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Adopting Containerization In Industrial Automation

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Abstract: The manufacturing and industrial sectors have faced numerous challenges over the decades, including the availability of skilled labor, cybersecurity issues, and plant downtime due to asset failures. The traditional non-containerized environments used for building SCADA systems are becoming less effective in recent days to solve industrial challenges as they have issues with portability, scalability, security, stability, agility, responsiveness, and resource consumption. It will also become difficult in future to provide innovative solutions to industrial customers using traditional SCADA systems that use traditional non-containerized applications. The demand for the implementation of advanced technology to optimize industrial and manufacturing plants has always been high. With the advent of Industry 4.0 (the Fourth Industrial Revolution), these challenges are being addressed through the integration of advanced technologies such as IIoT, Cloud computing, Artificial Intelligence, Machine Learning, Containerization, and other digital innovations. Industry 4.0 enables the creation of smarter, more efficient solutions that enhance productivity and reduce costs, thereby ensuring business sustainability. The combination of industrial automation with Industry 4.0 technologies results in more reliable and powerful end-to-end automation solutions, allowing digital systems to make autonomous decisions and assisting workers in making faster, more informed choices. Additionally, Augmented Reality and Virtual Reality expand human capabilities to interact with machinery, providing greater control over assets. Containerization technologies such as Docker and Kubernetes further enhance the efficiency of application by enabling consistent and isolated environments for applications, ensuring seamless deployment and scalability. These advancements collectively help to overcome traditional industrial challenges faced by traditional industrial applications and drive the sector towards a more optimized and sustainable future.

Keywords: - SCADA, I4.0, Industry 4.0, Kubernetes, Docker, Containerization, Cloud Computing, Artificial Intelligence, Machine Learning, IIoT, Digital.

I. INTRODUCTION:

Industry 4.0:

The manufacturing and industrial sectors have been continuously improving over several decades to enhance productivity and efficiency. These sectors face significant challenges, including the availability of skilled labor, cybersecurity issues, and plant downtime due to asset failures. The demand for advanced technology has always been high to further optimize industrial and manufacturing plants. With the emergence of Industry 4.0 (4IR - 4th Industrial Revolution), it is now possible to surpass existing limits by adopting digital technologies to strengthen industrial needs (such as scalability, reliability, security etc.), optimize existing plants, or build new ones.

Industry 4.0 revolutionized the sector with advanced technologies such as the Industrial Internet of Things (IIOT), Cloud Computing, Artificial Intelligence (AI), Machine Learning (ML), and other digital technologies. These technologies collectively solve a wide variety of industrial problems, resulting in smarter solutions, faster production, cost efficiency, and sustainability. The integration of Industry 4.0 technologies with industrial automation enables the creation of more reliable, smarter, and powerful end-to-end automation solutions. This integration allows digital systems to make self-decisions without human intervention, assisting workers in making faster decisions and optimizing their plants. Augmented Reality (AR) and Virtual Reality (VR) further enhance human interaction with machinery and assets. Originally, Containerization was introduced in IT sector and could be adopted in OT (Operations Technology) sector also. It plays a key role in integration of SCADA systems with I4.0 for digital transformation, it provides flexibility to integrate with SCADA systems with I4.0 technologies such as Cloud computing, Machine Learning, Data analytics, Artificial Intelligence. Containers are lightweight, platform independent packages that bundle applications code and all its dependencies to run application and they provide better security and connectivity with I4.0 technologies and containerization is considered as better technology in collecting the data from SCADA systems

and sending the data to Cloud computing environment. The data in Cloud computing environment could be easily read by Machine Learning algorithms, data analytics tools and hence it is possible to get forecast very easily.

2.0 Traditional SCADA System:

SCADA: Supervisory Control and Data Acquisition (SCADA) systems are industrial control systems that utilize computers, communication networks, and embedded devices to gather and analyze real-time industrial data. Typically, SCADA systems are used in utility companies such as waste and water management and power transmission and distribution.

Key components of SCADA systems include HMI, PLC, RTU, SCADA programming, Communication system, Supervisory system. Key components of SCADA system is shown in below diagram.

