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WEB OF THINGS APPROACH FOR SMART PORTS

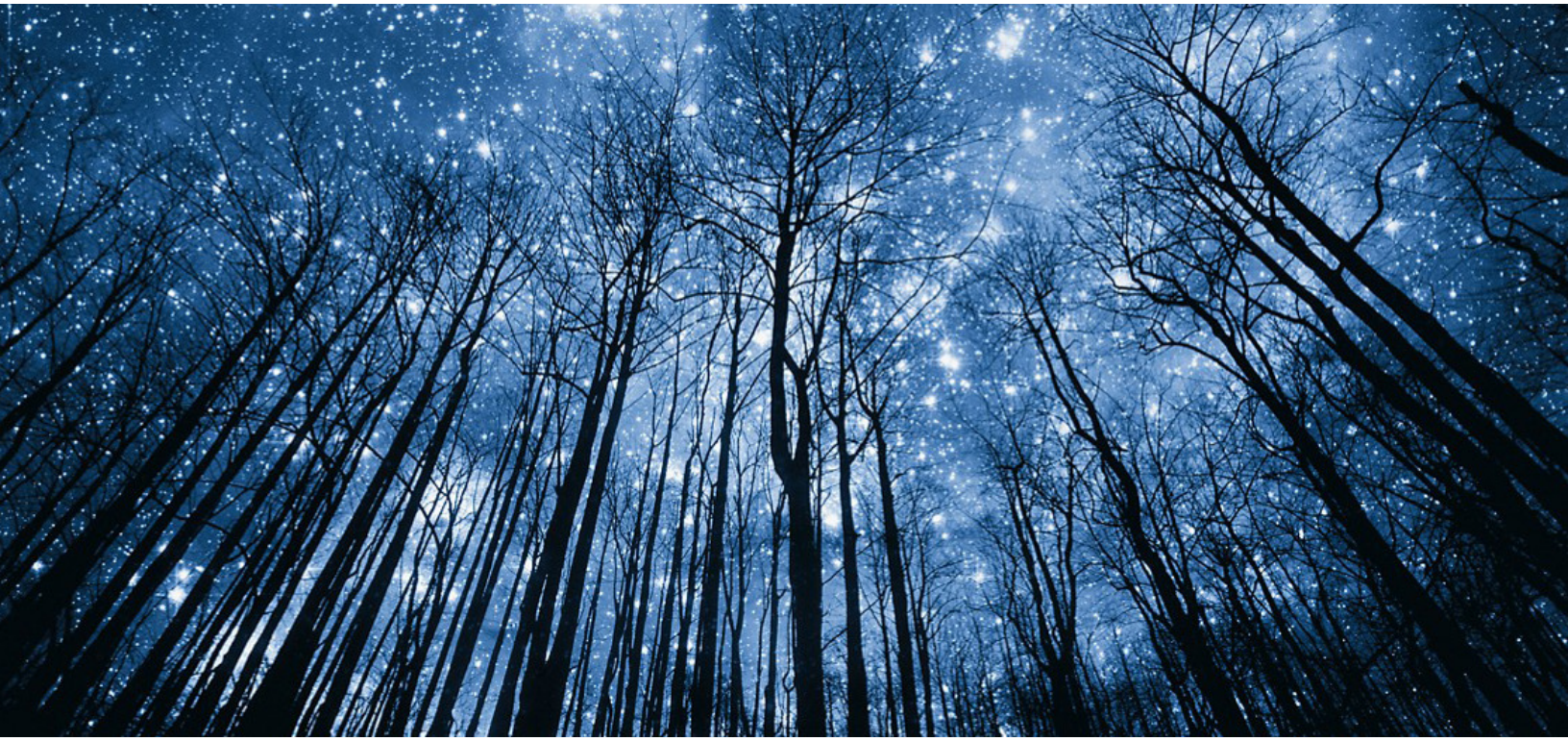

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Table of Contents

Abstract

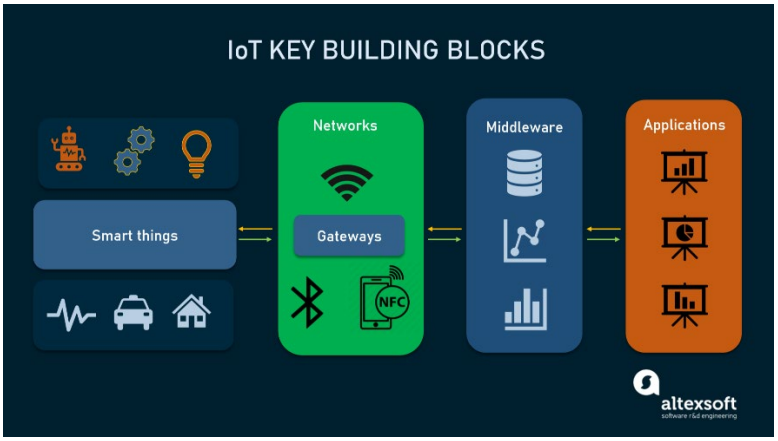
Significant advances in telecommunications and the Internet of Things have created several smart city scenarios in which smart services are deployed. What was once a dream of the future is now a reality. However, the need to deliver these intelligent services quickly, efficiently, interoperable and in real time is a cutting-edge technological challenge. Some software architectures offer solutions in this area, but they are often constrained by independent modules for reusability and maintainability. This includes the need for system downtime for maintenance or further development, and the lack of standards related to interoperability of those architectures.

This article proposes a standardized and fully reusable microservices architecture using the Web-of-Thing's paradigm. High-efficiency real-time data processing is possible by supporting complex event processing technology. To illustrate this proposal, we present a fully reusable implementation of the microservices required to deploy an air quality monitoring and alerting architecture in a smart port. Performance scores for this architecture show excellent results.

Introduction

The Internet of Things (IoT) is an internetworking of physical devices integrated with sensors, software, and network connectivity that allow these objects to gather and share information. Software architectures are the fundamental structures of a software system, the discipline of creating such structures, and the documentation of these structures.

The Internet of Things (IoT) has grown significantly in importance in recent years, largely due to significant technological advances and the ability to design smaller and cheaper electronic components. Together with the more affordable price of communications in general and improved wireless communications the development of smart cities is facilitated.



