WHITE PAPER

NEXT GEN EDGE POV ENERGY OIL & GAS

Abstract

Now more than ever, there is a pressing need to provide a faster response for real-time data processing, which has exponentially increased over the past decade. From smart devices, connected wind farms, to oil rigs to refineries and autonomous vehicles, modern distributed computing requires on instant feedback from systems. The emergence of AI and enhanced security developed in parallel aids triage timescales and increases resilience. This is achieved by reducing the round-trip processing time, shifting from a centralize data centric platform to an Edge Computing functionalities bringing response times down to mere milliseconds.

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Current Data Outlook

In current data transfer and processing protocols leveraging cloud services, data is moved via cloud protocols and leveraging the internet, and through Wide Area Network (WAN) traffic. This conventional approach works cloud-based applications, services, platforms, and solutions.

However, when operations move outside this framework, it can consume significant capacity and lead to additional workflows due to misconfigurations, especially if the systems are not part of the same cloud infrastructure.

The normalisation of these workflows via API gateways works well for many applications, if they are a part of the application cloud ecosystem. However a large proportion, at the cost of moving data out of the cloud, can incur bandwidth and data transfer fees. Additionally, due to bandwidth restrictions and data transfer demands, the time that it takes to move data to and from cloud results in inefficiencies. In contrast, Edge Computing provides a more efficient solution, offering lower latency while also minimizing costs related to bandwidth and data storage.

Leveraging AI for Edge deployments, organisations - especially those in the Oil and Gas industries - have realised the limitations of centralised cloud services, towards decision making and reaction times towards localised infrastructure. This realization has convinced many to adopt edge IT processes, bringing work flows closer to the business operations. As a result corporate entities can focus more on strategic issues, instead of day to day and operational functions, while being kept informed about risks through enhanced resilience.

This shift increases bandwidth and reduces latency, drives efficiency in decision making and freeing up critical network resource. This allows AI to operate more smoothly using Edge Computing power in remote and new established or upcoming locations. This is especially helpful in Oil and Gas industry, where remote locations under exploration can make real-time decision-making process about viability of oil fields or determine the next drilling area. Such efficiency is vital towards protecting daily operations that can cost millions of dollars.

