the confidentiality, integrity and availability of data.

iv) Interference:- Wireless communication in WSN can be susceptible to interference from other wireless devices or radio signals, which can degrade the quality of data transmission.

v) Deployment challenges:- Deploying WSN can be challenging due to the need for proper sensor placement, power management, and network configuration, which can require significant time and resources.

SCADA :-

Supervisory Control and Data Acquisition

SCADA is a computer system designed to gather and analyse real-time data. It is used to control and monitor the equipment and manufacturing processes in various industries in different fields such as water and waste control, telecommunications, oil and gas refining, power generation and transportation. SCADA systems were used for the first time in 1960s.

SCADA controls the functioning of equipment involved in manufacturing, production, fabrication, development, and more. It is

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also used for infrastructural processes such as gas and oil distribution, electrical power distribution, water distribution, and more. Thus, it has reduced human intervention to a great extent.

Furthermore, it is also used by industrial organizations to accomplish the following tasks.

- To control industrial processes locally as well as at remote locations.
- To monitor, gather and process real-time data.
- To interact with devices such as sensors, valves, motors, pumps and more using human-machine interface (HMI) software.
- It comprises both software and hardware.

Different industries have different requirements, so there may be some differences in their SCADA systems, but still, some features are common for all, such as:

- Graphic interface
- Process mimic
- Real-time checking
- Alarm system
- Data acquisition
- Data analysis
- Report generator

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How SCADA Systems Works :-

Let us take an example of a leak of pipeli When a pipeline starts leaking, the SCADA system gathers information and forward it to a central site and thus alerts the home station about the leak. It also analyses the situation, such as how big is the leak and how much water is being released.

A SCADA system can be very simple such as which are used to monitor the environmental conditions of a small office building or complex or can be very advanced such as which are used to monitor the activity in a nuclear power plant or the activity of a municipal water system.

What is SCADA?

It is a category of software applications for controlling industrial processes, which is the gathering of data in Real Time from remote locations in order to control equipment and conditions. SCADA provides organizations with the tools needed to make and deploy data-driven decisions regarding their industrial processes.

One of the most commonly used types of industrial control system, SCADA can be used

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to manage almost any type of industrial process.

SCADA systems include hardware and software components. The hardware gathers and feeds data into field controller systems, which forward the data to other systems that process and present it to a human-machine interface (HMI) in a timely manner. SCADA systems also record and log all events for reporting process status and issues. SCADA applicati warn when conditions become hazardous by sounding alarms.

Components of SCADA system:-

SCADA systems include components deployed in the field to gather real-time data, as well as related systems to enable data collection and enhance Industrial automation. SCADA components include the following:-

- Sensors and actuators: A sensor is a feature of a device or system that detects inputs from industrial processes. An actuator is a feature of the device or system that controls the mechanism of the process. In simple terms, a sensor functions like a gauge or meter, which displays the status of a machine; an actuator acts like a switch, dial or control valve that can be used to control a device. Both

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sensors and actuators are controlled and monitored by SCADA field controllers.

- SCADA field controllers :- These interface directly with sensors and actuators. These are two categories of field controllers :

1. Remote telemetry units, also called remote terminal units (RTUs), interface with sensors to collect telemetry, data and forward it to a primary system for further action.

2. Programmable logic controllers (PLCs) interface with actuators to control industrial processes, usually based on current telemetry collected by RTUs and the standards set for the processes.

- SCADA supervisory computers :- These control all SCADA processes and are used to gather data from field devices and to send commands to those devices to control industrial processes.

- HMI software :- This provides a system that consolidates and presents data from SCADA field devices and enables operators to understand and if needed, modify the status of SCADA-controlled processes.

- Communication infrastructure :- This enables SCADA supervisory systems to communicate with field devices and to control those devices.

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SCADA is sometimes compared with the industrial internet of things, and while there is considerable overlap, the two terms are different. SCADA vendors tend to provide more complete, monolithic monolithic systems with tight integration across levels and devices, while IIOT vendoss are likely to provide greater interoperability, and more options for deploying systems and devices across an organization.

