GTO

LTIMindtree

IIT MADRAS
Indian Institute of Technology Madras

Deep POV

Quantum Communication

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Contents

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Executive Summary

Achieving Safe, Secure, and **Faster-Than-Light (FTL)** communication has always been one of the key pursuits for mankind. Breakthroughs in quantum physics gave us hope that such kind of communication might be possible soon. Upon further research, it was concluded that such communication is based on quantum technologies which Einstein famously defined as "***spooky action at a distance***" and is feasible.

Quantum physicists are exploring the concepts of quantum entanglement, superposition, and teleportation to get a breakthrough in this area, and globally there is a surge of investment in this area. In broad terms, this area is categorized as **Quantum Communication**.

Quantum Communication's hardware and software development is following the same trajectory as that of Quantum Computing or may be faster in a few areas. We believe that realization of Quantum Communication will lead to the creation of Quantum channels that will revolutionize multipartite information transfer and sharing. Quantum channels will lead to ***"The Second Quantum Revolution"*** soon and will become a norm for a safe, secure, and faster way to communicate.

Tremendous traction can be expected in the Quantum Communication market in the coming few years. As per McKinsey, the market valuation of Quantum Communication is likely to reach around USD **8 billion** by **2030**. As Quantum Communication technology becomes more prevalent, it will eventually get access to a brand-new profit stream. Swift development in the Quantum Communication fields like Quantum Key Distribution (QKD), Quantum Internet, and Quantum Cryptography will emerge as the key market and industry growth drivers. They will play a critical role in laying the foundation of a safe quantum channel.

In this point of view, we summarize the opportunities for contributions and continued development within the Quantum Communication space, existing solutions, and framework initiatives, and provide some key takeaways concerning the technology evolution. In our opinion, Quantum Communication is here to not only stay but also have a significant impact on various aspects of communication, including the potential for the emergence of newer security protocols and the way we communicate today.

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Introduction

What is Quantum Communication?

We generate around 2.5 quintillion bytes of data every day. We have no idea how much of this information is secure. We are also struggling to find how vulnerable our data is on the web. These problems will gain further relevance as we take major leaps in the communication domain. This calls for a strong and secure method to safeguard the data in today's technologically advanced environment, thus leading to the generation of Quantum Communication.

Quantum Communication transcends the boundary of classical communication and provides impenetrable security. Here, **Quantum Communication** can safeguard the data with security layers that are impenetrable to external agents. Any eavesdropper who tries to intercept data will irreparably damage the information and thus their presence can be detected with ease with the help of Quantum Communication technology. As Quantum Communication is likely to reach mainstream very soon, we will get a communication system that is impossible to intercept without detection, irrespective of any technology that we develop in the future.

To understand the criticality and thorough examination of the need for Quantum Communication technology, let us dive into the various distinguishing aspects of Quantum Communication and Classical Communication.

Classical vs Quantum Communication

Classical Communication

In classical communication, a string of bits is modulated at a high data rate on a laser with a 1-watt output power in a typical free-space optical communication system used today. In this process, the laser emits approximately 7.8 x 1018 photons per second flowing from one sender to receiver at a steady output. When enough photons arrive at other persons' receivers to establish a coherent link, a data link is successful.

Quantum Communication

On the other hand, a Quantum Communication channel uses the quantum property of individual photons. Instead of modulating the signal, which controls the flow of photons, one instead manipulates the quantum characteristics of the individual photons. Due to this "processing," the output of photons from quantum transmitters (also referred to as sources) is often lower than that of a laser (in the millions of photons per second). There is still much space for advancement in the quantum sources and detectors (receivers) that are already on the market. However, we are yet to establish the technological stage where Quantum Communication can completely replace Classical Communication.

Our Perspective

In our view, Quantum Communication technology has started gaining traction in some of the new sets of applications where they can be deployed in integration with existing Classical Communication networks. Nonetheless, we expect this scenario to get transitioned into a fully equipped Quantum Communication channel. This channel will primarily provide safe and a supreme security feature ensuring data protection based on quantum mechanics rules rather than the mathematical complexity of traditional encryption systems.

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Before understanding various practical implications of Quantum Communication, we must understand various important components of the technology.

Quantum Communication is built upon concepts of quantum mechanics and quantum physics which also includes some major components such as **QKD**, **quantum teleportation, quantum internet**, **quantum secret sharing, super-dense coding, quantum repeater, quantum cryptography and post-quantum cryptography**. In this section, we discuss some of these concepts.

QKD

QKD is a secure form of communication for sharing encrypted keys that are only known to the shared parties. The communication technique exchanges cryptographic keys in a verifiable manner that ensures security by utilizing aspects of quantum physics.

