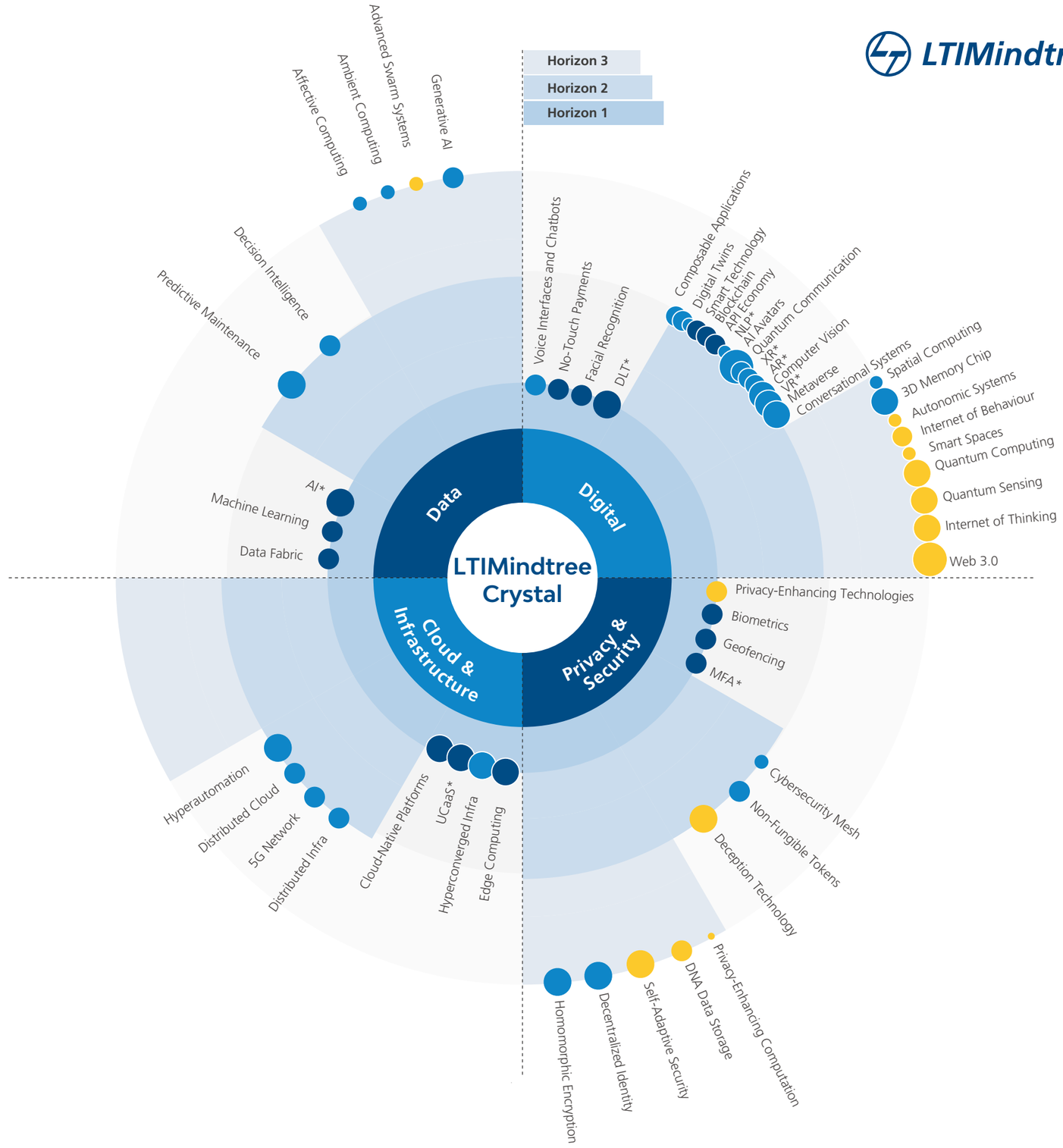
Adoption Phase

Adoption maturity of technology in the market

Emerging	Technology is still in R&D Stage
Improving	Technology has all the hype and promotion of innovation
Mature	Technology is accepted by the masses

LTIMindtree Crystal - **Technology Radar**

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



Abbreviations:

AI – Artificial Intelligence

AR – Augmented Reality

DLT – Distributed Ledger Technology

MFA – Multi-Factor Authentication

NLP – Natural Language Processing

UCaaS – Unified Communications-as-a-Service

VR – Virtual Reality

XR – Extended Reality

LTIMindtree Crystal - **Technology Radar Navigation**

The technologies listed below are arranged according to their corresponding horizon and grouped by their technology segment

Horizon 1

1. **Cloud & Infrastructure**
   - Cloud-Native Platforms
   - Edge Computing
   - Hyperconverged Infrastructure
   - Unified Communications-as-a-Service
2. **Data**
   - Artificial Intelligence
   - Data Fabric
   - Machine Learning
3. **Digital**
   - Distributed Ledger Technology
   - Facial Recognition
   - No-Touch Payments
   - Voice Interfaces and Chatbots
4. **Privacy & Security**
   - Biometrics
   - Geofencing
   - Multi-Factor Authentication
   - Privacy-Enhancing Technologies

Horizon 2

1. **Cloud & Infrastructure**
   - 5G Network
   - Distributed Cloud
   - Distributed Infrastructure
   - Hyperautomation
2. **Data**
   - Decision Intelligence
   - Predictive Maintenance
3. **Digital**
   - AI Avatars
   - API Economy
   - Augmented Reality
   - Blockchain
   - Composable Applications
   - Computer Vision
   - Conversational Systems
   - Digital Twins
   - Extended Reality
   - Metaverse
   - Natural Language Processing
   - Quantum Communication
   - Smart Technology
   - Virtual Reality
4. **Privacy & Security**
   - Cybersecurity Mesh
   - Deception Technology
   - Non-Fungible Tokens

Horizon 3

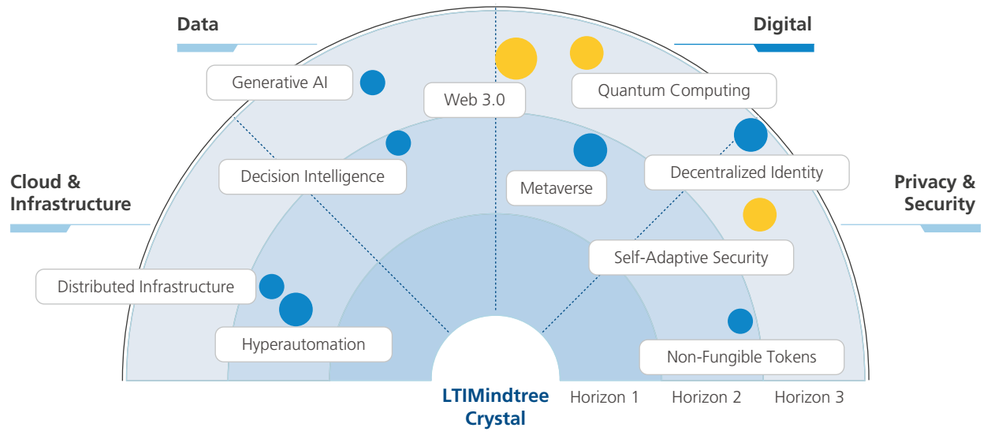
1. **Data**
   - Advanced Swarm Systems
   - Affective Computing
   - Ambient Computing
   - Generative AI
2. **Digital**
   - 3D Memory Chip
   - Autonomic Systems
   - Internet of Behaviour
   - Internet of Thinking
   - Quantum Computing
   - Quantum Sensing
   - Smart Spaces
   - Spatial Computing
   - Web 3.0
3. **Privacy & Security**
   - Decentralized Identity
   - DNA Data Storage
   - Homomorphic Encryption
   - Privacy-Enhancing Computation
   - Self-Adaptive Security

LTIMindtree Crystal – **Technologies for Tomorrow**

This is our first publication of Technology Radar which demonstrates where various technology trends lie on the horizon and the position of these technology trends based upon their maturity level from conception to a near-derived state. It presents exciting opportunities for the future and helps in decision making to evaluate existing and emerging technology trends. While the future is exciting, I believe there will be challenges and obstacles which can be further researched if we propitiously prepare for them and plot the necessary groundwork to address them.

For an unbiased opinion, I have selected ten technology trends from the LTIMindtree Crystal, based on Horizon **(Horizon 2 and 3)**, market potential **(~USD 1 Bn & above)**, and technology maturity **(Emerging & Improving)**. I anticipate these trends have higher potential and will yield more rewarding opportunities for the industry.

