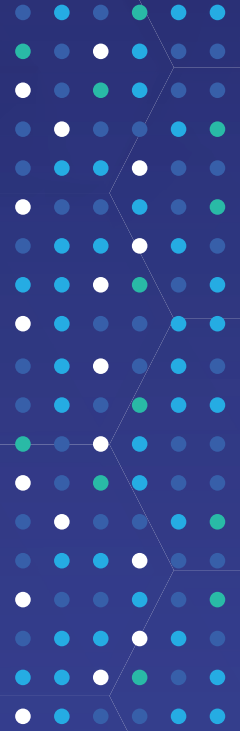
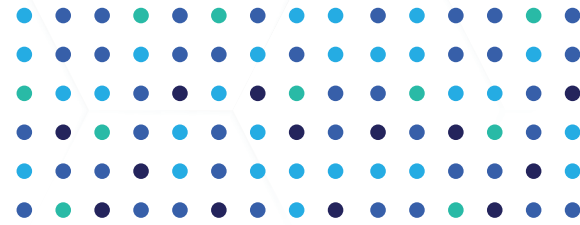


The **5G Revolution** Is Taking The World By Storm - Here's Why

Can 5G really transform business ecosystems?
An in-depth study of 5G Capabilities and what it means for businesses





Introduction

5G has arrived and there is an immense buzz around what the future holds. Broadly, 5G can be defined as the next generation of broadband connectivity but the reality is that there is so much more to 5G than just higher speeds. For starters, 5G is not just a network but a whole infrastructure on which networks, devices and the Cloud can be supported. 5G is the answer to existing issues with implementing the Internet of Things (IoT), with the capability to eliminate latency issues, support more devices, and have real-time Artificial Intelligence (AI) responses in dynamic situations. The applications of 5G are multifaceted and examining them in the context of four industries is detailed out in this whitepaper.

The four industries are:



Retail



Manufacturing



Mining

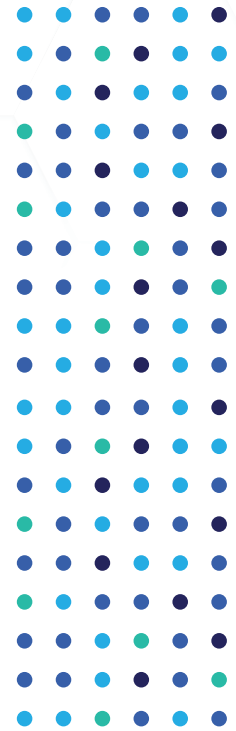


Ports

The paper also aims to understand the limitations faced by these industries till now and how 5G can change the way operations are carried out. It breaks down how 5G can increase production speed, improve employee productivity, analyze data more effectively, and improve safety for employees in high-risk jobs.

Where are we now?

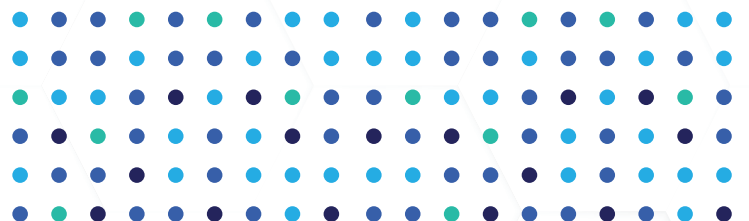
4G is still the most widely used network till date. 4G broadband transformed how individuals used their phones. Faster internet speeds, video streaming with a shorter lag time, and reasonable upload and download speeds truly added the “smart” to smart phones. More and more people started using their phones not only for shopping, gaming and video streaming but also to run their businesses. The era of apps dawned and a business not offering the convenience of a phone app to its customers was lagging behind its competitors. 4G also made Cloud technology possible which changed how businesses stored their data and conducted several of their operations. Software as a service (SaaS), infrastructure as a service (IaaS), and platform as a service (PaaS), made remote working and processing of data over larger geographies seamless and convenient.