Source: https://www.altexsoft.com/blog/iot-architecture-layers-components/

The combination of IoT and software architectures is often referred to as the "IoT architecture". This architecture is characterized by its ability to connect multiple smart things / devices, services, and middleware / systems to a network, allowing them to interact with each other. This connectivity enables the collection, exchange, and analysis of data, which can be used to improve the efficiency, safety, and security of the connected devices and systems. IoT architecture typically includes a variety of components, including sensors, controllers, gateways, communication protocols, databases, and analytics engines.

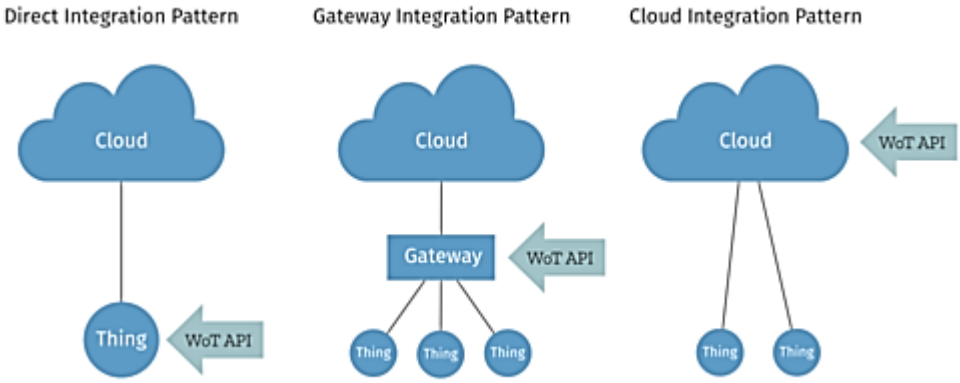
The integration of IoT and software architectures can enable a range of applications and services. Examples include intelligent lighting systems, automated vehicles, smart homes, connected healthcare, and smart cities. By combining these two technologies, organizations can create powerful solutions that enable them to better understand and manage their operations. Additionally, the insights gained from the data collected can be used to inform decision-making and optimize processes.

Web of Things (WoT) is an emerging technology that enables the interconnection, communication, and control of physical objects over the Internet of Things (IoT). It combines web-based technologies and services with physical objects, allowing them to be connected to each other, interact and exchange data. This provides new ways of discovering, monitoring, and controlling physical objects, as well as a platform for innovation and the creation of new applications and services. WoT enables the sharing of data between physical objects and the cloud, while allowing users to interact with them remotely. This allows for the development of a distributed, global network of connected devices.