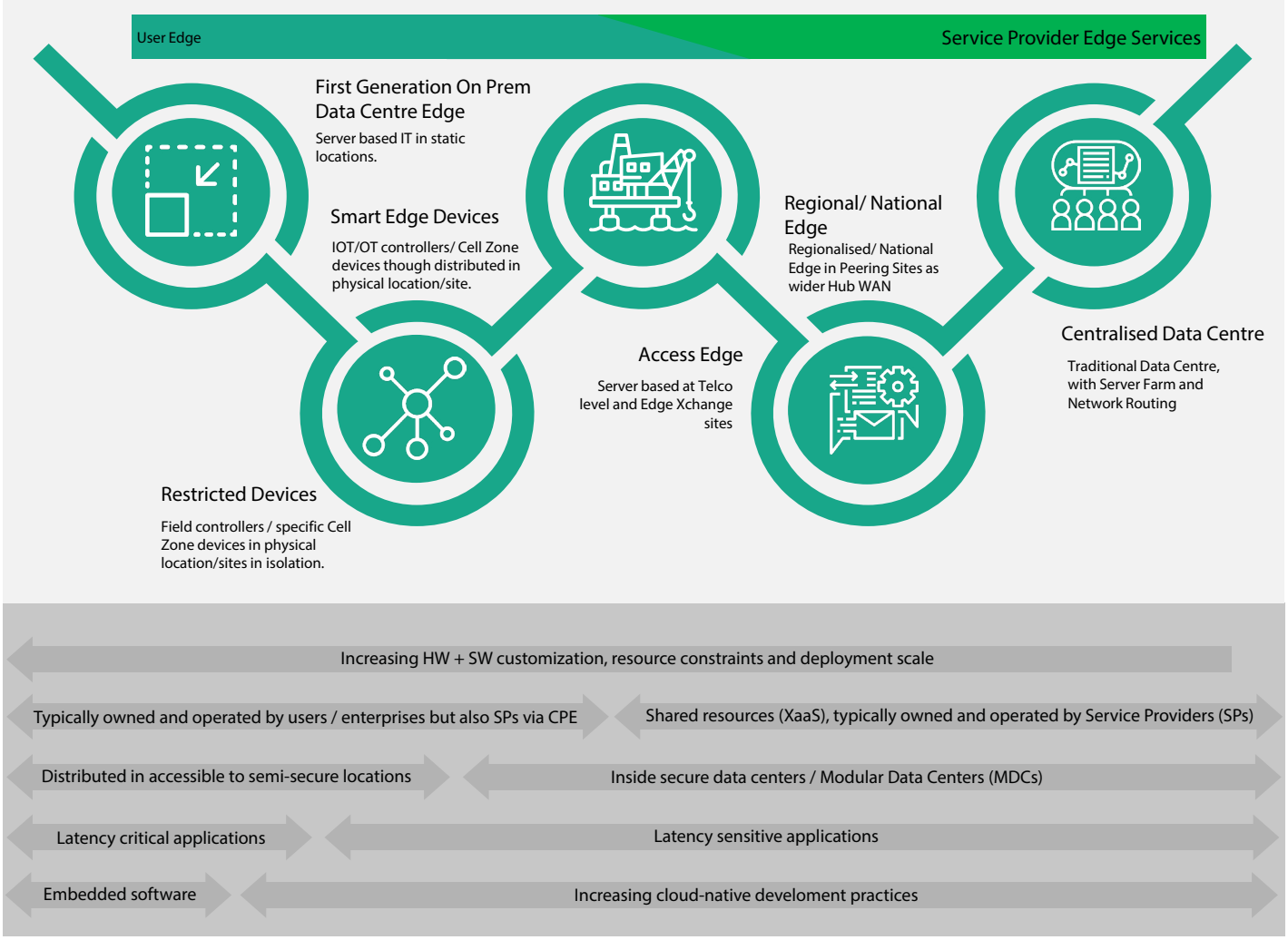
Therefore, not only does Edge Computing's power enhance the cost-reduction mechanism, but it also leverages the AI elements of decision-making. The key decisions with this processing power are made efficiently and effectively without latency. Edge AI-based applications are highly accurate due in part to knowledge decision gaining power of models built over time, but also through a quicker data feedback loop, which improves data retention and usage. This removes and discards data no longer required, rather than storing it and causing capacity issues yet further and resulting in another cost-saving benefit.

Supporting Edge AI this reduces the data privacy sovereignty issues, which is an ever-increasing issue for corporate global organisations. By collecting and processing data locally, companies can adhere to local laws and regulations, while functioning within their operational ecosystems. Corporations are increasingly focused on outcome-based decisions that drive business growth and create new opportunities.

This trend is especially seen in oil and gas, where exploratory systems identify oil and gas pockets. Decision can be made at local level regarding whether to proceed with drilling, with information sent back to the corporate centre, only when it becomes viable. This ensures cost appreciations are conducted using data models which highlight through algorithms oil field yields, barrels per day. This enhances efficiency of equipment deployment, management of site, while calculating revenue acquisition probabilities, all while ensuring the overall viability of operations.

Visualizing which Edge to Use

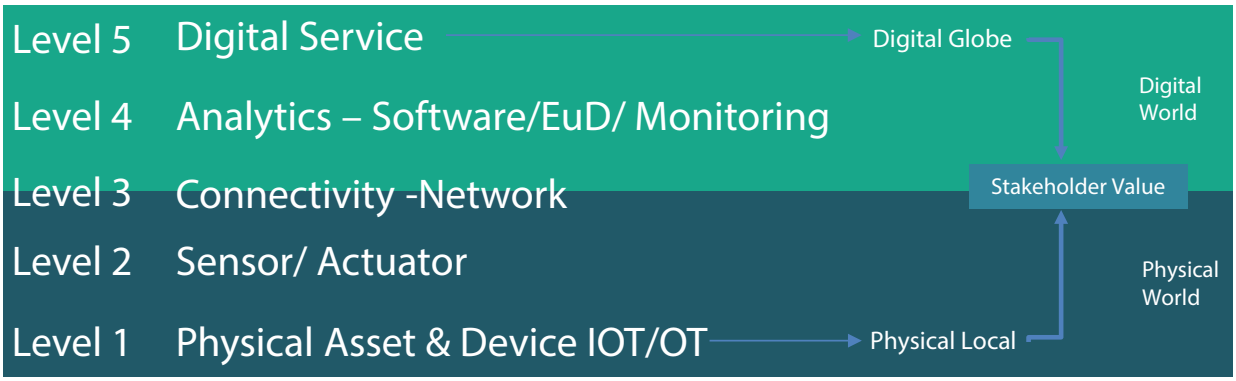
We see today three main Edge categories as in the Service Provider Edge (SP Edge) where a service is outsourced to a managed service provider, smart Edge and or in house User Edge.