Technologies for Tomorrow



While we have published Deep POVs for few trends, Deep POVs on the other topics are being selected and scheduled for consumption within this year.

In the end, I would like to thank all our contributors in shaping this report which reflects our LTIMindtree values and celebrates our spirit of GRIT.

Sunil Agrawal
Associate Vice President, Global Head of Enterprise Architecture Group, LTIMindtree

Technologies for Tomorrow - **Cloud & Infrastructure**

Hyperautomation

As we all know, automation has been an integral part of various digital transformation initiatives. Previously, automation was s olely implemented in driving very specific initiatives like in operational level automation, robotics process automation, etc. All these transformation initiatives were technology centric.

Gartner has recently refined its hyper-automation definition as **"a business-driven, disciplined approach that organizations use to rapidly identify, vet and automate as many business and IT processes as possible."** My key interpretation here is to encourage greater business-driven automation across the board. For instance, a customer journey involves different steps like marketing, running campaigns, customer's onboarding interactions, sales, order, provisioning/delivering products & services to customer support services.

Hence, according to me, hyper-automation will not only include identifying automation opportunity across a given journey but also ancillary processes to achieve the strategic objective of the organization. This trend has improved significantly and will only mature from here as supporting technologies like AI, Robotics etc. mature.

Distributed Infrastructure

In the past, enterprises used to align with only one cloud provider for all their scalability needs. However, the current scenario is very different.

Today, enterprises adopt **multi-cloud strategy along with limited on-prem applications** to avoid vendor lock-in and maximize infrastructure flexibility. Today's cloud providers also offer various cloud native services for deploying cloud native applications at enterprise level.

There are certain challenges that have emerged due to this multi-cloud strategy. Firstly, the complexity has increased significantly, as enterprise-wide applications are now distributed across various infrastructure. It is difficult to obtain enterprise-wide dashboard across such a diverse infrastructure.

The other challenge that persists, is smooth application and data integration across such a Distributed Infrastructure. I strongly believe that for service providers like LTIMindtree, it provides great opportunity to mature solutions around it as challenges around it emerges before it becomes seamless for enterprises.

Technologies for Tomorrow - **Data**

Decision Intelligence

Modern day enterprises are complex due to matrix operation modules. The complexity can be attributed to the enterprise's mutual dependence on other segments of the ecosystem and nature of work they perform. Decision making also becomes difficult due to these complexities. Individual personalities, and biases therein, limit the assessment of the situation objectively.

This leads to creating a **framework for decision making** that has configurable list of parameters with their individual weightage along with ability to perform multiple What-If scenarios is needed. Then, the next logical step will be an **AI based model that evaluates scenarios and provides recommendations** with rationale. The ML algorithms that keep track of past decisions and their subsequent impacts make the Decision Intelligence a trusted companion, helping leaders take decisions objectively. While enterprises have adopted some of its decision making, reliability on these decision intelligence model will only improve as the maturity of AI model and data quality technology improves. And then some of these decisions will be automated to reduce human intervention.

Generative AI

We know that the Generative AI uses unsupervised learning algorithms to generate novel images, audio, video, text, or code. The advent of Generative AI is fuelled by rapid advancements in neural networks and machine learning algorithms for data crunching and pattern analysis.

Even though Generative AI is still at a nascent research phase, I believe trial applications have exhibited spectacular results that might rival human competency. Natural language processing has emerged as a crucial component in Generative AI in terms of **evaluating how humans create and interpret content.**

Despite significant progress, market continues to remain fragmented with no clear directives. Generative AI is offering a conducive climate for budding start-ups. Start-ups are heavily invested in research phase while large service providers are now leveraging some of these products for solving use cases especially Healthcare and entertainment Industries. With increased research and sophistication, I can see that many more industries will leverage it in next 2-3 years.

Technologies for Tomorrow - **Digital**

Metaverse

This is amongst the newer areas of technology that has caught the attention across multiple domains and at an accelerated pace. While Facebook simply defined metaverse as "a set of virtual spaces where you can create and explore with other people who aren't in the same physical space as you", we don't think it has fixed set of features or attributes where you create a **digital platform to connect and interact with people in 3D forms virtually.**

This trend needs to be researched, invested extensively along with Web 3.0 where decentralized internet services will provide more power to its users controlling data they own and share.