Smart Ports & WoT Paradigm

Smart ports connect thrift, ambience, and individuals. Smart cutting-edge technology and digital transformation play a vital role to increase operational efficiency, improve port management, and reduce environmental impact. They are equipped with advanced technologies such as IoT, cloud computing, big data, artificial intelligence, and robotics to automate port processes, improve visibility and cargo tracking, and facilitate better decision-making. Smart ports also aim to reduce air and water pollution, traffic congestion, and energy consumption. They also provide better security, reduce operational costs, and improve customer satisfaction. The aim of a smart port is to maximize the flow of goods and services while minimizing the potential for disruption or delays.

The Web of Things (WoT) paradigm is an approach to the Internet of Things (IoT) that focuses on providing a uniform and unified way of connecting physical objects to the web. The main components of the WoT paradigm are the Thing Description, which is a description of the device and its capabilities, the Protocols, which allow for communication between devices and applications, and the Interoperability Layer, which provides a layer of abstraction to allow devices to communicate without understanding each other's underlying technology. By providing a unified approach to connecting physical objects to the web, the WoT paradigm aims to make the IoT more accessible and easier to use.



Source: Building the Web of Things - Mozilla Hacks - the Web developer blog

In the above diagram, there are 3 major integration patterns developed for linking things to the web. The controller exposes a WoT webservice to the cyberspace via direct integration. The gateway integration is useful for asset-constrained controllers that cannot run a web server and must rely on a gateway/router to establish to the internet. The WoT service is subjected to a cloud server that acts as a remote router, and the device communicates with the server on the backend via another protocol.

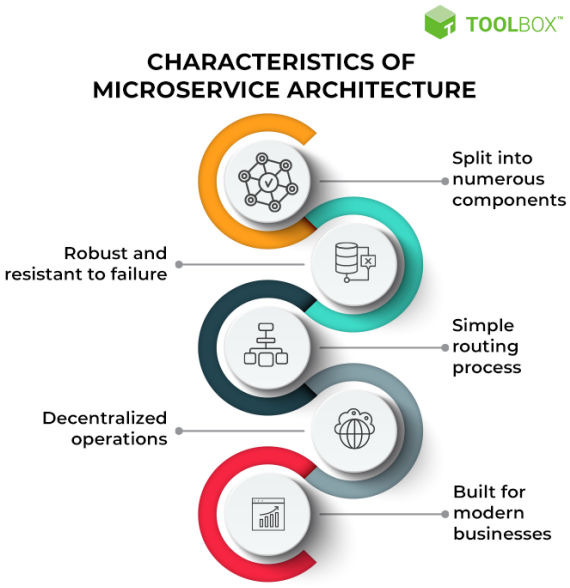
WoT describes the interconnectedness of physical objects and digital networks using sensors, software, and other technologies. This interconnectedness allows for remote monitoring, control, and automation of physical objects and systems. In the context of smart ports, the WoT can be used to monitor and control the flow of goods, services, and people in and out of the port. This can help to ensure that operations are running smoothly and efficiently while also providing a platform for predictive analytics and optimization. Additionally, the WoT can provide real-time data to help port authorities anticipate and respond to changes in the environment.

Need for Microservices Architecture

Microservices architecture is an approach to application development in which a large application is built as a suite of small services, each running in its own process and communicating with lightweight mechanisms. These services are designed across enterprise competencies and can be deployed independently by completely autonomous deployment. In smart ports, microservices architecture can be used to enable the port to be more agile and responsive to changing customer needs. It can also be used to reduce the complexity of integrating different systems.

Standardized and fully reusable microservices architecture is essential for organizations to create a well-structured, scalable, and easy to maintain environment where all components of the system are easily connected and distributed. Additionally, microservices can be used to enable the port to quickly develop new applications or services that can be deployed quickly and easily. This can help the port stay competitive in the ever-evolving digital landscape.

A standardized microservices architecture helps to ensure that all components are compatible with each other, and that each service can be deployed and scaled independently. This allows for a more efficient development process, since all services can be developed and tested in isolation, and it helps to reduce complexity and reduce the time to market. In addition, reusable microservices architecture enables companies to quickly integrate new services with existing ones, and to quickly deploy new functionality. This can result in cost savings and faster time to market.