SP Edge, leverages the existing centralised data centre, while pivoting to use the cloud-based computing services. This allows organizations to scale their operations up and down, achieving 'economies of scale' that are not possible on End User Devices (EUD) where capacity is limited especially in areas impacted by legacy systems and current IoT/OT challenges. This approach significant benefits the established remote locations.

The SP smart Edge utilises the same idea, but is designed for a smaller scale. It leverages global service over a fixed Network infrastructure. The SP Edge is more distributed than a centralised in-house Edge Data Centre. Most of the power leveraged here is efficient decision making over fixed and private networks provided by multi-tiered Communications Service Providers (CSPs), many of whom are deploying both edge services, 5G services and capabilities.

The third edge tier computing, often referred to as 'User marks a significant departure from the centralized data centre use. Compared to even the smart SP Edge, the User Edge represents a highly diverse combination of resources. The closer that edge compute resources get to the physical world, the more constrained and specialized they become. This is true in IOT/OT environment as well as in niche areas in oil and gas operations at rig control devices actuator, sensors, intelligence edge and nodes play critical roles. Examples include CCTV systems, door access controls, and robotic systems, all of which require tailored solutions to meet specific operational needs.



N.B. A Global Oil and Gas company utilises Edge Computing for predictive maintenance on its pipelines. By analysing data from sensors placed along the pipeline route, they can identify potential leaks or structural issues before they become critical, thereby minimizing environmental risks and operational disruptions. On the other end of the spectrum, edge technology companies are playing a significant role in the oil and gas industry by leveraging artificial intelligence (AI) and Edge Computing technologies to enhance various aspects of operations

While devices at this Edge have less compute and storage capacity than the centralized cloud, there are more of them, and developers can take advantage of the security, and privacy that local computing at the User Edge brings to the table. This is further highlighted principles of Secure by Design (SbD) and Privacy by Design (PbD).

As data has grown with complex applications, services and platforms, It is crucial for for simplification, standardisation, automation and optimisation. This will then force AI Gen need for automation and decision making ensuring key areas can be focused on as part of day-to-day life. This allows Edge Computing to take advantage over current cloud service architectures, enabling rapid market growth, and facilitating rapid decision making in business. As result of target Gen-AI mining through data hastens the process to seconds instead of days and weeks, for example in Oil and Gas this capability aids in costly decision making, while protecting assets and devices.

According to market research from McKinsey, AI adoption has surged from 55% to 72% in the last ten months, with at least one business function now using AI. The proportion of businesses utilizing AI across two to five functions has climbed to 20% and continues to grow. Edge Computing enables the continuous monitoring of equipment, pipelines, and processes in real-time. It filters and processes data locally, sending only the most critical information to the cloud. This reduces bandwidth usage and lowers operational costs.

Additionally, the oil and gas industry is highly sensitive to cybersecurity threats. Edge Computing helps mitigate these risks by keeping critical data within the company's network, reducing exposure to external threats associated with cloud-based data storage and processing

The integration of Edge Computing with other transformative technologies such as artificial intelligence (AI) and the Internet of Things (IoT) holds immense potential. AI algorithms running at the edge can make more complex and adaptive decisions, while IoT devices can provide even richer data streams for analysis. This convergence may further enhance operational efficiency and safety. According to forecasts, Enterprise and service provider spending on hardware, software, and services for edge solutions is expected to sustain this pace of growth through 2024 into 2025 and beyond reaching nearly $274Bn.

While Edge Computing offers substantial advantages, its implementation in the oil and gas industry is not without challenges. Furthermore, interoperability among different edge devices and systems can be a complex issue that requires careful planning.

Edge Computing types continue to expand

The number and type of Edge Computing devices and deployments are ever increasing and expanding. The Edge family of technology that includes Hardware, Software, Data and Service System Platforms is moving in 2024 at its fastest pace ever. It is essential to recognize that these asset and device elements are located where they can be optimized for maximum benefit. Low Latency increases efficient and effective reporting utilising bandwidth and capacity to become more strategic and broader in nature, allowing for quicker identification of vulnerabilities and faster remediation.