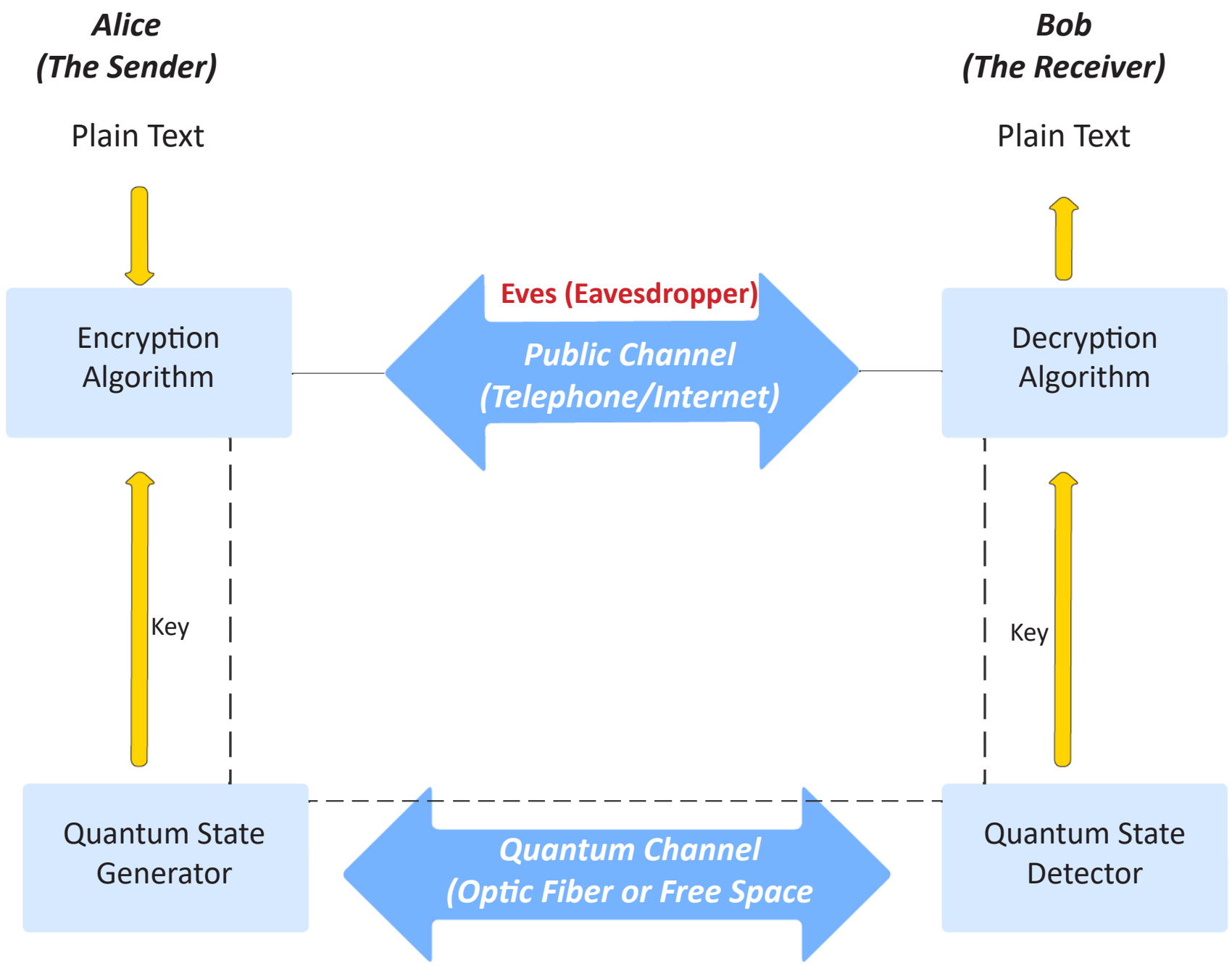

Fig.1: Quantum Key Distribution (QKD)

For QKD to function, many light particles, or photons, must be sent between parties. The photons delivered constitute a stream of ones and zeros, and each photon has a random quantum state. This would make the quantum channel more secure, and an eavesdropper will not be able to correctly interpret the final key.

However, before QKD can be widely adopted, it must overcome several significant challenges, including **secret key rate**, distance, size, **cost**, and practical security. Despite the implementation challenges, the development of this innovative technology will enhance high data rates and extend the QKD's overall effective range. With new networks and businesses offering commercial QKD solutions, it is starting to be used more frequently in a commercial context.

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Quantum Teleportation

Quantum teleportation is a method for sending information from a quantum transmitter at one point to a quantum receiver located at the other point. When two far-off, entangled particles are involved in quantum teleportation, the state of a third particle instantly “teleports” to the two entangled particles. In other words, it’s a process by which a qubit is transmitted from one location to another, without the qubit being transmitted through space.

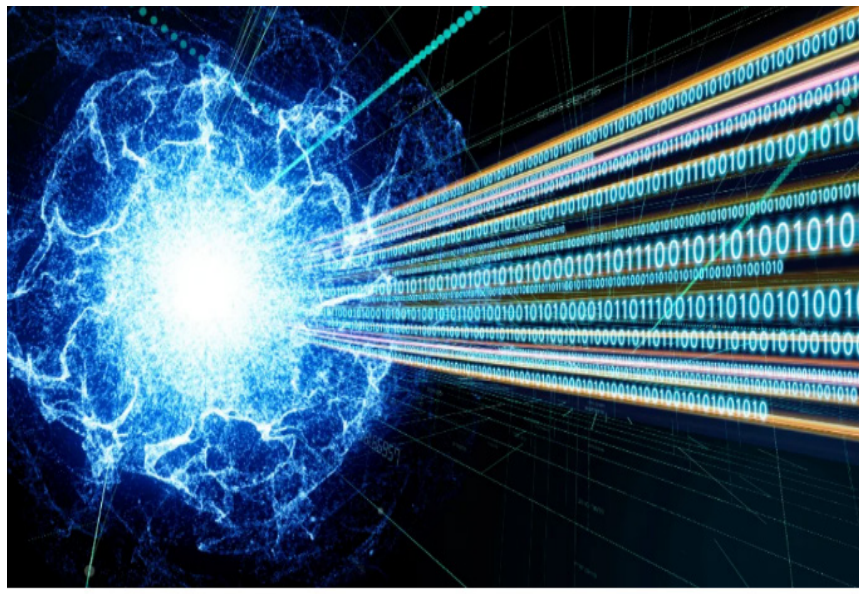

Fig.2: Quantum Teleportation (Source:azonano.com)

Quantum Internet

The quantum internet is a system of interconnected quantum computers that uses quantum signals to send information rather than radio waves. Various application areas for quantum internet include protocols for distributed system problems such as leader election or Byzantine agreement, clock stabilization, extending the baseline of telescopes, secure identification and two-party cryptography in the noisy-storage model, and position verification.

Fig.3: Quantum Internet (Source: Phys.org)

Quantum Repeaters

Quantum repeaters are used to divide long communication into various segments. Each of these segments can be separately distributed with a quantum key and use entanglement exchange and purification techniques to establish a longer-distance Electron Paramagnetic Resonance (EPR) between adjacent nodes. Ideally, the need for quantum repeaters with quantum processors in them has increased as it allows encryption keys to remaining in quantum form as they are amplified and sent over long distances.