	SCADA	IIOT
Interopurability	Likely to use proprietary communication protocols for controlling components	Interoperability through standard internet protocols
Sensors & Actuators	Usually wired connection typically connected directly to field controllers	Wired or wireless, may not be directly connected to field controllers.
Data Collection	Usually collected directly from controllers on premises	May be collected in cloud or on premises.
Integration	Proprietary vendor lock-in many affect ability to integrate cross-vendor devices or software	Adherence to open standards enables integration of different devices, software

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Features of SCADA systems :-

Although SCADA systems may include special features for specific industries or applications, most systems supports the following features :-

- Data acquisition :- It is a foundation of SCADA systems; sensors collects data and deliver it to field controllers, which, in turn, feed data to the SCADA computers.

- Remote Control :- It is achived through the control of field actuators, based on the data acquired from field sensors.

- Networked data communication :- It enables all SCADA functions. Data collected from sensors mus be transmitted to SCADA field controllers, which, in turn, communicate with the SCADA supervisor computers; remote control commands are transmitt back to actuators from the SCADA supervisory computers.

- Data presentation :- It is achieved through HMIs, which represent current and historical data to the operators running the SCADA system.

- Real-time and historical data :- These are both important parts of the SCADA system, as they enable users to track current performance against historical trends.

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- Alarms :- They alert SCADA operators to potentially significant conditions in the system. Alerts can be configured to notify operators when processes are blocked, when systems are failing, or when other aspects of SCADA processes need to be stopped, started or adjusted.

- Reporting on SCADA system operations can include reports on system status, process performance and reports customized to specific uses.

SCADA architecture :-

SCADA systems operate at five of the six levels defined in Purdue Enterprise Reference Architecture for enterprise integration:

- Level 0:- The field level includes field devices such as sensoss, used to forward data relating to field processes and actuators used to control processes.

- Level 1 :- The direct control level includes local controllers, such as PLCs and RTUs, that interface directly with field devices, including accepting data inputs from sensors and sending commands to field device actuators.

- Level 2:- The plant supervisory level includes

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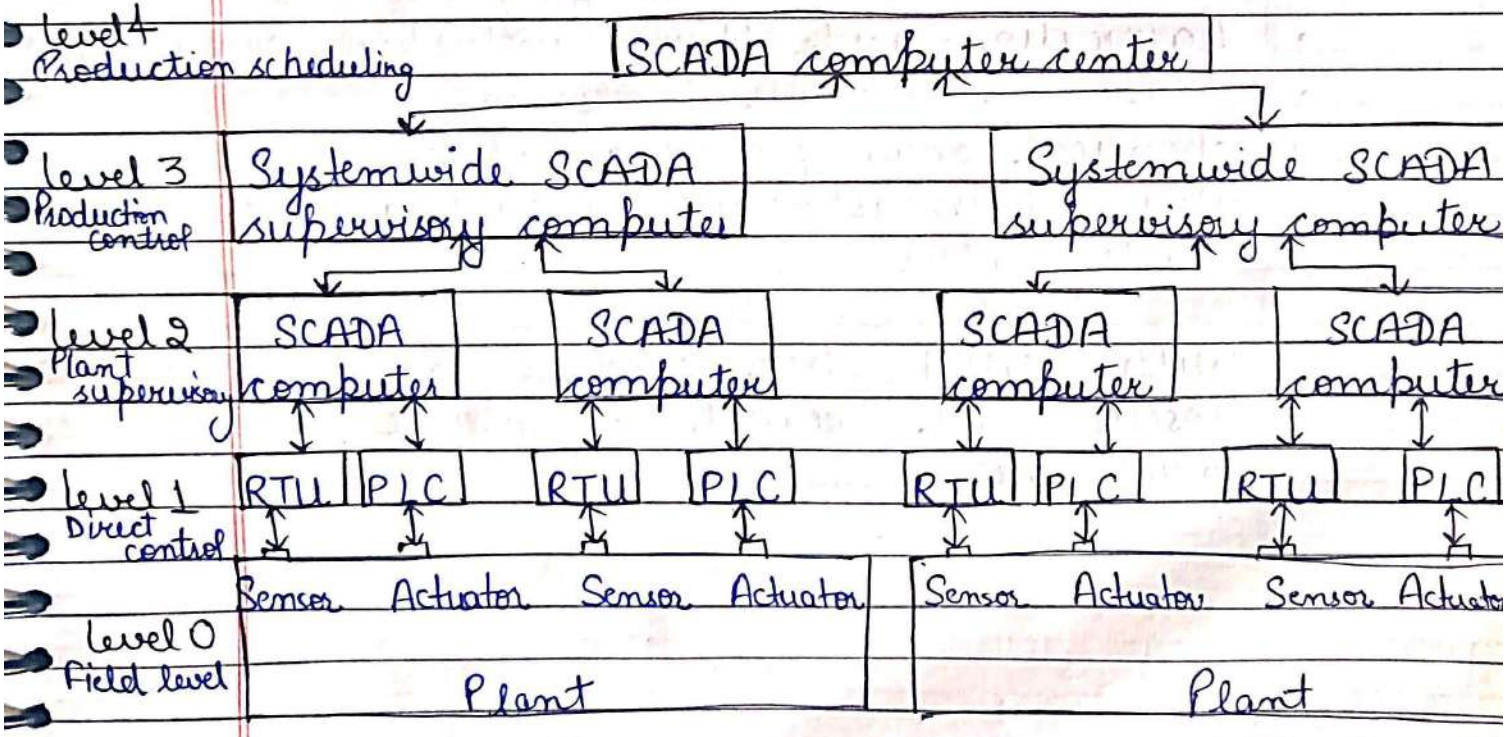
local supervisory systems that aggregate data from level controllers and issue commands for those controllers to carry out.