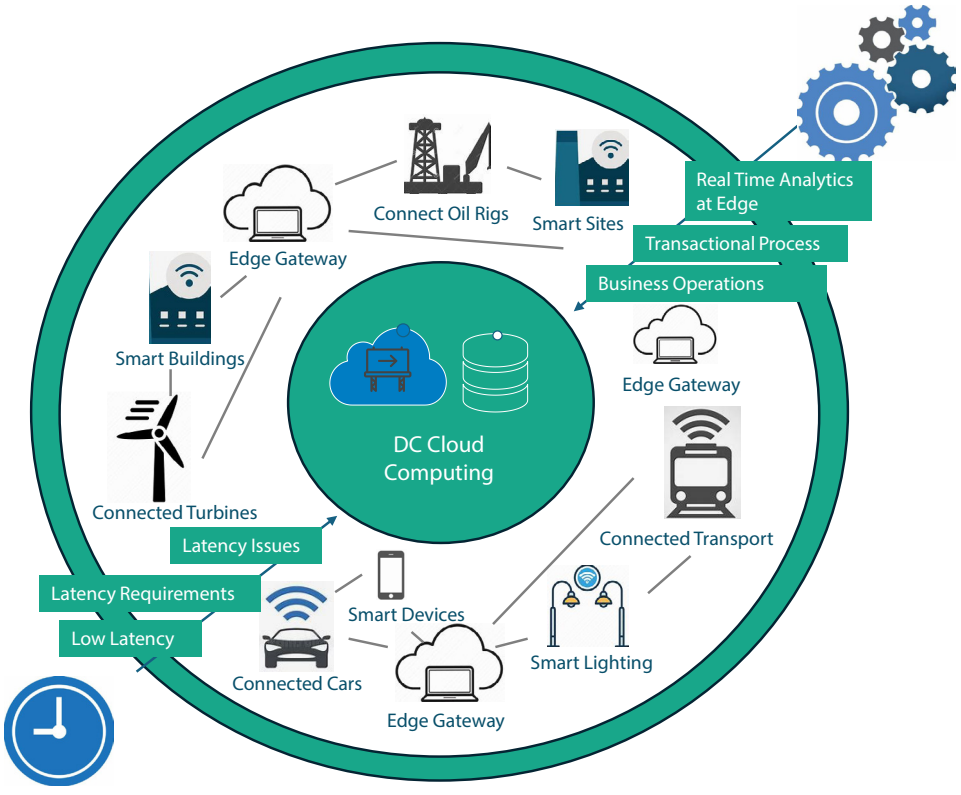
With organizations across Oil and Gas industries deploying purpose-built Edge Computing devices within their own facilities, they are now creating second- and third tier communications and data centres to house Edge capabilities. Communications room may leverage an onsite satellite building to process data within that specific facility, site or location of exploration. These drives divested user edge mandates, reducing both response time and outage time for expensive resources, when communications back and forth with Core infrastructure albeit physical or technology in the oil field. This helps drive efficient decision making especially when investigating potential oil discoveries.

Oil and Gas organisations are using content distributed networking and delivery techniques - (Content Delivery or Distributed Networks -CDN) - to augment the end-to-end transport networks. These techniques distribute loads onto a variety of intelligent applications designed to optimize content delivery, providing high availability, whilst ensuring integrity and confidentiality.

The resulting tightly integrated overlay uses web cache, server-load balancing, request routing and a combination of content services. It comprises a collection of geographically distributed yet interconnected servers that cache content locally, providing high-speed performance to end users. This capability is critical to Oil & Gas exploration and movement of high value assets.

Oil and Gas organizations are buying Edge Computing capabilities via Telco vendor providers, whose widespread infrastructure and expansive reach allow them to put Edge devices physically close to nearly all potential customers and supply chains. Consequently, these telco vendors can offer Edge Computing equipment, services and supporting components such as Secure-Access-Service Edge, which bundles and delivers network and security functions as a single service.

If content owners are not satisfied with the options or costs of a commercial CDN service, they can create their own CDN. This is called a private CDN. A private CDN consists of Points of Presence (PoPs) that serve content exclusively for their owner. The PoPs can include caching servers, reverse proxies, or application delivery controllers, which support the Edge environment local to the point of operations that remains efficient and available without interruptions.