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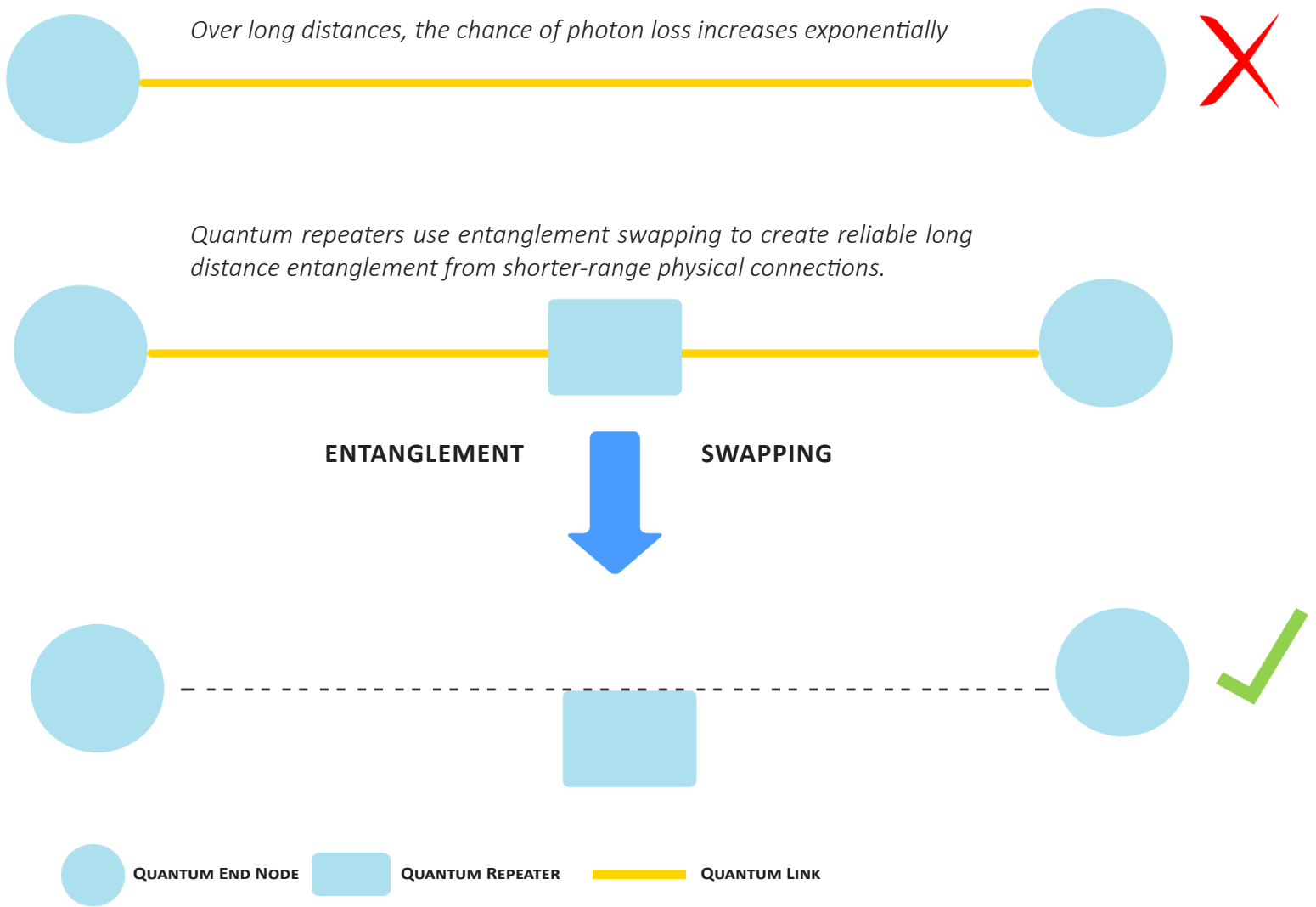

Fig.4: Quantum Repeater

Quantum Secret Sharing

To achieve the highest level of communication security, it alters the conventional secret sharing (CSS) system, utilizing quantum information and the no-cloning theorem.

Super-dense Coding

It is a Quantum Communication technique that relies on the transmitter and receiver pre-sharing an entangled resource to convey a larger number of classical bits of information while only sending a lower number of qubits.

Quantum Cryptography

Data is encrypted and protected using cryptography so that only those with the proper secret key may decrypt it. In contrast to conventional cryptographic systems, quantum cryptography uses physics rather than mathematics as the primary component of its security concept.

Post-Quantum Cryptography

Post-Quantum Cryptography refers to cryptographic algorithms that are expected to be secure against a cryptanalytic attack by a quantum computer. It aims to create cryptographic systems that are resistant to both quantum and conventional computers and are compatible with already-existing networks and communications protocols.

All these components have proved to be decisive milestones in the overall adoption phase of Quantum Communication technology. For instance, some organizations have taken advantage of various peculiar features of these components to create some convincing Quantum networks for transmitting highly sensitive data. Various protocols including **BB84 (Bennett and Brassard 84)** have also been built around one of the important components of Quantum Communication i.e., QKD. Moreover, we also need quantum repeaters as they allow encryption keys to remain in quantum form as they are amplified and sent over long

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distances. These Quantum Repeaters would surely help to create some robust quantum algorithms, however, once the quantum computers are fully commercially viable, only then we can see an upward trend in the implementation of Quantum Repeaters on a larger scale.

Our Perspective

We believe that critical enterprise infrastructure witnessing frequent cyber-attacks will compel the IT teams to explore a resilient Quantum Teleportation network. Moreover, CXOs of large organizations are currently exploring the potential of QKD encryption to secure their communication infrastructure against future advancements in mathematics and computing.

Following is the illustration of the ***Quantum Communication Component Radar***, wherein, major components of Quantum Communication are plotted based on their advancement phase.