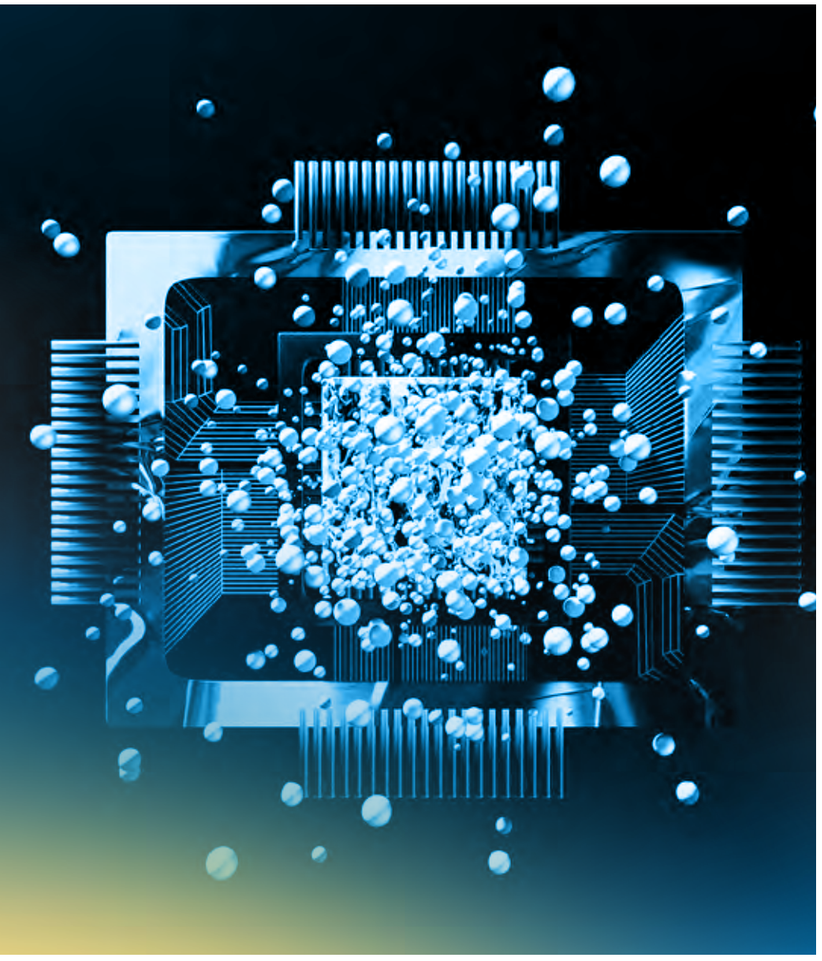
There are multiple business use cases which are coming up and getting prototyped at a very rapid pace as surrounding technologies required to realize metaverse have evolved & are being adopted faster in last decade e.g., AR/VR, AI, decentralized identity, NFT, decentralized payment platform. Hence business leaders should start embracing this technology to enhance their customer experience by **inventing new interaction models.** The global Metaverse Market is estimated to reach **USD 758.6 Billion** by the year 2026, growing at a **CAGR of 37.1%**.

Web 3.0

Web 3.0 has moved well beyond this original concept of Decentralized and Semantic Web. We believe that Web 3.0 projects can be complete gamechangers. bringing to users a **fairer internet by enabling individuals to become stakeholders** on the internet, like that of a peer-to-peer network.

While web 3.0 is still very new and there are a lot of emerging players and VCs are investing in the ecosystem, it is majorly within start up community, enterprises and government needs to incubate use cases and increase its adoption to bring this into mainstream. Hence any investment made today will lead to substantial ROI in times to come. The Web 3.0 Metaverse and Commerce stands as an opportunity for businesses to start with.

Technologies for Tomorrow - **Digital**



Quantum Computing

This trend has picked high level of investment in last 2 years. Almost every week there is news around quantum computing by large players like Google, IBM.

All major countries are investing billions of dollars in quantum R&D. High amount of government funding has caused a lot of academic researchers to take up quantum as part of Ph.D. programs in partnerships with enterprises and government organizations.