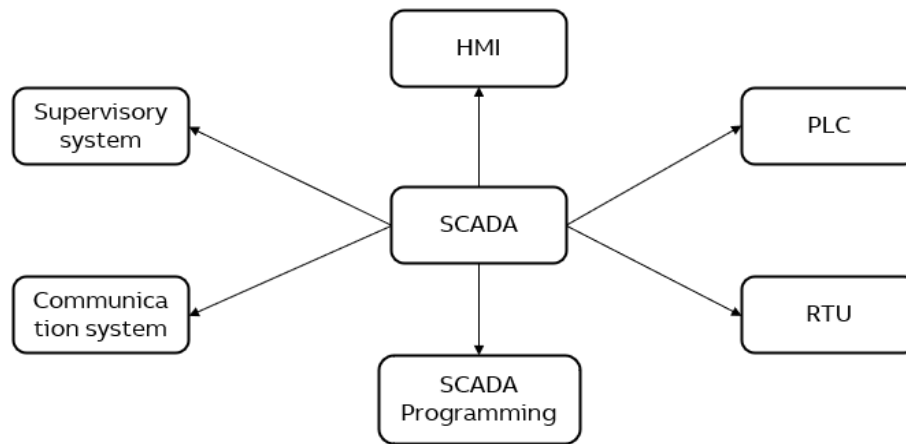


Figure 1.1: Important parts of SCADA system

The above diagram in Figure 1.1 shows the important parts of SCADA system in general. The SCADA system is designed to connect with industrial control systems such as PLCs (programmable logic controllers). PLCs are connected to sensors and actuators via input and output modules that are connected to PLC via hardwiring.

Human-Machine Interface (HMI): It is an electronic input-output device with a graphic display that provides process data to human operators for monitoring and control of industrial processes.

Supervisory System: It is a connectivity server that communicates between core control systems such as Programmable Logic Controllers (PLCs) and Remote Terminal Units (RTUs).

Remote Terminal Units (RTUs): RTUs are Intelligent processor-based devices that collect and transmit telemetry data. RTUs are distributed across plants.

Programmable Logic Controllers (PLCs): PLCs are processor-based devices that logically control the SCADA system and its equipment. It allows industrial engineers to write control logics using various languages such as Function block diagrams, Ladder diagrams, Structured text etc.

Communication Infrastructure: It consists of various communication techniques (e.g., Cellular, Radio, Ethernet) that connect process devices, workstations, and servers.

Below is the diagram of traditional SCADA system:

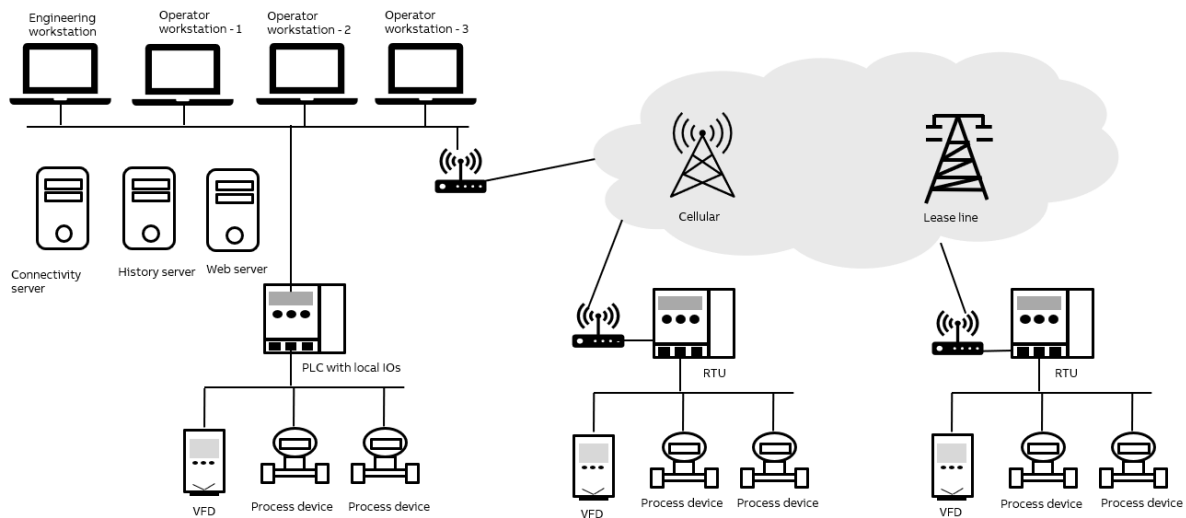


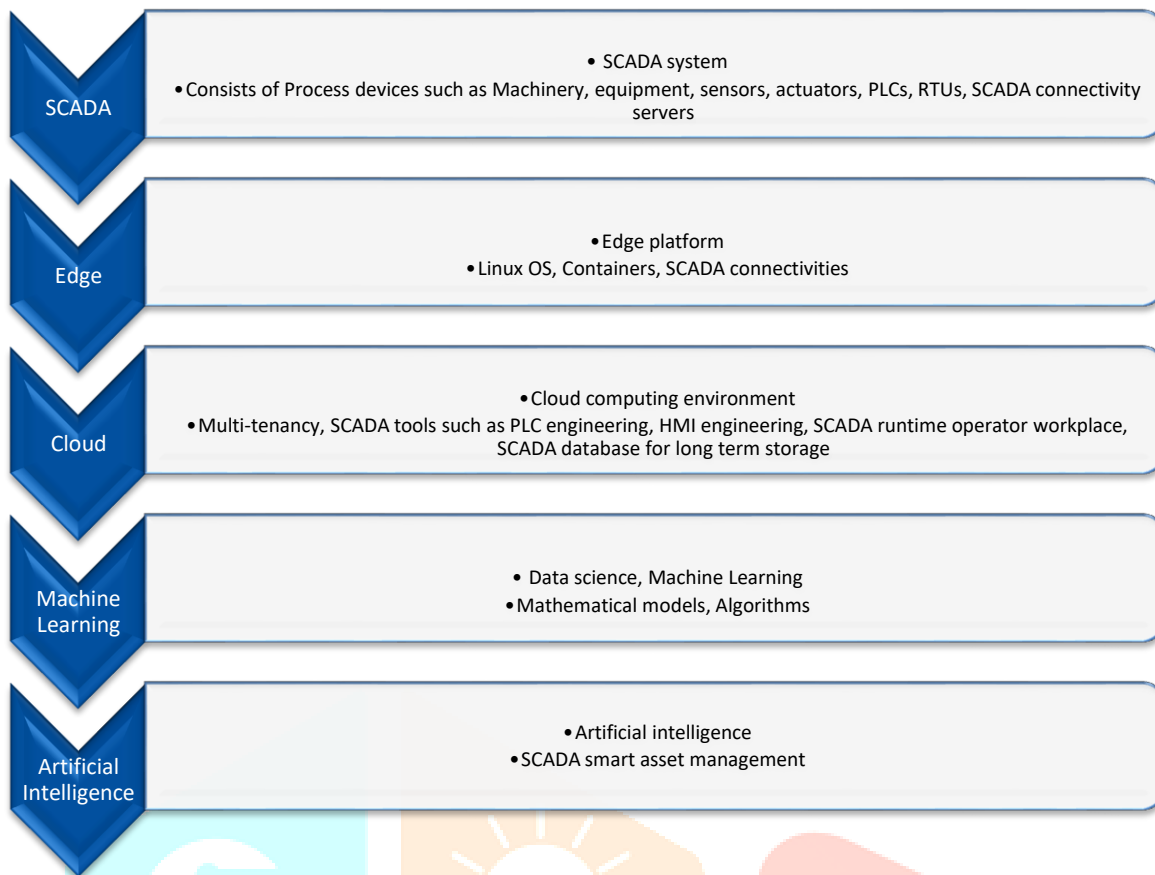
Figure 1.2: Traditional SCADA system

3. Modernized SCADA System (I4.0-based Containerized system):

3.1. Flow of Data in modern containerized SCADA system:

When designing the modernized SCADA system, it is important to understand how various components of I4.0 are integrated with SCADA system and how the data are collected from SCADA system, processed, stored, analyzed. It is also important to understand how data reaches Cloud computing environment and how analytics tools, Machine Learning and Artificial Intelligence concepts are applied.

The below diagram shows the high-level flow of process data from process devices in SCADA based industrial control system to containerized Edge platform. The data from Edge platform is processed and filtered and then sent to Cloud computing environments through the internet. The data available in the Cloud computing environment could be utilized for analytics purposes to derive meaningful insights. Data science concepts are applied to obtain clean data and then could be fed to Machine learning models. AI utilizes various Machine Learning models and Deep Learning algorithms to simulate human like behavior. With the support of data science, Machine Learning models it is now possible to solve industrial problems with less human intervention in an efficient way.



3.2. IIoT Architecture:

IIoT stands for Industrial Internet of Things which refers to the application of IoT (Internet of things) technology in industrial applications. IIoT is a network of intelligent industrial devices such as industrial machines, sensors, and devices that are connected to Cloud via the internet. The data generated by IIoT devices could be sent to Cloud environment and then analyzed with the help of Artificial intelligence and Machine Learning models to improve efficiency, productivity, and asset health management.