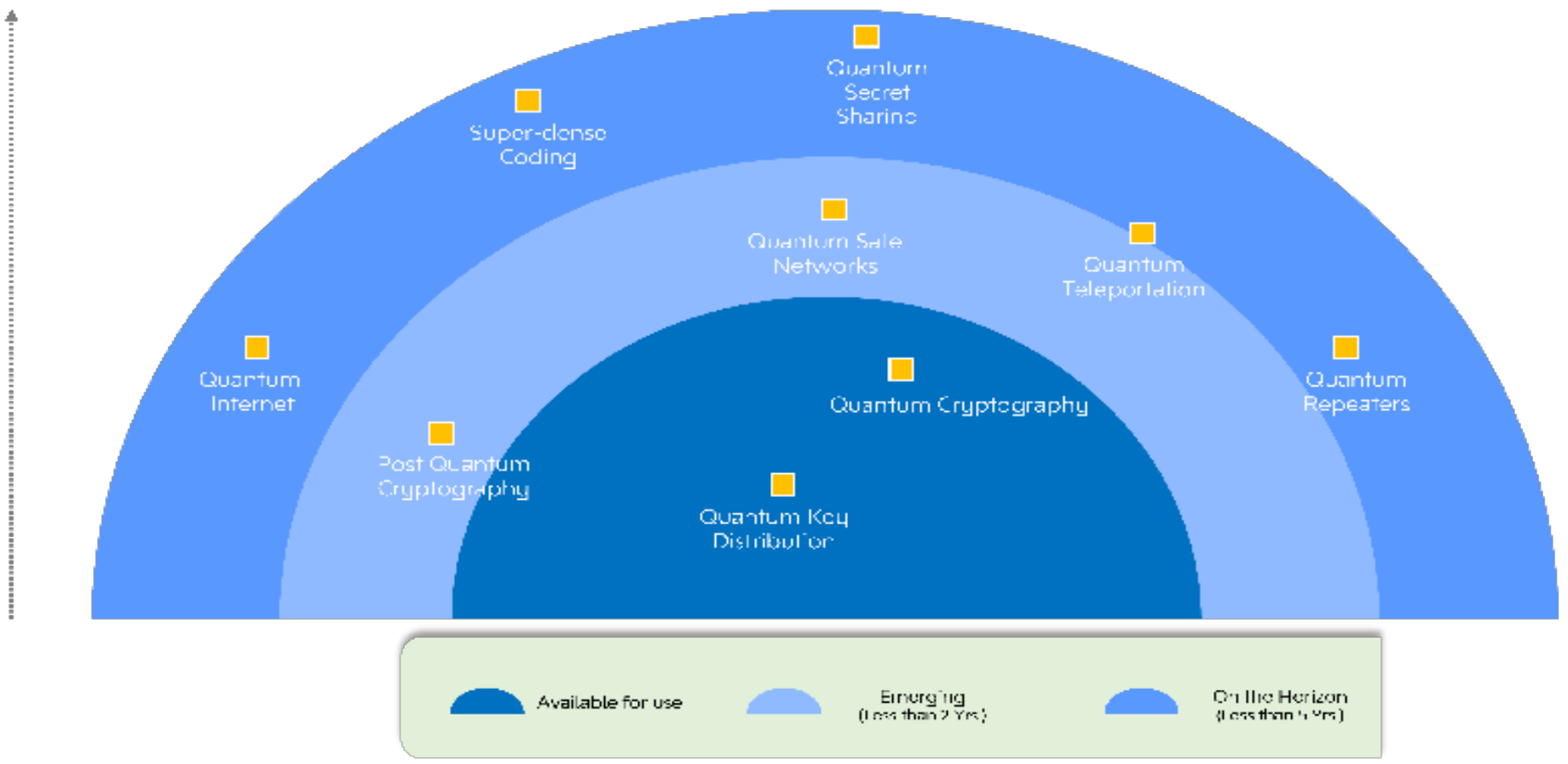

Fig.5: Quantum Communication Component Radar

The components mentioned above in the diagram have been strategically positioned based on factors such as scalability, reliability, commercial viability, cost, maturity, security, and availability. In the Radar, QKD is one important component of Quantum Communication technology that is readily available for commercial deployment. Similarly, Quantum-Safe Networks fall under the 'Emerging Phase' as this component will be commercially viable in less than 2 years.

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Industry View on Early Adoption

To gain the first-mover advantage in the Quantum Communication space, executives are looking for direction or guidance on how to best plan for this technology integration and implementation into their existing infrastructure. Industry experts debate over the subject of whether Quantum Communication technology may generate substantial economic value before reaching full fault tolerance. Many disagree, though, and claim that Quantum Communication technology is nonetheless useful despite its imperfect fault tolerance.

We believe, the following steps could be taken by different enterprises preparing for Quantum Communication technology to reach the mainstream.

- Build a digital infrastructure that can support the fundamental needs of Quantum Communication, set up current communication workflows to be quantum-ready, and make pertinent data accessible in digital databases
- Think about hiring Quantum Communication specialists internally. An organization may find it helpful to examine prospective use cases and evaluate potential strategic investments in Quantum Communication even with a small team of experts

Establishing an engagement with the academic institutions by funding their research and offering mentorship will in turn strengthen the technical capabilities and develop innovative products and processes for the organizations. Along with the importance of the actual research, it is quite beneficial to talk with academicians about the concepts and gain their opinions on the significance of the most recent advancements in the field of Quantum Communication.

Below are some of the key examples of different groups taking advantage of technology's 'golden phase,' wherein corporations, universities, and governments are collaborative and aim for achieving different milestones.

Our Perspective

In line with the industry view, LTIMindtree is also collaborating with IIT Madras for joint research in Quantum and connectivity. Through this partnership, LTIMindtree hopes to advance innovation in the rapidly developing quantum industry and enable the validation of frameworks and use case testing on a quantum kit. However, while this early spirit of partnership is critical to accelerating development, a precaution needs to be taken to prevent intellectual piracy. This will help to reduce the advent of fraud and data infringement.

Companies ranging from start-ups to well-established global leaders can now collaborate with researchers to play an active role in delivering potential technology such as Quantum Communication. At this stage of quantum development, collaborating will help everyone get to market faster, and users do not want to be left behind. Furthermore, enterprises are better positioned for faster growth owing to early opportunities for partnerships and potential go-to-market channels.

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- Craft Prospect, a UK based quantum computing firm, began working with the Quantum Communications Hub (QCH), an association of various enterprises and academia on several important projects. QCH was recently awarded the funding for a study to examine the commercial and technical viability of deploying CubeSats (small satellites) as part of future communications networks.
- The UK Quantum Network (UKQN), which connects metro-scale and long-distance optical fibre lines for Quantum Communication, was created with the help of Toshiba and the Hub.
- Since the UK National Quantum Technologies Programme's Phase 1 began, IDQ has emerged as prominent supplier of QKD systems to the Quantum Communications Hub. IDQ is playing a crucial role in supporting the Hub's metropolitan quantum network in Bristol.

- In 2019, the University of Tokyo formed the Quantum Innovation Initiative Consortium (QIIC) with Toshiba Corp., IBM, and other prominent Japanese technology visionaries to advance Japan's position in quantum science, business, and education.
- Indian Institute of Technology Madras (IIT M) is leading a crucial project to create a hub for quantum science and technology that produces top-quality graduates.

- Qunnect announced its Series A financing of over $8M USD, led by Airbus Ventures. These funds will be used to further develop their product suite, scale manufacturing, and launch a multi-node R&D quantum network testbed to demonstrate entanglement distribution protocols. This network, connected to existing fiber optic cable in New York City, will be the first of its kind in the US.
- In the US, the Department of Energy (DOE) allotted USD 625 million in 2020 to set up several research labs comprising academia, government, and private companies. They also developed a blueprint that points the way forward to the future quantum internet.