- Level 3:- The production control level includes systemwide supervisory systems that aggregate data from Level 2 systems to produce ongoing reporting to the production scheduling level, as well as other site or regionwide functions, like alerts and reporting.

- Level 4:- The production scheduling level includes business systems used to manage ongoing processes.

Layers of the SCADA system architecture



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SCADA use cases and industry examples.

SCADA is used to assist in automating and managing industrial processes that have become too complex or cumbersome for human monitoring and control. SCADA is particularly useful for processes that can be monitored and controlled remotely, especially in cases where it is possible to reduce waste and improve efficiency.

Some common industry examples of SCADA industrial automation are the following:

- electricity generation and distribution;
- oil and gas refining operations;
- telecommunications infrastructure;
- transportation and shipping infrastructure;
- fabrication and other industrial processing;
- food and beverage processing;
- chemical manufacturing; and
- utilities infrastructure, including water and waste control.

With SCADA, these processes can be monitored closely and tweaked to improve performance over time.

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Evolution of SCADA architecture

The history of SCADA parallels the history of enterprise computing. The earliest SCADA system were implemented in large industrial enterprises as they first started to integrate mainframe computing resources with industrial processes.

As computing networking and process monitoring and control system have improved, SCADA evolved through the following four stages:

1) First generation :- Monolithic systems. SCADA systems implemented in the 1960s and 1970s usually incorporated RTUs at industrial sites connected directly to mainframe or minicomputer systems, usually also on-site or connected over wide area network.

2) Second generation :- Distributed system. SCADA systems took advantage of wide availability of proprietary local area networks and smaller, more powerful computers during the 1980s to enable greater sharing of operational data at the plant level and beyond. However, the lack of open networking standards prevented interoperability across SCADA product vendors.

3) Third generation :- Networked systems. SCADA systems depended on greater interoperability provided by industry acceptance and incorporation of

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network protocol protocols during the 1990s. SCADA systems could be scaled more easily, as enterprises were able to integrate systems across their own industrial infrastructure, while using a wider variety of devices and systems.

4) Fourth generation :- Web-or IIOT-based systems. SCADA systems began appearing in the early 2000s as SCADA vendors embraced web software development tools to enable transparent interoperability and access via universally available interfaces, like web browsers running on handheld devices, laptops and desktop computers

As cloud computing increasingly dominates the enterprise computing world, it is also changing SCADA systems. SCADA systems can be scaled faster and more easily by allocating cloud computing resources as needed for surges and reducing those resources when demand drops

Benefits of modern SCADA :-

The benefits of updating legacy SCADA systems include the following:

- Scalability :- Modern SCADA systems are more scalable than legacy systems for several reasons, including better availability of supported hardware and software and

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use of cloud computing to meet workload demand.

- Interoperability :- Legacy SCADA systems rely on proprietary hardware and software, resulting in vendor lock-in.

- Communications :- Modern SCADA systems support more widely supported and modern communications protocols, which enable greater accessibility to SCADA data and controls.

- Support :- Legacy SCADA systems may have limited options for support, while modern systems are more likely to be well supported by vendors. Use of commercial off-the-shelf hardware, open networking standards and modern software development platforms makes third-party support more accessible as well.

RFID Protocol :-

It is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object or person. It uses radio frequency to search, identify, track, and communicate with items and people.

RFID (Radio Frequency Identification) is a technology

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