4G and its limitations

4G however, is not without its limitations. Most notably, its relatively high latency, lower capacity for device connectivity, and security concerns are some of the major issues with the 4G network. 4G has a latency of about 20-30 milliseconds. In other words, there is a delay of 20-30 milliseconds between the time a command is sent and the corresponding action occurs. When it comes to certain sensitive functions that have to be carried out in real-time, 20-30 milliseconds can make a big difference.

Because of lower device capacity, congestion becomes a problem for the 4G network when too many devices are clustered in an area, for example, a football stadium or an auditorium. This congestion could slow down the network speed considerably causing lags in videos, or websites to time-out while they are loading. Finally, 4G has its share of security concerns. While there are a variety of protection and encryption softwares keeping hackers at bay, the network is not bulletproof.



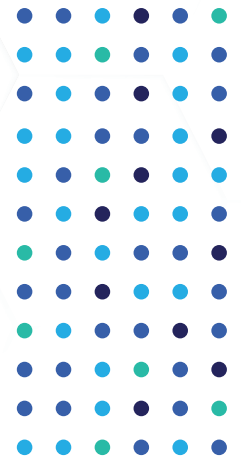
How 5G can overcome these challenges

5G not only effectively overcomes all of the 4G limitations but is also leaps and bounds ahead in several areas. 5G when run on the right mix of frequencies is able to transmit stronger signals, over longer distances and in densely populated areas. A 5G network that includes the 700 MHz frequency also has deep indoor coverage. Latency on 5G can be as low as 1 millisecond which means that a response to commands can happen in almost real-time. The ultra-reliable low latency communication (URLLC) that 5G brings to the table is absolutely essential for several of the functions that 5G will make possible. 5G also has higher security as it follows a two-step security feature, one at the network level and the other at the device level with the 5G SIM encryption.

When it comes to device connectivity, a 5G network can support up to 1 million devices per square kilometer area. Compare this to the 4,000 devices that 4G can support in the same area and you start to understand how far ahead of its predecessor the next generation of communications technology is. 5G is also much faster than 4G with network speeds going up to 20 Gbps, whereas 4G averaged at about 35 Mbps. This means that 5G is almost 100 times faster than 4G.

Let's now take a closer look at the application of 5G in the various industries using real-life case studies:





The applications of 5G in retail

Retail has been one of the fastest growing industries over the past few decades. Along with this growth, the industry is ripe for disruption and evolution and 5G technology can provide the necessary stimulus for the next phase.

The use cases for 5G in brick-and-mortar retail stores cater to two user groups. The first is that of the store owner, the other is that of the customer. Let's take a more detailed look at how 5G can be used in retail and the benefits it can bring.

Currently, stores have no way of tracking customer behavior, inventory depletion, products past their expiration date, or areas of the store that don't receive much footfall. This means that store owners and managers are losing out on valuable data that could help them serve customers better and have more efficient systems in place.

E-commerce stores already collect a vast amount of data based on customer behavior which allows them to conduct better target marketing. Studies have shown that targeted advertising can be twice as effective as regular or mass marketing. This is an area that brick-and-mortar stores should not miss out on. Here's where 5G technology comes in. 5G-powered Internet of Things (IoT) devices that are equipped with artificial intelligence (AI) and machine learning (ML) can collect the required data and transform the retail industry.



Let's understand this use case with an example. A supermarket sets up surveillance cameras across the store that have IoT sensors and AI. These cameras are able to keep track of areas of the supermarket that receive the most visitors and those areas that don't. They can also record how much time on average people spend at a particular location of the store. Furthermore, invaluable information like what products sell better, which brands of those products are preferred and so on can all be tracked by the cameras.

Here's what the supermarket can do with the data that it collects from the smart cameras:



Improve its floor plan

If a certain area of the store is not getting a large number of visitors, its location and means to get there can be compared to an area that does receive a lot of shoppers. This information can then be used to improve the product assortment of that location to attract more shoppers.