The Industrial Internet of Things (IIoT) architecture comprises four stages as shown below:

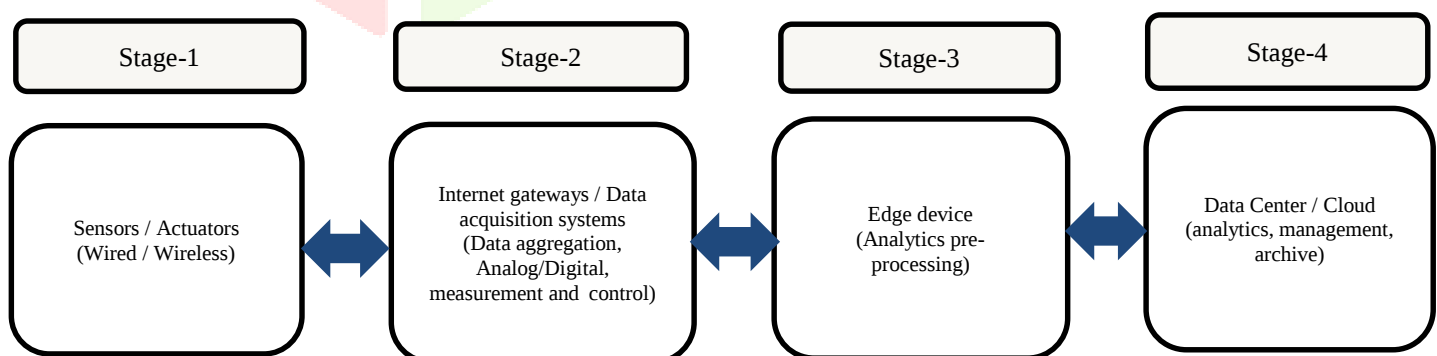


Figure 1.3: IIoT architecture

Sensors/Actuators:

Sensors convert non-electrical inputs to electrical signals. They are classified into active sensors, which emit their own energy to collect real-time data (e.g., GPS, X-ray, radars), and passive sensors, which use energy from external sources (e.g., cameras). Sensors can measure various parameters such as position, occupancy, motion, velocity, acceleration, force, pressure, flow, humidity, light, radiation, and temperature.

Internet Gateways/Data Acquisition Systems:

These systems bridge sensor nodes with the external Internet or World Wide Web. They aggregate data, perform analog-to-digital conversion, and control measurements.

Edge Infrastructure:

Edge infrastructure processes data at the point of collection, reducing latency and network traffic. It performs basic pre-processing tasks like filtering and aggregation before transferring key pre-processed data to Cloud services for further analysis.

Cloud:

The Cloud layer processes, stores, and analyzes data. Cloud applications provide visualization and analytics tools, presenting data to end-users through dashboards and visualizations. These applications also offer high-level management and monitoring of the entire system.

3.3 Modern containerized SCADA system:

Overview diagram of modernized industry 4.0 based containerized SCADA system:

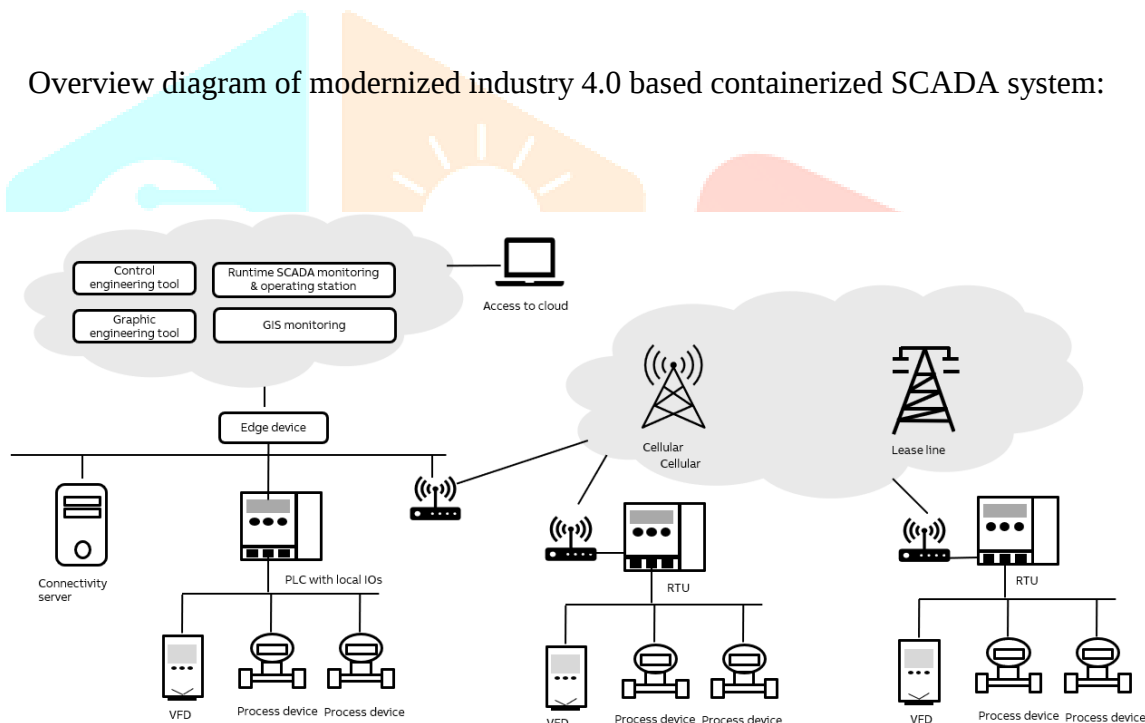


Figure 1.4: Modern containerized SCADA system.