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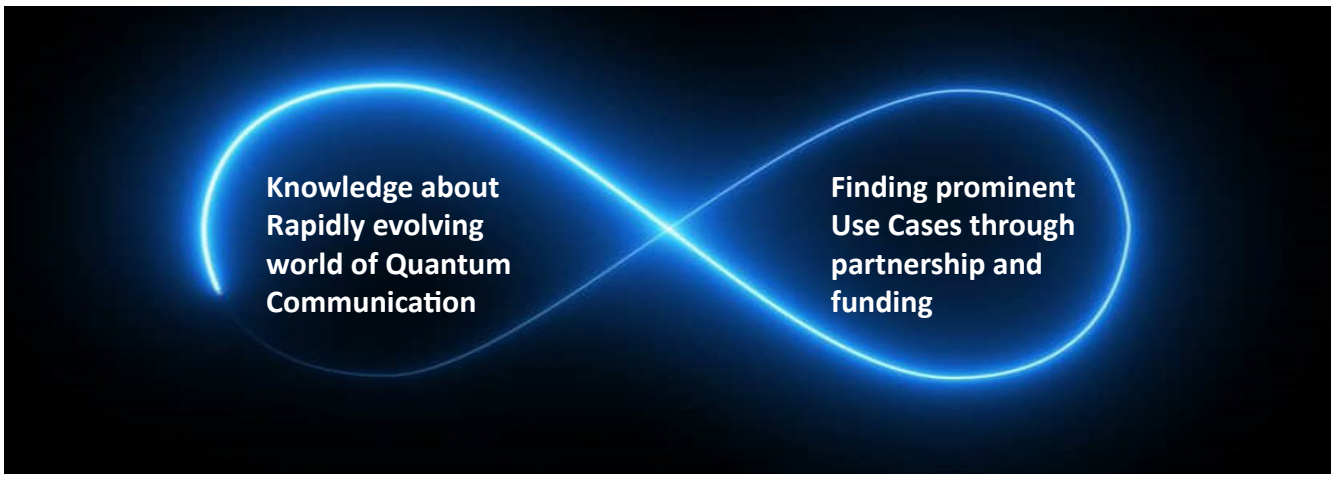
What is driving the Quantum Communication Industry?

Quantum Communication adoption is on the horizon. McKinsey predicts that the technology will achieve widespread adoption within the next few years. With the increase in demand for safeguarding sensitive information, Quantum Communication will offer significant growth opportunities across multiple verticals. Consumers, businesses, and governments are willing to pay a premium for Quantum Communication-based security features.

Top organizations are already making moves towards developing the first commercial applications. Companies are teaming up with academia and other research facilities to achieve this goal. We believe that these early movers will be driving the innovation in this field and will be the first to provide their customers with more secure communication. System integrators who are employing this technology will be helping their customers assess and explore the potential of Quantum Communication. While the science behind Quantum Communication can be complicated, the pathway to success is clear; gain knowledge about Quantum Communication technology, collaborate with academia for skill development, and identify prominent use cases.



Market Forecast of Quantum Communication Technology

Quantum Communication has the largest estimated market after Quantum Computing. As per Statista, there are currently ~111 active players in the field of Quantum Communication, as of 2022. Combined, they have received funding of around USD 600 million.

Research by McKinsey has shown that the market valuation of Quantum Communication is expected to reach around USD 8 billion by 2030. Despite the tremendous market potential, the main concern for businesses now is how much time and money to devote to a technology that has the potential to change the game but is still in the expanding phase.

Quantum Communication Market Trends by Region

China and UK are among the leading adopters of Quantum Communication technologies with a 42% adoption rate followed by the US and India with a 22% adoption rate, as of 2022. Below are some of the key investments within different regions across the globe.

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Europe

- ID Quantique collaborates with Poznań Supercomputing and Networking Center (PSNC) to establish a new QKD link between Poznan and Warsaw
- ID Quantique expands the XG Series with the launch of the Clavis XG
- In 2023, a UK corporation will begin using satellites to transmit secret quantum keys
- In October 2022, Quantum Xchange expanded its global presence through partnering with Warpcom to bring Quantum-safe networking to Spain and Portugal
- In January 2021, the French government disclosed a EUR 1.8 billion quantum road map for 2021-2025, focused on quantum computing, communication, and sensing.
- The EU is collaborating with companies including Airbus, Leonardo, and Orange on a project called EuroQCI
- In April 2021, the Netherlands invested over USD 700 million to build quantum labs and the UK assigned another USD 200 million to quantum research in March 2021

North America

- Qrypt Takes the First Step Towards Cloud-Based Quantum Secure Cryptography
- In 2022, the Cisco started investing in photonics development, which will support other hardware and software developments for quantum computing, networking, and cryptography. Photonics will also enable quantum communication.
- AWS announced a research alliance with Harvard University to address the fundamental scientific challenges associated with building quantum networks.
- JPMorgan Chase, Toshiba and Ciena build the first QKD network
- A program funded with a USD 51 million grant from the National Science Foundation has helped the University of Arizona establish a Center for Quantum Networks
- Canada launched its National Quantum Strategy in July 2020 funded with almost USD 300 million

APAC

- QNu Labs launches a new QKD system and QRNG chip
- China created a National Laboratory for Quantum Information Sciences backed with USD 10 billion in funding over five years
- In India, the National Mission on Quantum Technologies & Applications was established in 2020 with a USD 1 billion budget
- 4,600km | Length of a quantum communication network in China that already connects several cities and a satellite in space

Figure 6: Key developments in funding and research

When it comes to technology maturity, below are the short- and long-term technology development potential scenarios in the Quantum Communication industry:

Short-Term Development Potential

Within Quantum Communication, technologies for autonomous QKD systems for metropolitan and urban settings are expected to achieve low-cost, high-security key rates of 10 Mbps or faster, including multiplexing (Stage 4 **Technology readiness level** (**TRL**)). Here, TRL is a method for understanding the technical maturity of a technology during its adoption phase. Systems for certification and standardization of Quantum Communication devices will likely be established according to the requirements of the security community, industries, and government authorities (Stage 7 TRL). It will be possible to enhance the functionality of multi-party network building blocks based on quantum repeaters and quantum entanglement (Stage 4 TRL) through the creation of fundamental technologies such as scalable & effective quantum interface teleportation, frequency modulation, memories single-step error correction, and entanglement reduction entangled light sources and photons

Long-Term Development Potential

The goal is to realize the generalized use of autonomous QKD systems and other important aspects of quantum networks, device-independent quantum random number generator (QRNG) systems and QKD communication for urban streets (Stage 7 TRL), and quantum cryptography over a range of 1 000 km (Stage 7 TRL).