Tracking and maintaining inventory

Stocks can be increased of the products that sell better while those that don't can be removed from the shelves. Discounts and special offers can also be created around high-selling products to attract more sales.



Market more smartly to customers

If a particular segment of customers frequents one area of the supermarket more than others - for example, parents of young children in the fruit juice aisles, new products in that category can be specially marketed to this demographic to create more awareness. This can be done by placing staff near the entrance to inform parents with young kids about a new brand of organic fruit juice or a discount voucher being handed over at the time of check-out.

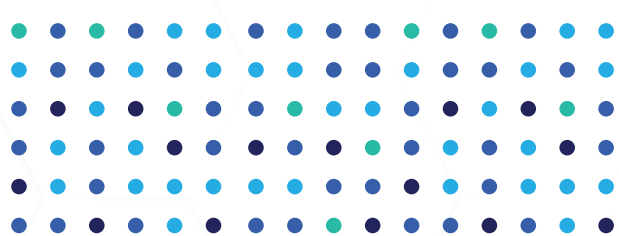


Besides these changes, smart surveillance cameras can also keep track of inventory and send an alert when the volume of a product is getting low on the shelves. This allows the staff to restock the product without causing an inconvenience to customers. Furthermore, smart scanners at check-out that have been programmed with the information of batch numbers of products can send an alert when overall stocks have reduced to a certain number and a new shipment needs to be ordered. This too requires AI and ML technologies that piggyback on the 5G framework.

As mentioned earlier, the benefits to retail are two-pronged. While the stores can greatly benefit from incorporating 5G technology, the customer experience too can be vastly improved. Let us look at another use case where 5G technology could transform retail.

An apparel store is equipped with IoT, smart sensors, AI and ML which are all enabled by 5G. The store then develops an app that can directly link the smart sensors to the customer's phone when they are in the store. This app can then show the customer the entire store layout, where different categories of clothes are located, and even where dressing rooms, check-out counters or store assistance can be found.

A customer can browse the store catalog online, get product codes of items they are interested in purchasing and be guided directly to those products in the physical store. Moreover, the app can also scan price tags and inform the customer of their total purchase amount, or even if an item is on sale or has a special offer attached to it. Mixed reality-enabled dressing rooms could also allow customers to view the products in different sizes or colors instead of having to try on several outfits.