On Oct 23, 2019, Google announced it performed a calculation on a quantum processor in 300 seconds that would be impractical with the algorithms available at the time.

While a lot of academics have started writing quantum algorithms for various problems, we must be patient till quantum computers becomes readily available. They are said to be the **most disruptive technology of this century.**

In 2019, IBM also unveiled their 127-Qubit Quantum processor and by 2023, IBM expects to have a 1000 qubit processor.

At LTIMindtree, we are collaborating with IIT Madras and IBM on Quantum technologies by investing in building capabilities in quantum computing. In future, this would be an area which large enterprises would look to solve their complex business problems.

Technologies for Tomorrow - **Privacy & Security**

Decentralized Identity

Decentralized identity (DID), also referred to as "self-sovereign identity" (SSI), is an open standards-based identity framework that uses digital identifiers and verifiable credentials that are self-owned, independent, and can enable trusted data exchange. DID is currently being considered as an alternative to current traditional centralized and federated infrastructure. To simply put, it enables individual to manage its own identity.

Decentralised identity gives **back control of identity to consumers using an identity wallet** in which they collect verified information about themselves from certified issuing authorities (such as the Government, Employer, University, Financial Institutions etc.).

By controlling what information is shared from the wallet to requesting 3rd parties (e.g., when registering for a new online service), the user can better manage their identity online and their privacy. For instance, only presenting ID proof that states that you are over 18 without disclosing your actual date of birth.

W3C, DIF and other organizations are providing base framework and standards for implementation of Decentralized Identities. With **Web 3.0 coming up, decentralized identity would become a necessity.**

Self-Adaptive Security

Security implementation protocols must evolve in direct proportion to the rate of transformation of the system. As cyber-attacks are on the rise, automatic early detection of threats is the need of the hour.

Automatic security mechanism will help in preventing data theft and network interference. With the growing number of Internet-based devices, particularly multimedia devices, it is critical to build **self-adaptive security mechanisms.** These mechanisms will leverage artificial intelligence and machine learning technologies to continuously monitor, detect, and mitigate future attacks.

Enterprises can no longer rely on traditional security systems to protect today's complex ecosystem. It must fast track the adoption of self-adaptive security mechanisms and bring it to horizon 1.

Despite multiple research publications and theories available today, this technology lacks maturity. The implementation also must work across networks and continuously adapt to newer threat and vulnerabilities on the go. However, we must be cautious during its implementation and ensure that latency is not increasing. Rise in latency will certainly hamper the system throughput.

Technologies for Tomorrow - **Privacy & Security**

Non-Fungible Tokens

Non-Fungible Tokens are essentially digital tokens which are unique and irreplaceable like an autographed book, real estate, or an original painting. NFTs represents ownership, authenticity, and origin of unique items.

It allows you to buy and sell these items and keep track of the owner through blockchain. Use cases such as tokenizing patents or IP rights will allow owners to commercialize them in open market. NFTs will bring more **transparency in terms of ownership across the entire supply chain life cycle.**

An NFT can either be one-of-a-kind, like a real-life painting, or one copy of many, like trading cards, with the blockchain keeping track of who has ownership of the file. Currently digital art is the most common use of the NFT.

NFTs have been making headlines lately, some selling for millions of dollars, with high-profile memes like Cyan Cat and the "deal with it" sunglasses being put up for auction. However, for enterprise use cases, questions such as risk, security and governance need to be answered. ERC-721 Non-Fungible Token Standard is the mainstream standard being used here.

LTIMindtree

THANK YOU

For any queries and suggestions, please write to **GTO_Crystal@ltinfotech.com**

LTIMindtree is a global technology consulting and digital solutions company that enables enterprises across industries to reimagine business models, accelerate innovation, and maximize growth by harnessing digital technologies. As a digital transformation partner to more than 750 clients, LTIMindtree brings extensive domain and technology expertise to help drive superior competitive differentiation, customer experiences, and business outcomes in a converging world. Powered by more than 90,000 talented and entrepreneurial professionals across 30 countries, LTIMindtree — a Larsen & Toubro Group company — combines the industry-acclaimed strengths of erstwhile Larsen & Toubro Infotech and Mindtree in solving the most complex business challenges and delivering transformation at scale. For more information, please visit **www.ltimindtree.com**.

LTIMindtree Limited is a subsidiary of Larsen & Toubro Limited