The modernized SCADA system leverages Industry 4.0 technologies and containerization. Key features include,

Edge device which collects the process data from SCADA system and then sends the collected data to Cloud computing environment. The Cloud computing environment should facilitate hosting of SCADA control, HMI engineering and runtime tools. Cloud computing environment should support engineers to configure PLC, RTU logic creation, input/output signals configuration and engineering activities such as communication and networking configuration. Engineers should be able to create HMI configurations such as alarms, events, trends and graphic displays. The configured logics, communication and networking settings should be deployed to PLC, RTU and IO modules in SCADA system. The configuration such as control logic, communication and networking settings deployed to PLCs, IO modules and RTUs from engineering tools hosted in Cloud computing environments via Edge device located in customer owned industrial plant.

The Cloud hosting environment shall also host HMI operator workstations to visualize plant data and control the industrial plant process equipment remotely. Operators should be able to monitor process data in the form

of alarms, events, trends, graphic displays, and faceplates. The Graphic displays created for monitoring industrial control process could be viewed via web browser.

The Cloud environment shall support analysis of industrial data using advanced analytics tools to transform the industrial data into meaningful insights to empower industrial users to make effective decisions. Cloud environment shall also facilitate the implementation of Artificial Intelligence and Machine Learning technologies for more advanced solutions for industrial problems.

To reduce the space or storage constraints limited by Edge devices, Cloud computing environments shall facilitate large storage capacity for industrial process data that are acquired from various process devices from SCADA environments.

Containerized SCADA system consists of Edge device which is located closer to industrial control room. Edge devices should be capable of supporting establishing connections with connectivity servers of SCADA system and collecting process data. Edge devices should be capable of supporting various industrial protocols such as OPC UA, Modbus etc. Edge devices could be built using Containerization technologies such as Docker and Kubernetes.

Edge devices could be built on a physical platform as well as virtual platform. Edge devices which are built on top of virtual platforms could provide opportunities to create a more secure Containerized SCADA environment. It is more secure when the Edge is hosted on Virtual platform as attackers must penetrate the host virtual platform and then to an actual Virtual Edge which is difficult to break security of Edge. Docker is very popular to set up Containerized eco systems. Containerization provides portability, isolation, efficiency and security and hence it is more reliable. Portability ensures consistent performance across different variants of environments, isolation allows containers to execute independently so that when one container is down, it will not impact on other running container functionality. Containerization provides isolation and a minimal attack surface for cyber security issues, so it offers better security. Important key components of Docker include Docker engine, Docker image, Docker hub, Docker file and Docker registry. Docker engine is the heart of the containerized platform as it manages the creation of containers and execution of containers. Docker image serves as blueprint or template which is useful to create containers. A Docker hub is a Cloud service which is mainly used to store and share container images among various developer communities. Docker file is a script used for building images. Docker registry is a centralized location for storing Docker images.

Since there could be possibilities of having a greater number of Docker containers in an Edge system, it is often very common and efficient to use orchestration techniques such as Kubernetes. Kubernetes manages orchestration of large number of containers seamlessly and helps software developers to quickly deploy their applications on Container-based Edge platform.

Edge device collects process data and sends it to Cloud through internet. Edge device provides a data filtering mechanism to ensure only desired data is sent to Cloud. This helps organizations to ensure internet bandwidth is utilized efficiently and reduce the cost of operation.

Cloud computing is built using Virtualization technology which is accompanied by remote servers to store, manage and access data through the internet online. Cloud computing has many important characteristics such as agility, high availability and reliability, high scalability, device and location independence, multi-sharing, low cost of usage, ease of usage and pay per use model. Agility characteristic helps for faster sharing of resources, high availability and reliability characteristics ensure less failures and downtime of Cloud connectivity, high scalability characteristic ensures seamless provisioning of resources as per the demand of the users, multi-sharing characteristic ensures efficient resource sharing among users, it is possible to access Cloud resources from anywhere across the world. Cloud computing environment offers pay per use-based billing model and hence, it is also cost effective to use Cloud computing environment and it is also easy to maintain.