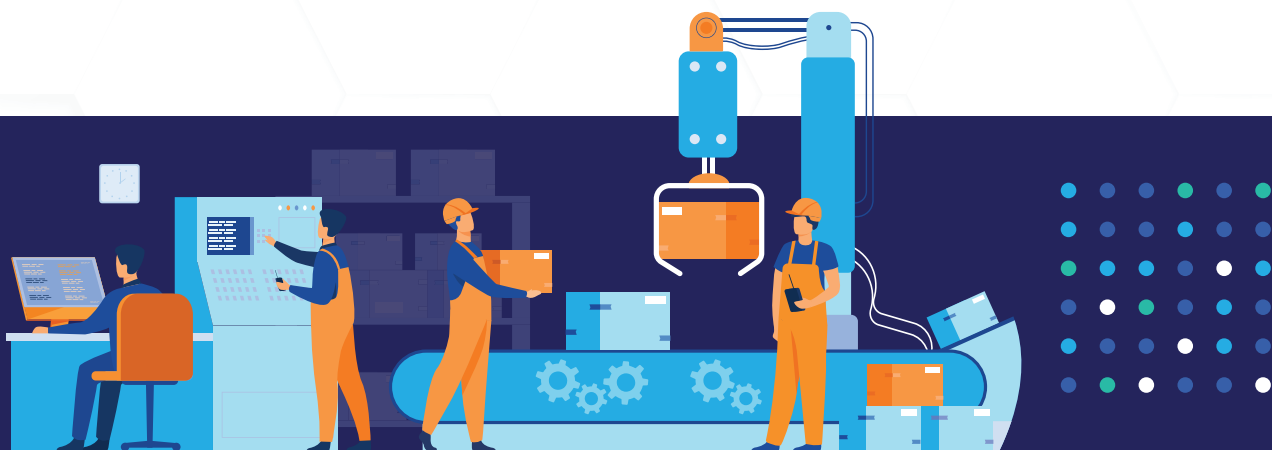


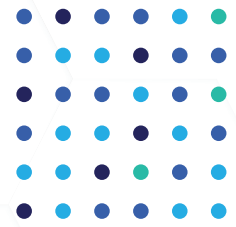
Finally, both stores and customers benefit from smart carts and self-checkout. Smart carts are fitted with sensors and scanners so that each item is scanned as it is put in the cart. Once the customer has completed their shopping they can use a corresponding app or a function on the cart to get the amount they need to pay and payment can be done with a credit/debit card and the receipt is generated. Self-checkout of this kind can completely eliminate queues and save a large amount of time. As the old adage goes, time is money.

The applications of 5G in manufacturing

Industry 4.0 is upon us with 5G technology, and is poised to make manufacturing faster, more efficient and with fewer errors. 5G networks within a factory set-up can have several use cases including, monitoring of equipment, carrying out intricate processes, and ensuring quality control.

To highlight how private 5G can increase productivity and lower costs in manufacturing we can look at a Bosch case study. The Robert Bosch electronics parts factory in Salzgitter, Germany started a trial in March 2022 to observe the effectiveness of 5G in quality control of their products.





This is how it was set up:

1

The factory manufactures electronic parts that need to be quality checked for defects.

2

This quality check needs to happen around the clock to reduce downtime and save on costs.

3

Therefore, a robot fitted onto an autonomous vehicle was enlisted for the job.

4

Both the robot and the vehicle are connected to the private 5G network.

5

The robot arm can be remotely instructed to pick up items from the production line and hold them under a high resolution camera.

6

The camera then takes a picture of the item which is sent via the 5G network to an AI-powered server.

7

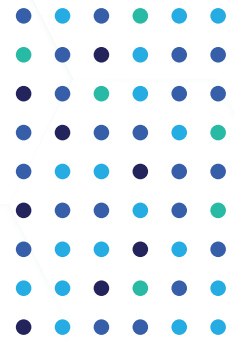
The AI server is able to verify if the product passes the quality check or has a defect by comparing the image to a pre-programmed image.

8

The server then instructs the robot what to do with the part that is being examined.

9

Good items are placed back on the conveyor belt while defective items are placed in a separate bin.



The advantages of using 5G in this quality control trial:

- There is no downtime in the production process.
- Machines don't get tired and can therefore work around the clock without breaks.
- There is a 0% error rate.
- 5G enables quick responses so that all the steps mentioned above happen in a matter of milliseconds.
- 5G also offers high reliability without the need for cables. Therefore, the autonomous vehicle has more flexibility and freedom across the factory floor.
- This allows the quality check robot to be transported at will to wherever it is required.

The speed and reliability that is displayed by the autonomous mobile robot can only be made possible with 5G. The 5G network can also support up to 1 million devices within a 1 square kilometer area. This means that multiple robots can efficiently operate on the same network within the factory.

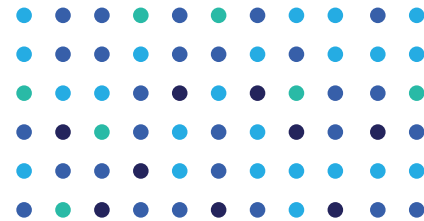
While this is a trial that has already been carried out, the implications of 5G in manufacturing are much more far-reaching. In another case study, 5G-powered sensors were used in a bladed-disks manufacturing facility. Bladed-disks are used in turbines and are manufactured in a closed setup for safety reasons.