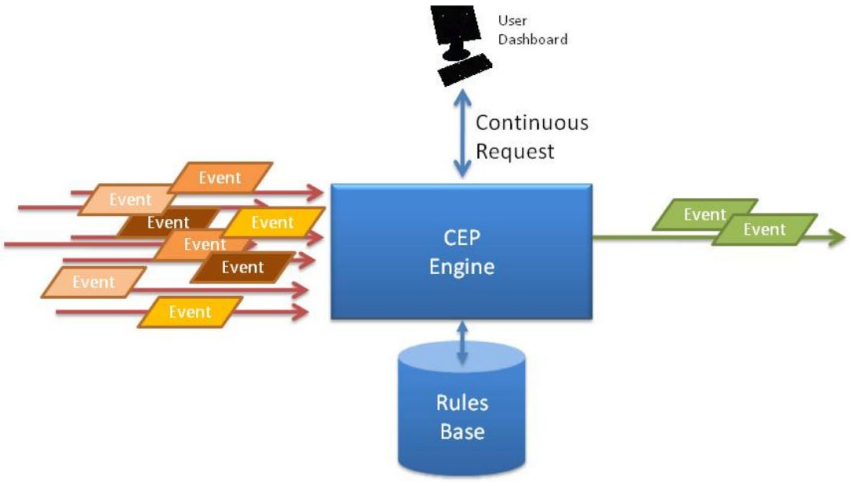
Source: https://www.spiceworks.com/tech/devops/articles/what-are-microservices/

In the context of a smart port, microservices can be used to deploy an air quality monitoring and alerting architecture. The architecture can be designed to monitor air quality in different areas of the port, from the dock to the terminal. The microservices can be configured to detect any airborne pollutants and to issue alerts when a threshold is exceeded. This alerting system can be used to notify the port authorities of any air quality issues, allowing them to take appropriate action.

Furthermore, microservices can also be used to integrate the air quality monitoring system with other systems in the port. For example, they can be used to integrate the system with the port's security systems, enabling the port authorities to respond quickly to any air quality issues.

Complex Event Processing (CEP) & it's uses

Complex event processing (CEP) technology is a form of event-driven computing that helps to identify meaningful patterns from many events or data streams. It can be used to detect and respond to events in real-time, allowing businesses to make decisions quickly and accurately. It enables the collection, analysis, and correlation of large amounts of real-time data with the goal of detecting interesting situations in a specific geographic area.



Source: File: Complex Event Processing.jpg - Wikimedia Commons

CEP technology can be used in a variety of applications, such as fraud detection, online marketing, customer segmentation, and risk management. It can also be used to analyze events from multiple sources, such as social media, mobile devices, sensors, and other data sources. By analyzing these events, organizations can detect patterns and act quickly. CEP technology can help businesses improve their decision-making processes, reduce costs, and help them stay ahead of their competition.

By combining the microservices with CEP, organizations can create powerful applications that can quickly respond to the most complex of events. For example, in smart port scenario, sailors could use CEP to monitor the stream of traffic of the port, and then trigger a microservice to handle it. The use of complex event processing technology with microservices can help organizations improve their operational efficiency and gain insights from their data. With it, organizations can quickly and easily detect anomalies, automate processes, and respond to events in real-time.

This combination can also be used to create proactive applications that can detect potential issues before they become a problem. Scenario of Tsunami alerts can be a potential usecase. These alerts are issued when a tsunami is detected or forecasted to occur. Alerts can be issued for a specific region or for a larger area, depending on the severity of the tsunami and the potential for damage. Alerts typically include information about the size and direction of the tsunami, as well as instructions on how to respond and evacuate. These alerts can be broadcasted in efficient and cost-effective way. The cost savings and improved efficiency it provides make it an attractive option for organizations looking to reduce development time and cost.

Case Study

Case 1:

In 2013, the Port of Rotterdam Authority began a pilot project to develop a ‘smart port’ that would facilitate the efficient movement of goods and services through the port. By integrating various systems and technologies, the goal was to create an intelligent port that could offer predictive information on port operations, allowing for improved decision-making and the optimization of port operations.

The project was based on the development of an ‘intelligent port platform’ that could collect and analyze data from a variety of sources, such as GPS and radar. This data was then used to create an intelligent port model, which could be used to identify potential bottlenecks, anticipate disruptions, and optimize port operations.