Our Perspective

We think that short-term and long-term development potential of Quantum Communication technology will be dependent on the strategies that will be adopted by different industries. The pilot conducted within various industries would help in thoughtful evaluation of various aspects of the technology leading to development of real-time use cases. We also believe that a significant percentage of a company's emphasis should be on practical matters, such as the steps necessary to get from the initial prototype to at-scale manufacturing or the partnerships that might speed up their return on investment in the short term.

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Paramount Trending Events Across Quantum Communication Space

Here we examine the present state of key players in the **Quantum Communication** space from a variety of perspectives, including tech giants technological advancements, collaborations, practical application, and start-up enthusiasm.

Quantum Communication Market is dominated by start-ups like **ID Quantique, ISARA, Quintessence Labs, MagiQ Technologies, and Qubitekk** as they account for significant market share within the entire Quantum Communication market space. Some hardware providers like Toshiba, Cisco, and Quantum Xchange are also investing in low cost QKD hardware development. These companies are likely to focus on verification based on location, security sharing, and queries for anonymous data long-distance transmission using QKD on test bed networks.

Rise in number of strategic alliances, mergers and acquisitions among technology partners is witnessed in this domain. They are looking to expand their product and market reach. We think that organizations will focus on building certification and standardization systems for Quantum Communication devices in response to the needs of various communities such as security community, industry, space agencies, and government bodies. We firmly believe that practical protocols and different forms of efficient algorithms for quantum networks, such as digital signatures, should also be considered while building any kind of certification.

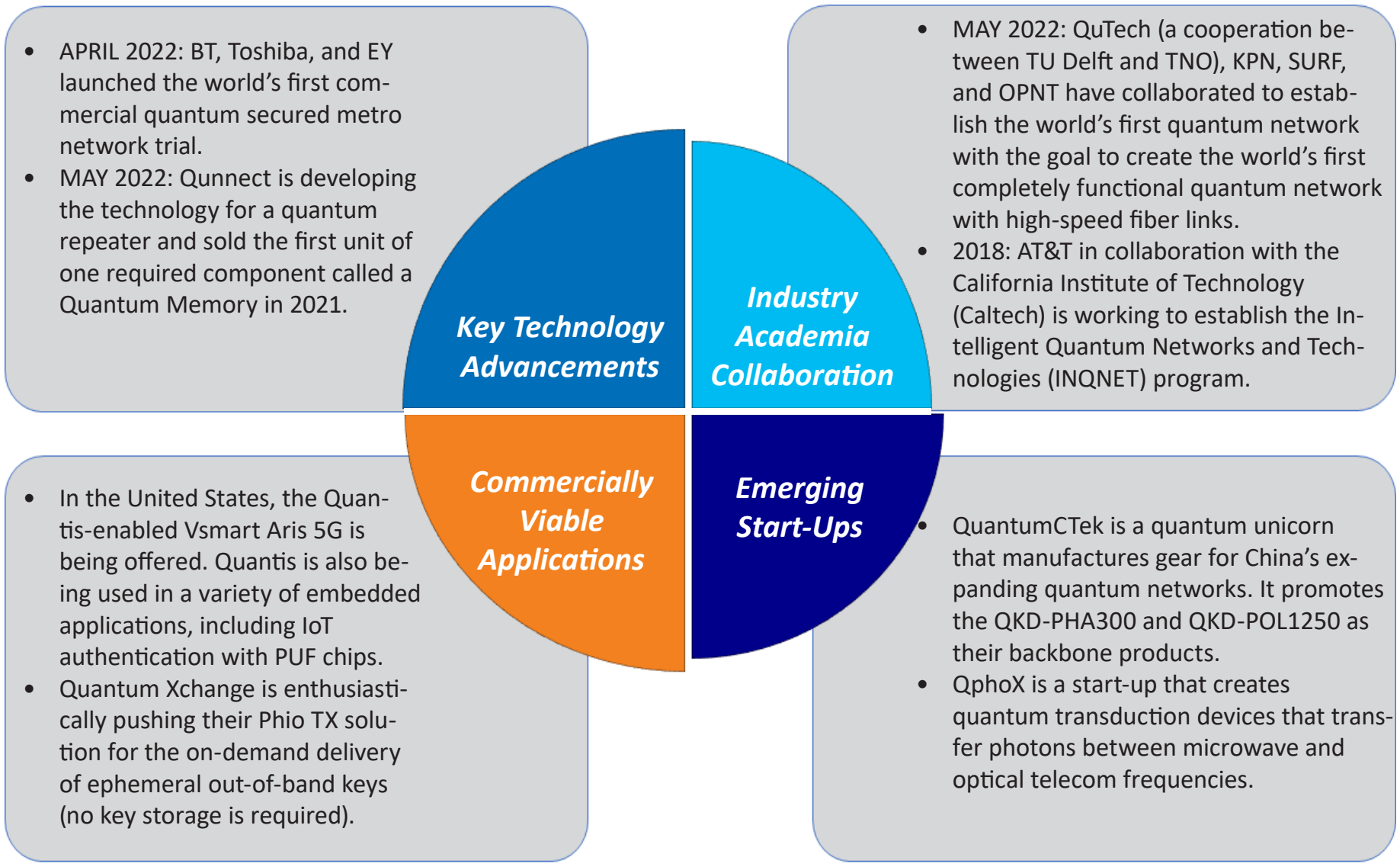

Fig. 6: Categorization of the Players

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As per '**The Quantum Economic Development Consortium'** (QED-C), various innovative firms, headquartered in Japan and China accounted for majority of the share in the top 10 patent holders in the Quantum Communication space in 2021.