Up until quite recently there was no way to monitor the process during manufacturing. Production could take up to 100 hours and if the end product was defective it could result in considerable losses for the company. 5G was able to solve this problem as sensors and communications devices could be fitted inside the milling tool set up where the disks were made.

These sensors were able to monitor manufacturing conditions and pick anomalies in vibrations and other factors which could then be relayed to the servers through a communication device. This helped with early detection allowing any problem to be corrected as soon as detected. With the installation of the 5G network, the number of defective bladed-disks was vastly reduced, saving the company both time and money.

Due to the low latency of 5G several time-sensitive manufacturing processes can now be automated as the technology allows for instant response to alerts. Everything from monitoring the manufacturing machinery to checking the end product can be carried out autonomously and accurately with 5G.

The applications of 5G in mining



5G's applications in mining go far beyond convenience. Mining has been around for over 10,000 years and has always been one of the riskiest professions. Long gone are the days of taking canaries into mines to detect toxic gasses. The advances in science and technology have vastly improved safety conditions in mines. However, mining accidents continue to happen which endanger the lives of miners and cause great damage. As recently as September 2022, a mining accident in Mexico trapped 10 miners underground.



This is why 5G technology plays a crucial role in this industry. The technology allows for machines to carry out a major part of the high-risk jobs while humans remain at a safe distance and operate the machinery remotely. One of the most widely used unmanned machines in mining is the excavator. Remotely operated excavators that even drive themselves are an ingenious way of digging mining sites and clearing out the debris without putting humans in dangerous situations.

An excellent example of the use of 5G in mining can be seen in China Molybdenum's Sandao Zhuang molybdenum mine in Luanchuan County, Henan. The mine, currently the only one of its kind, has 30 5G-powered excavators at the digging site. The excavators are operated remotely by a crew that sits in a completely different area. This arrangement offers a wide variety of advantages including:

The crew is well protected from harsh weather conditions like freezing temperatures.

1

The crew is no longer exposed to dust and potentially toxic particulate matter that they could inhale.

2

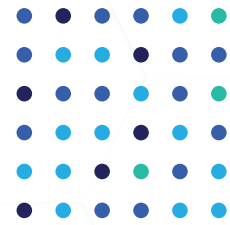
Cave-ins at the digging site don't pose a danger to human life.

3

Work continued even during the pandemic as the crew could work in isolation and maintain social distancing with their colleagues.

4





The amount of data being transmitted between the mining site and the operating centre is astronomical. Each of the 30 excavators has several moving parts both for driving and operating the digging arm. Each of these parts needs to transmit and receive data in order to function smoothly. In addition, there are cameras placed at strategic positions to provide the operator with a clear view of the site. The visual feed also needs to be transmitted back to the operating center in real-time. Once again, this can only be done because of the 5G network. Trying to transmit such large volumes of data on a 4G network would only cause lags which could lead to disastrous consequences.

The ultra-low latency offered by 5G allows for real-time responses of the unmanned equipment. It is almost as if the operator is actually sitting in the driver's seat and operating the digging arm of the excavator. The fast responses are crucial to the type of work being carried out as certain shifts in the land could result in the need for quick maneuvering of the vehicle to move it to a safer spot. Only 5G technology has the capability for this type of URLLC. Ever since the implementation of 5G at the China Molybdenum mining site, the monthly capacity of the mine has gone up to 500,000 tons and the safety and health of the employees has vastly improved.