To ensure the success of the project, the Port of Rotterdam Authority partnered with several leading companies, including IBM, Cisco, and Microsoft. These companies worked together to develop the platform, which was then tested and implemented in the port.

The project was a success, with the port’s efficiency improving significantly. The platform allowed for the optimization of operations, leading to a reduction in fuel costs and emissions, improved safety, and improved customer service. In addition, the port was able to increase its capacity and handle more traffic, allowing it to compete more effectively with other ports.

The Port of Rotterdam’s success with its smart port project has served as an example to other ports around the world. Since the completion of the project, many other ports have begun similar initiatives, looking to improve their efficiency and operations through the use of technology.

Source: https://www.porttechnology.org/news/sdp21-rotterdam-outlines-smart-port-priorities/

Takeaway:

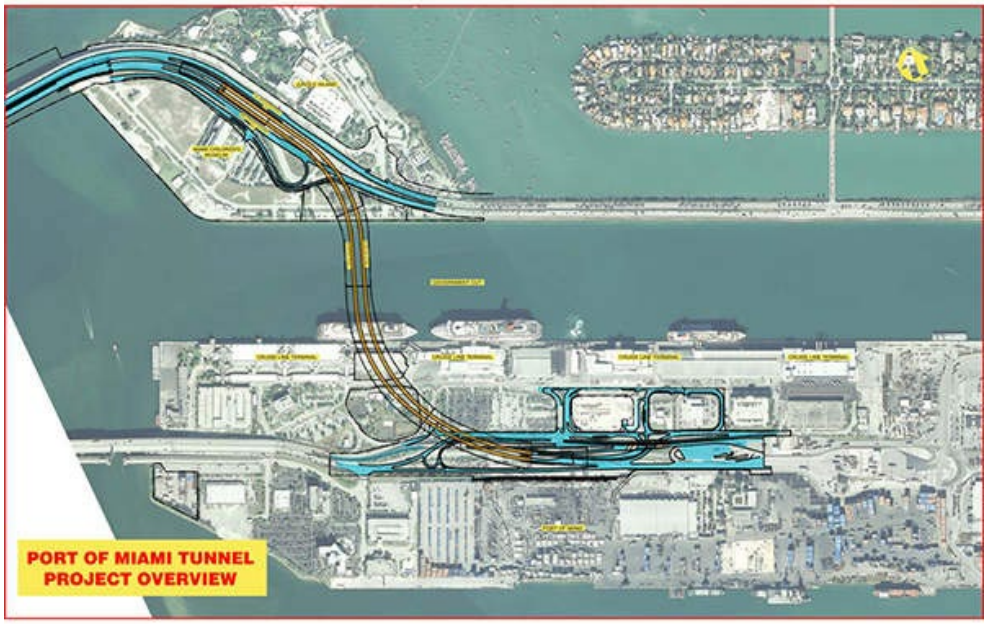
It is essential for ports and other maritime businesses to embrace digital transformation in order to remain competitive in a rapidly changing landscape. By leveraging the latest technology and digital tools, businesses can improve efficiency, reduce costs, and create new opportunities. The Port of Rotterdam Authority has taken a proactive approach to digital transformation, creating a dedicated digital platform to manage activities and data, and using artificial intelligence to optimize operations. This is an example of how digital transformation can help businesses to stay ahead of the curve.

Case 2:

In the United States, the Port of Miami is a leading example of a smart port. The port has implemented a number of initiatives to improve efficiency and safety, such as the installation of an automated terminal operating system and a traffic management system. The automated terminal operating system allows for faster and more efficient loading and unloading of cargo, while the traffic management system helps ensure vessels are able to move safely through the port. The port has also implemented a number of security measures, such as the installation of surveillance cameras, that help deter crime.

The Port of Miami has seen a number of benefits since implementing its smart port initiatives. For example, the port's container throughput has increased by more than 10% since implementing its automated terminal operating system. The port has also seen improved safety, with the number of accidents decreasing by more than 40% since the installation of its traffic management system. Finally, the port has seen a decrease in wait times, with the average wait time for vessels decreasing from 6 hours to 4 hours.

Overall, the Port of Miami is a great example of how smart ports can improve efficiency, safety, and security. By utilizing advanced data analytics and automated systems, the port has been able to improve its operations and provide a better customer experience. As more ports adopt smart port initiatives, the benefits will become even more evident.