Edge device relies on stability and reliability of internet connection to effectively transfer data from control room in industrial plant to Cloud. A Cloud computing environment should be designed to host SCADA control, HMI tools, Runtime SCADA monitoring and operations workplace, GIS monitoring. The process data available in the storage of Cloud environment could be utilized by advanced analytics tools, AI & ML technology-based tools to provide meaningful insights and information to industrial plant users. Such advanced analytics tools help industrial plants to optimize their assets to efficiently deliver production by reducing downtime.

Machine Learning:

Machine Learning (ML) is a branch of Artificial Intelligence (AI) that deals with empowering computers and machines to imitate the learning and perform tasks autonomously similar to humans who learn and perform their tasks, thereby improve performance and accuracy of computers and machines through experience and exposure to vast amount of collected data.

Artificial Intelligence (AI):

Artificial Intelligence is a technology which provides abilities and empowers computers, robots and smart electronic systems to simulate human capabilities such as learning, decision-making, creative thinking, problem solving, speech recognition, image recognition and autonomy. Computers and machines should be capable of simulating human capabilities and performing tasks. AI combines technologies such Machine Learning, Deep Learning, and Natural Language Processing (NLP) to simulate human-like capabilities.

AI systems are carefully designed and developed to simulate human-like intelligence and perform tasks autonomously. AI has four important parts such as learning, reasoning, perception and Natural Language Processing (also called NLP).

Learning characteristics of AI ensures with vast amount of collected data, AI systems can learn and improve their performance over time. AI comprises important techniques as its subset such as Machine Learning, where algorithms are trained on very large datasets to identify important patterns from those datasets and make predictions. After learning using large data sets, reasoning characteristics of AI systems aims to make better decisions based on logical rules, and algorithms, draw conclusions and solve simple to complex problems. The Perception characteristic of AI systems have capability to interpret and understand sensory data collected in its database such as texts, images, and sounds from real world. Computer Vision is used for image recognition and speech recognition is used to identify sounds. The fourth characteristic of AI ie Natural Language Processing (NLP) which is a subset of Artificial Intelligence that uses Machine Learning models to interpret and communicate with the language that human understands. Language translation, sentiment analysis, and text generation are some of the core concepts for NLP.

4. Adopting Containerization in Industrial Automation

Adopting containerization in industrial automation requires a deep understanding of operating systems, containerization technology and its management and needs expertise on industry 4.0 technologies. However, there are some very important considerations that needs to be understood such as assessment and Planning, choosing the right containerization tools, containerizing applications, integration with existing systems, deployment and monitoring, scaling and load balancing.

4.1 Stages in adopting containerization in industrial automation:

A) Assessment and Planning stage: It involves evaluation of current infrastructure where assessment of existing industrial automation systems, software, and hardware takes place to identify areas that could benefit from containerization technology and industry 4.0 technologies. The next step is to define objectives by setting clear goals for adopting containerization, such as improving scalability, reducing downtime, or enhancing security. It is necessary to select suitable applications by identifying applications and processes that are suitable for containerization. It is vital to focus on the aspects that require frequent updates or have scalability needs.

B) Choosing the Right Containerization Tools:

Docker could be used to create, deploy, and manage containers. Docker provides a consistent environment for applications, making it easier to develop and deploy across different platforms.

Kubernetes is one of the very popular orchestration platforms which is used to deploy and manage large number of containers seamlessly and efficiently. Therefore, implementation of Kubernetes for container orchestration helps to automate the deployment, scaling, and management of containerized applications, ensuring high availability and efficient resource utilization. To manage containerization more effectively, consider additional tools such as Helm for managing Kubernetes applications.

C) Containerizing Applications:

Develop Docker images for each application component such as Modbus connectivity, OPC UA connectivity, proprietary driver connectivity, popular SCADA protocols connectivity, including all dependencies and configurations. Use Docker files to define the build process. Connect mentioned above such as Modbus connectivity, connectivity refers to executable container that is capable to connect with process devices using Modbus protocol and collect data to Edge device and then store the device locally on Edge device storage or forward data to Cloud. Similarly, it is necessary to build containers for all protocols such as OPC UA and other SCADA protocols to connect with process devices and collect data and then store them on Edge device or forward the collected data to Cloud.

Microservices Architecture should be utilized to break down a large unmanageable monolithic application into easily and seamlessly manageable, smaller, independent microservices that can be containerized and managed separately.