Some of the other applications 5G could have in mining include:



Using AI-powered devices to check the safety of new mining sites



Drilling and blasting at mining sites using unmanned equipment



Analyzing air quality of mining shafts and tunnels



Identifying fault lines or structural damage in mines



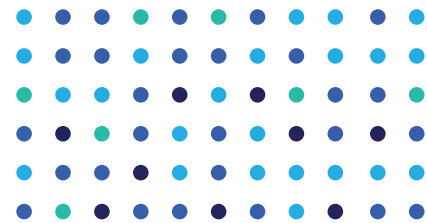
Using rock bolt sensors to alert to potential cave-ins or other accidents before they happen



Implementing smart ventilation systems in mines

We would only be scratching the surface when it comes to all the possible applications of 5G technology for the mining sector. We are already in a place where we can consider 100% unmanned mines where machines do all the work without putting humans in dangerous situations. But for now, we can already see how a few initiatives as discussed above, have greatly improved the safety conditions for miners and also contributed to their good health.

The applications of 5G for ports



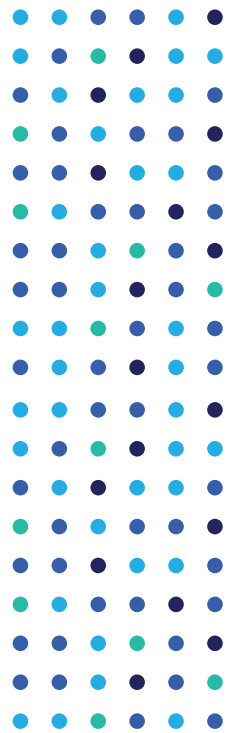
When it comes to ports, 5G finds multiple applications. Busy ports require a robust network that does not get overwhelmed with thousands of connected devices on a daily basis. It also needs a network that can be deployed for a variety of different functions some of which include monitoring of road traffic within the port, monitoring of vessels in the water, providing port workers with a stable network and mixed reality capabilities, IoT, emissions checks, and monitoring of unexpected incidents.



Here are some areas where 5G is already being tested in ports with favorable results.

The Smart Sea Port use case is being put to the test at the Port of Hamburg, Germany. The port is one of the busiest in Europe, spanning an area of 80 square kilometers and with a complex transport network including waterways, roads, railways, and bridges. To add to this, the port also contains container terminals, cruise terminals, and 50 specialized facilities handling the roll-on roll-off and break-bulk of cargo. The port also has contracts with over 7,000 logistics companies within Hamburg which operate to and from the port.

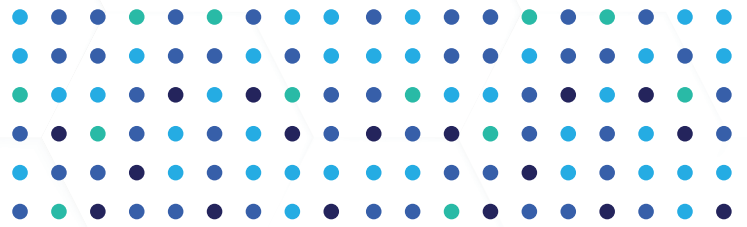
In 2020 a trial began to check the feasibility of 5G in three areas of the port: road traffic flow, port operations and port health monitoring.



Road traffic flow

The port uses smart traffic lights to safely guide both incoming and outgoing traffic like large trucks. The reliability and latency required for the traffic lights to be controlled remotely from the Hamburg Port Authority (HPA) control center was thus far brought about by fiber connections. Fiber connections however pose a major limitation in that updating and replacing fiber is a time-consuming and expensive activity. Additional hardware is also required if new traffic lights need to be installed.

By using a 5G network slice dedicated to smart traffic lights, the port has been able to achieve the same level of low latency and high reliability without the complications brought on by fiber. Furthermore, scaling up on a 5G network is far more convenient and requires less physical inventory. 5G is showing great promise in increasing reliability and lowering costs when used to support the smart traffic light infrastructure of the Hamburg Port.



Port operations

The Port of Hamburg has a 100-strong engineering team that carries out maintenance, repairs and construction within the port. These engineers work both on the land and waterside and depend heavily on communicating with each other across the vast port. The HPA has dedicated a 5G network slice to providing its engineers with a stable mobile broadband connection.