Source: https://www.roadtraffic-technology.com/projects/port-of-miami-tunnel-florida/

Takeaway:

The Port of Miami is a major hub for international trade and transportation and serves as a valuable asset to the local economy. It is essential to ensure that the port remains well-managed and efficient in order to maximize its potential. Attention should be paid to the development of new technologies, investment in infrastructure and services, and the maintenance of a safe environment for workers and visitors alike. The technology has allowed the port to streamline operations, increase security and reduce costs. It has also enabled the port to better monitor and manage cargo, improve customer service, and improve the overall flow of goods.

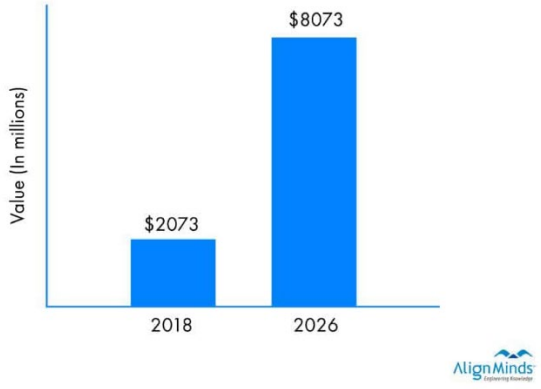
Future Scope

Smart ports are the future of maritime transportation and trade. They are a new type of port that uses high-tech digital technologies to improve efficiency, reduce costs, and increase safety. Smart ports are equipped with sensors, automation, and other technologies to provide real-time data about ships, cargo, and port facilities. This data can be used to optimize port operations and improve customer success.

The potential of smart ports is immense, with opportunities for greater automation, efficiency, and sustainability. As technology continues to evolve, so too will the capabilities of smart ports. In the future, smart ports could become increasingly sophisticated; incorporating artificial intelligence, blockchain, and Internet of Things (IoT) technologies to further improve efficiency and security. In addition, machine learning can be used to automate and optimize operations such as vessel scheduling and cargo tracking. They will be able to monitor and control all aspects of port operations, from ship arrivals to cargo handling. They will also be able to track and analyze data in real-time to identify potential problems and opportunities.

Smart ports could also use sensors and robotics to monitor air and water quality, thus reducing emissions and pollution. Additionally, more efficient, and sustainable energy sources such as solar and wind power could be implemented to reduce the environmental footprint of ports. They could facilitate the development of smart cities and smart regions, connecting them with the transportation and logistics networks that support the global economy. This could create a more connected and efficient world. They have the potential to revolutionize the maritime industry and provide significant cost savings and efficiency gains.

Microservices architecture enables applications to be built as a set of independently deployable services that communicate with each other through well-defined APIs. The scope of microservices architecture covers all aspects of an application, from the underlying infrastructure to the user-facing components. This means that it can be used to structure applications of any size, from small web applications to enterprise-level systems.



Source: https://alignminds.com/benefits-of-microservices-architecture-2/

The microservices architecture market is anticipated to grow from an estimated market size of $2073 million in 2018 to $8,073 million by 2026, according to Allied Market Research. From 2019 to 2026, the compound annual growth rate is 18.6%. The conclusion drawn from all these statistics is that microservices are the way of the future.

Conclusion

The Web of Things (WoT) is an approach to creating a smarter, more connected, and more efficient port environment. It is based on the concept of using open standards and protocols to enable the sharing of data across multiple systems and devices. This approach can be used to create an intelligent system of sensors, devices, and data networks that can be used to monitor, analyze, and control various aspects of a port environment. By leveraging the power of the Internet of Things (IoT) and the capabilities of connected devices and systems, port operators can gain insights into their operations and make informed decisions to optimize their operations and improve safety and efficiency.

Using the Web of Things in smart ports, operators could create a network of sensors and devices that can collect data on port activity. This data could be used to monitor and analyze shipping traffic, cargo operations, and other port activities. The collected data could then be used to produce real-time insights into port operations, allowing operators to make timely decisions to optimize operations and improve safety and efficiency. Along with microservices architecture and complex event processing, and sophisticated technologies from artificial intelligence (AI) and machine learning (ML), to blockchain and the serverless architecture could bring in disruptive impacts to current model of WoT integrated Smart Port. These technologies will drive innovation in a Web of Everything (WoE).

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