D) Testing and Validation:

Test containerized applications in a staging environment to ensure they function correctly and meet performance requirements as per customers' expectations. Test if containerized platform meets cyber security requirements to prevent the system from cyber security attacks. Testing containerized system needs new skill sets as it involves monitoring of containers health, container performance, overall performance of container-based system, Docker and Kubernetes configurations, interaction between containers, resilience of containerized platform after failure. Testing container-based applications and systems needs usage of new tools.

E) Integration with Existing Systems:

To integrate containerized platform with SCADA based industrial system, It is vital to implement networking and connectivity, data management, security effectively. Establish connectivity to ensure that containerized applications gain capabilities to communicate with existing systems and devices. Implements networking solutions such as Docker Networking and Kubernetes Services.

To ensure data management is established and managed successfully and effectively, implement persistent storage solutions for containers. Tools such as Kubernetes Persistent Volumes and Docker Volumes could help to achieve data management. Regularly assess containerized platform-based solution and apply security best practices, such as using secure images, implementing network policies, restricting unauthorized users to access containers, providing privilege to operate container platform based on user roles, and regularly scanning for vulnerabilities.

F) Deployment and Monitoring:

To speed up software development, testing and delivery of products quickly to customers, it is very important to ensure implementation of automation in software development process. Continuous Integration/Continuous Deployment (CI/CD) pipelines should be created to automate the build, test, and deployment processes. Many tools are available for CI / CD activities such as Jenkins, GitLab CI, and Azure DevOps which could be utilized to integrate with Docker and Kubernetes based containerized solutions.

Monitoring and Logging activities are very important to perform deep investigation of containerized platform-based solutions. It is very important to understand how each individual container is performing during runtime operations, how two or more containers are interacting with each other, the hardware resource utilization such as memory, hard disk, CPU, memory leaks in the containerized platform, errors and exceptions which are reported by containers during runtime. Monitoring tools such as Prometheus and Grafana / OTEL (Open Telemetry) could be utilized to track the performance of containerized applications. Implementation of logging solutions such as ELK Stack (Elasticsearch) for centralized log management.

G) Scaling and Load Balancing:

In containerized platform-based solutions, there could be possibilities of raising and reducing of demand of resources. Therefore, it is important to implement and configure auto-scaling and load balancing to handle varying workloads efficiently and seamlessly. Kubernetes Horizontal Pod Autoscaler and Ingress Controllers could help manage traffic and scale applications more effectively.

4.2 PLC Programming and SCADA Design in Containerization:

Containerization of PLC programming environments and SCADA software systems provide opportunities to deploy consistently across different platforms. This ensures that the software runs reliably irrespective of the underlying infrastructure. By implementing microservices architecture PLC and SCADA systems are broken into microservices that allow individual components (e.g., data acquisition, processing, visualization) to be containerized and managed independently. This enhances modularity and scalability of PLC and SCADA systems. Deploying Edge devices that consist of containerized applications at the industrial plant allows for real-time data processing and decision-making closer to the source by reducing latency and improving system responsiveness.

4.3 Benefits of Containerization in Industrial Automation:

It improves portability due to a consistent environment with cross-deployments. Containers ensure that applications run consistently across different environments, from development to production, reducing compatibility issues. Containers can be deployed on various platforms, including on-premises, Cloud, and hybrid environments, providing flexibility in infrastructure choices. Scalability is one of the most useful achievements with containerization. It is possible to achieve dynamic scaling of containers where each container has capabilities to be scaled independently. Dynamic scaling of containers means scaling of containers either scale up or scale down based on demand. Scaling ensures optimal resource utilization and cost efficiency. Microservices architecture allows individual components to be scaled independently, improving overall system performance.

A) Resource Efficiency:

Two important characteristics of containers are lightweight and higher density. Containers share the host OS kernel which make them more lightweight compared to Virtual machines and lead to better resource utilization. Higher density means more containers can run on a single host which helps to maximize the use of available hardware and reduce infrastructure costs.

B) Faster Development and Deployment:

Containers can be quickly started, stopped, and replicated, enabling faster deployment of applications and updates. Continuous Integration/Continuous Deployment (CI/CD): Containers integrate seamlessly with CI/CD pipelines, automating the build, test, and deployment processes, leading to shorter development cycles.

C) Isolation and Security, network segmentation, access control and security updation:

Containers provide strong isolation between applications, ensuring that issues in one container do not affect others. Containerization includes security features like namespaces and control groups, which enhance the security of applications by isolating them from the host system and each other. Containerization is effective in mitigating security risks by isolation of applications and their dependencies. It is also very effective in limiting attack surfaces, enabling easier security patching process and frequent updates. Containerization is effective in facilitating network segmentation and access control implementation for improved security. One of the important characteristics of containerization is the isolation of containers which means any fault in one container will not affect other running containers. All isolated containers are capable to run seamlessly in their own environments, so they are also called self-contained. Therefore, if any container is compromised with security due to attack by malicious code, then it will not impact or affect other running containers. Containers provide enhanced functionality for defining security permissions, providing strong control over what can and cannot enter containers which results in better container security.