Edge Computing for Oil & Gas

Edge growth creates infrastructure challenges

Due to the distributed nature of Edge Computing, certain challenges arise; though these are tempered alongside the increasing for deploying hardware and computing power close to local sites and locations. This proximality not only allows faster decisions making processes and greater agility, but also ensures resilience when it comes to segregation and separation.

One critical area to balance for Oil and Gas companies to sustain Edge assets across multiple locations and devices to support the user edge experience even in remote areas. It is equally important to manage changes to asset and devices in the Configuration Management Database (CMDB) as solutions are built in, and throughout the supply chain, including during decommissioning.

While telecom service providers and large corporate organisations continue to build Edge Computing capabilities, they are working to address various issues. Leveraging Cloud services or private cloud infrastructure plays a significant part to ensure confidentiality, availability and resilience of Edge services, which are essential for stability and accessibility. The increasing availability of computing power is driving the adoption of edge computing; however security and risk concerns must be addressed early to ensure build quality assurance. To that end, integrating security by design and privacy by design throughout the process, as emphasized by Infosys' 4Ds, is crucial.

More hackers are targeting Edge deployments

One factor that plays a crucial role in the efficiency of Edge Computing and its deployment are IoT systems, the speed of data transmission and its processing power. Developers are trying to address these days by leveraging Edge, data processing takes less time and level of data protection is higher at the Edge. The introduction of the 5G connection standard has been a huge boost in improving the quality of all data-related processes enabling faster and more reliable communication. However, threat actors have noted the growing number of IoT and Edge Computing devices as prime targets.

We at Infosys have identified numerous potential threats, including:

- Attacks against the user and endpoint devices, leveraging poor User protocols.
- Sniffing attacks against logical SD WAN/ WAN poorly configured architecture inclusive of 5G Core Network Architecture and DDoS RAN services. Inclusive of attacks against servers and data at the network edge and sniffing attacks against endpoint (user) devices and components through connections.
- Attacks against associated cloud workloads and against applications at the network edge.
- Attacks through supply chains, with poor security by design and privacy by design features.
- Physical attacks against technical components such as IoT devices and abandoned assets still connected to Network but dormant in nature, leveraging multi-access Edge Computing channels.

Vulnerabilities related to devices and assets in local and site-specific locations, through disjointed connections, highlights the need for Edge computer services. It is though must be assured throughout the supply chain as well as network architecture towards quality assurance and through test and build phases. Organizations must prioritize security from the outset as a part of their feasibility studies, rather than treating it as an afterthought..

In 2024, security is ranked second only to the construction of service and system architectures as a top area of investment for organizations. Consequently, network design, deployment, and maintenance are positioned as the foremost priorities, while overall strategy and planning follow closely in importance.