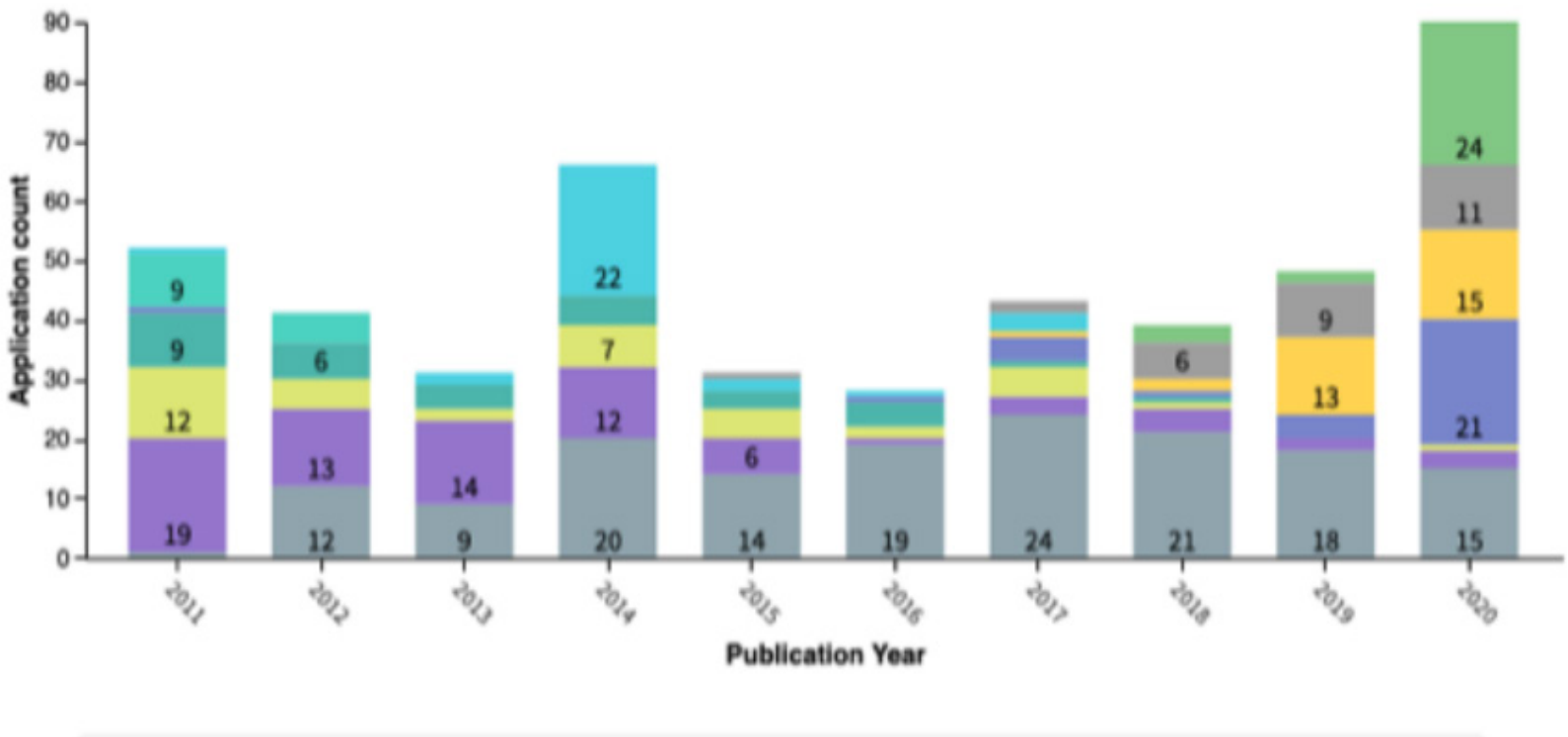

Fig. 6: Quantum Communication Patents, 2011-2020 (QED-C)

According to patent application data mentioned above, the US, Japan, and China are expected to have the strongest foothold with regards to the number of patent offices headquartered in these countries. The **US Patent and Trademark Office**, the **Japan Patent Office**, and the **China National Intellectual Property Administration** are the organizations that have granted the most patents. This reflects the degree of activity as well as the areas where Quantum Communication space is most likely to develop in short term.

Every day, new quantum applications are discovered, and new findings are documented in research papers or patented. To keep up with this tech evolution rate, these organizations are either collaborating in joint research or deploying a Quantum Communication hardware & software from companies which are doing core research in the technology. Other prominent players who have patented the technology include Toshiba, NEC, Nippon, Alibaba, among others.

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Quantum Communication Industry Use Cases

Based on breakthroughs happening in the field of Quantum Communication, we have articulated some of the use cases to understand the potential impact of Quantum Communication discoveries and outline how these developments may translate to use cases in all the industries. Moreover, we can also cross leverage some of the use cases mentioned below into more than one industry which we think will be very crucial in the upcoming phase of Quantum Communication.

Banking & Financial Services (BFS)

Protecting sensitive client information and safeguarding critical business data in the banking and financial services industries

Start-up ID Quantique (IDQ) has demonstrated the use of Quantum Communication in data security applications. They have utilized techniques such as QRNG (Quantum Random Number Generation) and QKD. Quantum Communication also has the potential to encrypt credit cards. Researchers have proposed "***Quantum-Secure Authentication***," a solution based on quantum cryptography for developing hack-proof credit cards.

Government & Defence

Protecting Classified and Sensitive Data in Government and Defence Industry

Companies have started providing quantum key generation and management solutions for governments, as well as advanced QKD solutions for long-term data protection secured against future attacks by quantum computers.

Healthcare

Protecting sensitive data in Remote Data Centers (RDCs)

For the transfer of sensitive data, including patient records that include names, addresses, dates of birth, social security numbers, and clinical records, healthcare institutions also need extremely trustworthy networks.

QKD Integration to Safeguard the Data

Healthcare businesses may employ QKD to safeguard their data in the present and future security landscapes in the field of quantum communication.

Space Industry

Secured Satellite Communication through Quantum Communication

The near-term applications of Quantum Communication in space include secure satellite communication, potent new sensors, and precise timing synchronisation. In today's time, various software & hardware integrators are collaborating closely with business partners and the governments of different countries to develop quantum sources, detectors, electronics, and ancillary devices that can withstand rocket transport and perform dependably in hostile space environments to meet the growing demand for space-qualified quantum technology.

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Cross Domain Use Cases

Traitor Tracing in IT and Telecommunication

Every user in a traitor tracing system has a unique secret key. Content providers can use a quantum key to encrypt messages, and each end user can use a combination key to decrypt the ciphertext. For instance, some of the users work together to create a pirate decoding box. The tracing method then has a unique algorithm, named **Tardos Tracing algorithm**, that can locate at least one of the hidden keys that were used to build the pirate decoding box.