D) Simplified Management:

Orchestration and version control could be implemented to simplify the management process of containerization solutions. Tools such as Kubernetes automate the management of containerized applications, including deployment, scaling, and monitoring, reducing the operational burden. Containers simplify version control and rollback processes, making it easier to manage application updates and configurations.

E) Integration with Containerization:

Deployment from Vendor Location brings more convenience to customers and provides more control on their assets. Remote Deployment of modern containerized SCADA and PLC systems can be deployed and

configured remotely from the vendor's location. This includes remote configuration where vendors can configure PLCs and SCADA systems remotely using secure connections.

- F) Cloud-Based Solutions:** Cloud platforms should be utilized to host SCADA control, HMI tools, and engineering applications. Security Compliance with IEC 62443 Standards provides a series of standards that address security for operational technology in automation and control systems. These standards cover both technical and process-related aspects of security. The key aspects of Cloud security is to conduct thorough risk assessments to identify potential security threats and vulnerabilities. Implement security measures based on defined security levels to protect against identified risks. Ensure strict access control mechanisms to prevent unauthorized access to the system. Segment networks to limit the spread of potential security breaches. Regularly update and patch systems to protect against known vulnerabilities. Develop and implement incident response plans to address security breaches effectively. Benefits of Cloud includes enhanced security and hence it protects industrial systems from cyber threats and unauthorized access. It ensures compliance with international security standards, enhance trust and reliability. It reduces the risk of disruptions due to security incidents, ensuring continuous operation.

5. Comparison of containerized versus non-containerized environments:

In Containerization, applications code, runtime, system tools and libraries are together bundled into a single package which is called as a container, this mechanism allows containers to run on different platforms seamlessly that supports container runtime. In non-containerized deployments, applications are directly installed on a system which leads to environment inconsistencies and portability issues. So, it requires careful configurations to be made to run applications on different platforms in non-containerized applications. So, environment consistency and portability are high in container applications and is low in non-containerized applications.

Containers are designed to share the host operating system's kernel which effectively reduces the overhead and resource consumption resulting in better efficiency in managing resources as compared to Virtual machines. Therefore, Containerization has better resource usage compared to non-containerized applications. Containerization facilitates up scaling and down scaling of containers which makes it very suitable for microservices and scalable architectures. Containers can be quickly started, stopped, and replicated which results in seamless scaling of applications in response to demand. By using container orchestration tools such as Kubernetes scaling applications can be achieved easily. Virtual machines that are part of non-containerized applications also offer scalability but are more resource-intensive and take longer to start which limits the number of VMs that can be added, so they are less suitable for microservices and distributed applications. VMs take longer to spin up when the load increases and hence it reduces responsiveness.

CONCLUSION:

It is observed from above information that the non-containerized environments are becoming less effective in recent days to solve industrial challenges as they have issues with portability, scalability, security, stability, agility, responsiveness, and resource consumption. It will also become difficult in future to provide innovative solutions to industrial customers using traditional SCADA systems that use traditional and less effective non-containerized applications. So, it is good to explore the latest technologies available today that foster innovation, care, curiosity and help to solve industrial customers' problems more efficiently and effectively. The adoption of Containerization in industrial automation represents a significant transformative step towards achieving better productivity, scalability, and security in manufacturing and industrial operations. By leveraging technologies such as IIoT, Docker and Kubernetes, industries can ensure consistent, scalable, portable, light weight, secured, stable, efficient and isolated environments for applications, facilitating seamless deployment and management. This approach not only enhances the reliability and performance of automation systems but also supports the integration of advanced technologies such as Artificial Intelligence, Machine Learning and Cloud computing to SCADA system that have capabilities to bring innovative solutions to industrial customers. As industries continue to evolve, Containerization will play a pivotal role in driving innovation, reducing operations costs, and ensuring sustainable growth in the era of Industry 4.0. As it is well known in Digital era that the phrase "the data is the new oil" which signifies that the growing vast data from industrial control systems has hidden huge potential to transform the data into meaningful insights. So, with a vast set of data, it is possible to drive innovation to solve various industrial customers problems, effective

decision making and economic growth. So, it is very important to consider the I4.0 technologies integration with SCADA system for effectively and efficiently serving industrial customers to improve productivity, generate more Return on Investments, effectively manage industrial assets and human resources and reduce costly downtime in industrial processes.

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