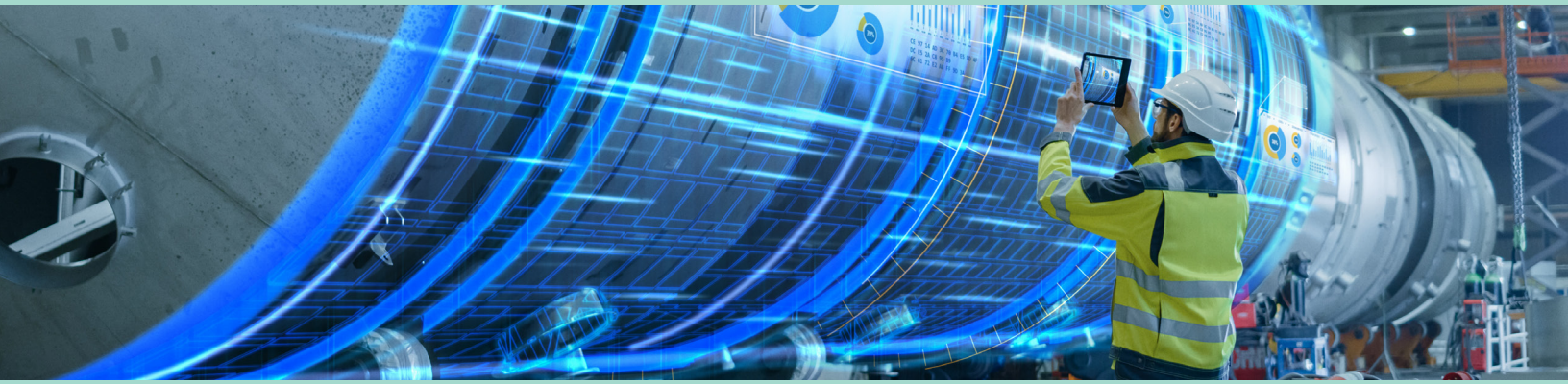
Summary

Edge Computing is rapidly advancing, significantly, aided by the utilisation of AI to advanced speed, computation and Edge Computing power itself. This synergy facilitates the development of best cloud service lines and offers multiple benefits such as increased data analysis capabilities and innovative solutions for managing deployments swiftly and agilely, all while ensuring security by design and quality assurance.

Edge Computing has been the push of AI power, leading to the realization of cloud computing's ability to handle the vast amounts of data it processes and analyzes. The downstream requirement of sending data from an end point to a central repository for further processing and evaluation requires higher bandwidth, which in turn drives costs upwards when it comes to network communication power and latency issues. Hence, the use of Edge Computing, not least, helps in reducing security issues.

As the capability to support AI applications at the edge continues to improve, we can expect reduced latency and increased bandwidth capacity, thus enabling near real-time processing and analytics. This evolution will empower organizations to optimize their operations and leverage technology more effectively, ultimately enhancing performance across various sectors.

Advancements in processing power allows organizations and industries such as Oil and Gas to move AI capabilities into Edge devices, reducing the latency and costs automatically, which in turn opens a host of potential uses across the industry from low level maintenance of high capacity noncritical services, to more specific niche working strategies with appropriate overwatch. Ultimately, this synergy allows organizations to optimize resources and processes more efficiently while leveraging technology to work seamlessly together.



Conclusion

Inception of 5G growth transforms Edge Computing capabilities

Although Edge Computing helps reduce latency by putting compute resources close to the endpoints generating data, the speed of 5G combined with Edge Computing will further reduce latency to support use cases where near-real-time processing is critical. Since the inception of 5G, which creates a bigger, faster pipe to carry data, it has also reduced packet dropouts and delivers ultra-low latency required for many applications, including the widespread deployment of autonomous assets and devices and the metaverse - platforms and devices that work seamlessly with one other.

Organisations across the board now are embracing the expansion of 5G networks, which are on track to become the fastest growing and most widely adopted wireless cellular technology, exceeding 4G LTE by over 2.5 billion connections in 2028. 5G connections are expected to hit 2.5 billion by the end of 2024 and are forecasted to reach 8 billion by 2026, surpassing the first-decade growth of LTE by more than 3 billion connections, according to a study by Technology and Telecommunication statistics. Although those are big numbers, 5G is not yet universal; however by 2030 over 96% of the global population is expected to have access to 5G.

Hints of 6G's potential influence on edge to emerge

Even as 5G continues to roll out and be heralded for its low latency and high bandwidth, many are already working to bring 6G to the market. 6G networks will use higher frequencies and higher capacity than 5G while still delivering significantly lower latency. The advent of 6G networks will eventually replace 5G connectivity just as 5G is replacing 4G, which displaced earlier generations. As 5G provided capabilities that boosted Edge Computing and supported new used cases involving Edge Computing, 6G will offer even more possibilities. While work on 6G is underway, and many tech companies are promoting their efforts, the technology won't arrive anytime soon, but the industry is on course for eventual adoption it.

In about 4-5yrs in 2028, we can expect to see the first draft standards for 6G, with full functional and design specifications not expected until 2030. These features are projected to support more assets and devices at unprecedented levels and layers. Through AI-driven Edge Computing, the benefit will shift monitoring and logging back to the asset and device, away from centralised services. This transition aims to reduce latency and packet dropouts while increasing protective mechanisms and decision-making processes, bringing operations closer to real-time than ever before.

References

1. According to September 2024 study by 5G Americas, a wireless industry trade association, working with research firm OmIdia.

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Luke, a seasoned security professional, brings extensive expertise in designing and implementing robust security frameworks, safeguarding sensitive data, and ensuring regulatory compliance. His proficiency in various cybersecurity frameworks, cloud platforms, and infrastructure security enables him to drive organizational success through strategic technical leadership.

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