Quantum Keys for Enhanced Device Security at Personal and Professional Front

This use case involves ensuring the integrity and identity of the device to develop a safe and trustworthy IoT solution. Additionally, the user is to make sure that no one has tampered with the hardware or software integrity. On the other side, keep a certainty of the identification of the device that the user is interacting with and authenticate it without any doubt. There are solutions available in the market for each of these issues. Most of them combine secure hardware components with cryptographic methods. Moreover, Quantum Communication has built-in two factor authentication and quantum keys can be refreshed at bulk whenever required.

Creating foundation of safe Quantum Communication using QKD technique

QKD is anticipated to take the lead in the information security sector. Moreover, organizations can now implement product quality control (PQC) based solutions and then back them up with QKD to ensure the security of the transition from classical communication to Quantum Communication.

Our Perspective

All these use cases aim to establish enterprise security, which is essential as Quantum Communication technology matures. We also believe that most Quantum Communication solutions have limitations with respect to processing power and pricing. Some of the solutions are not technically or financially viable because of their limitations, especially when they involve time-consuming, computationally expensive cryptographic processes such as temporary key creation or encryption. However, organizations can advance concurrently with the development of quantum hardware so that software applications are ready when the Quantum Communication network/channel launches.

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Potential Regulations & Standards Scenario for Quantum Communication

Once Quantum Communication becomes mainstream, it will become important for researchers, regulators, and legislators to begin discussions around the related benefits, threats, and risks that Quantum Communication can mitigate with its capabilities. Some of the security aspects to focus on are data privacy, protection, and sharing. We must not only focus on tools used to perform malpractices but also keep a close eye on legal and illegal utilization of Quantum Communication.

This could be done by establishing proper regulatory compliances for Quantum Communication. As Rob Heverly of Albany Law School said, “Instead of focusing on the way in which fraud happens over the internet, just make a fraud law.” Thus, with data privacy and national security on the line, agile and adaptive regulatory strategies are required to manage the risks of rapidly approaching quantum computers without risking their potential benefits.

Standards and regulations will be crucial in allowing the integration of quantum communication devices into larger and more complicated systems. The testing and measurements required to validate quantum-enabled measurement systems and methods are supported by the establishment of standards. Moreover, the development of components and devices is made possible by standards which may communicate with one another and help to ensure the quality in relation to objective criteria.

Additionally, in terms of developing new standards for Quantum Communication and other Quantum based technologies, the UK is in the forefront. The UK National Quantum Technologies Programme (UKNQTP) was created in 2013 after the government announced a USD 308.2 million investment in recognition of the revolutionary potential of new Quantum technologies. It has created new possibilities for trading with the UK as a crucial link in the global supply chain. Implementation of the UKNQTP is already progressing. Standards for Quantum technologies by participating in international standards agencies, giving the UK the opportunity to drive the latest developments in Quantum technologies.

The Institute of Electrical and Electronics Engineers Standards Association (IEEE) is currently developing terminology and performance metrics for Quantum Computing and Communication. Given IEEE’s global authority and reputation, these standards could become quite influential and even beneficial to the industry, if adopted. Quantum Communications Hub, a UK based Quantum technology research company also states that its goal for QKD is to develop measurement protocols for each component of a system. These protocols will then enable uniform product validation through a defined assurance process and a network of accredited testing facilities that can provide testing and validation against agreed-upon standards.

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Recommendations for LTIMindtree

Quantum communication is an exciting area of research that is rapidly moving towards commercialization. Organizations are looking to explore new revenue avenues. Despite challenges in terms of hardware integration and use case identification, there is a possibility of a high valuation market on the horizon. Apart from this, the timelines for Quantum Secure Communication demand from industry seems to be nearer than expected.

Quantum communication is a rapidly growing field with immense potential. To stay at the forefront of this rapidly changing landscape, it is critical for companies to collaborate with academia. LTIMindtree has recognized this and has been working to build relationships with various academic institutions. While this can be challenging, it is also very rewarding, as it allows LTIMindtree to access the latest research and develop a competent workforce. Additionally, by leveraging the skills and knowledge available within LTIMindtree, the company can keep costs down and optimize profitability.

Moreover, LTIMindtree can enter the field of Quantum Communication by leveraging its existing service offerings. Rather than starting from scratch, LTIMindtree can use its Infrastructure as a Service (IaaS) service model to provide a subset of its Quantum programming tool stack to clients. This would give programmers access to production-ready Quantum software that they could use remotely over the Cloud.

Incubating Quantum Communication at this stage is the right strategy as the market exhibits tremendous demand of such a solution.

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Key Takeaways

- As companies race to develop quantum-safe technologies, it is becoming increasingly important for organizations to identify their most sensitive data and take steps to protect it. By doing so now, they can ensure a smooth transition to a more secure future
- As data protection and security become increasingly important, organizations must work with independent software vendors, suppliers of quantum hardware platforms, and cloud service providers. By collaborating with these groups, organizations can ensure the safety and security of their data
- Everything that is Quantum seems incredibly interesting & promising. Within this decade, as few globally established businesses dominate the Quantum Communication industry, including ID Quantique, ISARA, QuintessenceLabs, MagiQ Technologies, and Qubitekk, which control more than 50% of the market, quantum research is increasingly speeding up and moving from labs such as those at Toshiba Corporation, IBM Corporation, ID Quantique, and QuantumXchange Inc. to real-world environments
- Along with these tech giants, governments and defense researchers are investing significantly to achieve quantifiable breakthroughs. Considering the rate of advancement in Quantum Communication, established organizations are likely to build certification and standardization systems for Quantum Communication devices
- Practical protocols and different forms of efficient algorithms for quantum networks are also on the horizon. Top organizations such as Cisco and Toshiba will focus on verification based on location, security sharing, queries for anonymous data, and long-distance transmission through targeted tasks to enable QKD on test bed networks
- The timelines for Quantum are not precise – they are just a range – just like in the quantum realm. The direction however is certain. It is time to ensure that technology-centric organizations take note of Quantum Communication and keep it on their radar

As quantum technology progresses from fiction to reality, the new age of Quantum Communication beginning throughout the world will no longer be prescient. A wait-and-watch approach is no longer an option. ***Now is the time to be prepared for the Quantum Era.***

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