Using the 5G network the engineers can not only stay connected to each other and HPA headquarters but can also make use of mixed reality to aid in their tasks. Using tablets and AR/VR enabled goggles, the workers can easily access information about various sections of the port including blueprints, construction plans, technical installations, information on bridges and water gates, and so on. The goggles also help the engineers to envision how a structure would look in a particular part of the port once construction is complete.

Applying mixed reality to assess viability of constructions within the port could help in spotting inaccuracies in calculations or conflict areas that might arise that could cause costly mistakes. The high throughput required for these vast amounts of data to be available to the engineers is only possible with 5G. Because of network slicing, the engineers' work does not get disrupted even on days when the port's network has to support a larger number of devices.



Port health monitoring

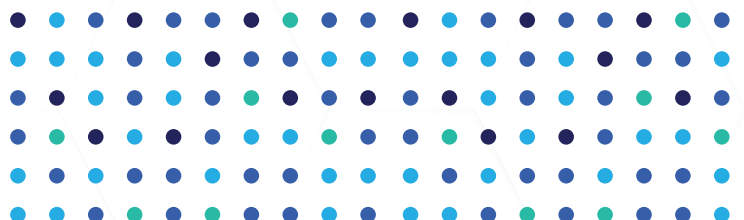
The port is fitted with a vast array of sensors that monitor various functions. Environmental sensors fitted on barges collect data on emissions of carbon dioxide and other gasses, while IoT sensors monitor fixed and movable assets across the port like traffic lights, bridges, water gates, railway switches and more. Maritime navigation systems like lighthouses and beacon and fairway buoys are also fitted with IoT sensors.

These sensors help to collect data about movement, pick up abnormalities in vibrations, and even predict where maintenance will be required in the near future. With the help of these sensors errors and accidents within the port can be brought down to minimum. However, the challenge up until this point was that thousands of sensors are required for an operation of this scale which is not possible using either fiber connectivity or a 4G network.

With the help of 5G the port is now able to connect these sensors wirelessly to various operation centers within the port. The 5G network also allows for continuous data collection and analysis so that port health can be constantly monitored. Port authorities can be instantly alerted in case an anomaly is detected so that the required safety measures can be taken.

Using 5G, dedicated slices were employed to carry various types of data to their respective operation centers. 5G-powered sensors can also establish dual connectivity between two operation centers. This type of dual transmission is essential in the case of barges that have mobile terminals as they move from one port to another. With 5G-enabled IoT sensors, the port can constantly be in contact with the vessels entering and leaving which greatly improves the flow of traffic, can reduce bottlenecks, and even prevent accidents from occurring.

The trial at the Port of Hamburg commenced in 2020 and will be observed till 2030 in order to form conclusive results. However, the trial is already showing how important 5G is within the port environment and why integrating it within the systems could lead to more efficient port operations. Smart ports are the need of the hour with the growing amount of sea traffic and the activities related to this sector. The Maritime and Ports Authority of Singapore has also successfully trialed standalone 5G connected drones to monitor port operations and report incidents.



Conclusion

It is apparent from these case studies, trials and use case examples that 5G technology will not only improve the speed and reliability of industries but is also essential to the safety of employees. The Service Level Agreement (SLA) offered by 5G network providers is what drives the robustness and reliability of the technology.

In India, only Jio 5G offers the true 5G experience. Jio True 5G is a standalone network which allows it to reach its full potential of speed and capacity. The right mix of network frequencies that work together with carrier aggregation technology gives Jio True 5G the widest and most reliable connectivity across the country including far reaching rural areas. With Jio True 5G, India is poised to become a global superpower in technology both in the private as well as Government sectors.

As Wordpress CEO, Matt Mullenweg said, "Technology is best when it brings people together." This rings true for 5G technology. The 5G infrastructure not only brings people together but also connects people with devices and devices to each other to form a vast communications network that can transform industries, enable new innovation, and change lives.

