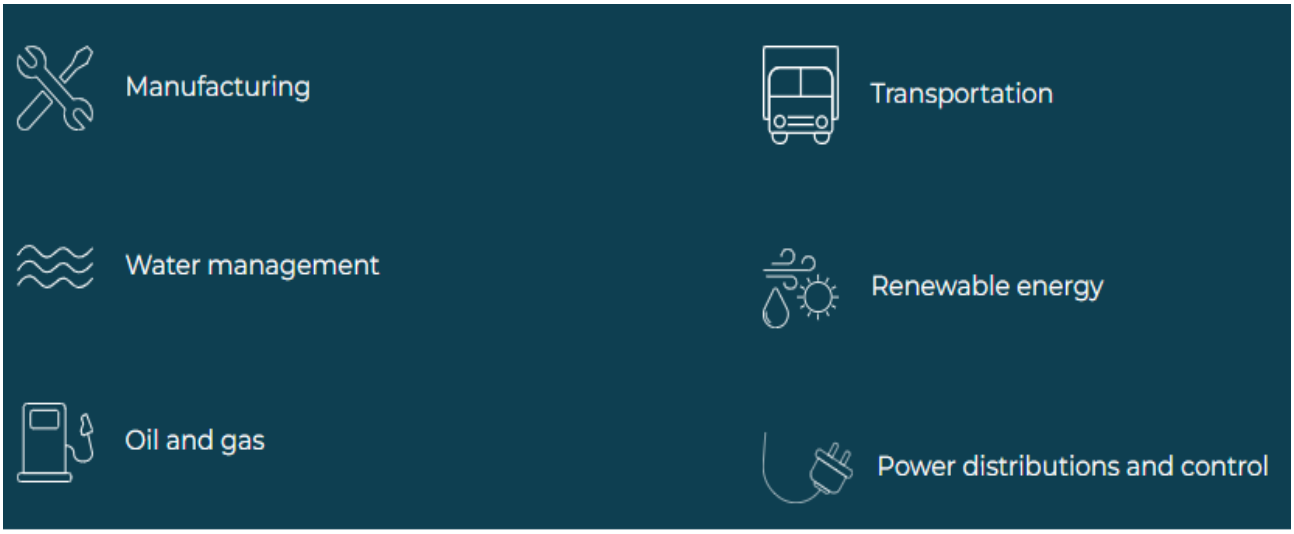
SCADA System

Supervisory Control and Data Acquisition (SCADA) (التحكم الإشرافى واستحصال البيانات) systems are used for controlling, monitoring, and analyzing industrial devices and processes. The system consists of both software and hardware components and enables remote and on-site gathering of data from the industrial equipment. In that way, it allows companies to remotely manage industrial sites such as wind farms, because the company can access the turbine data and control them without being on site.

Thus, SCADA systems are seen almost everywhere. Typically, SCADA systems are used in



In these industries, SCADA systems provide valuable information to key stakeholders (أصحاب المصالح / الملاك الرئيسيون). They can use the system to improve the performance of the industrial plants (المنشأت الصناعية), keep track of the plants' efficiency and mitigate errors and downtime (التوقف) through messages received from the system.

In today's industrial advanced world, SCADA systems are crucial (مهم/ حاسم) for operating industrial plants more efficiently, as they are much easier and faster in collecting essential data. This allows for better allocating of resources in many businesses.

Components of a SCADA system

SCADA systems include components deployed (منتشرة) in the field to gather real-time data, as well as related systems to enable data collection and enhance industrial automation (الأتمتة الصناعية). SCADA components include the following:

- **Sensors and actuators (اجهزة الاستشعار والمحركات) .** A sensor is a feature (ميزة او صفة) 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 sensors and actuators are controlled and monitored by SCADA field controllers.
- **SCADA field controllers (وحدات تحكم ميدانية).** These interface directly with sensors and actuators. There are two categories of field controllers:
    1. Remote telemetry (القياس عن بعد) units, also called *remote terminal units* (RTUs), interface with sensors to collect telemetry data and forward it to a primary (الاساسي) 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.

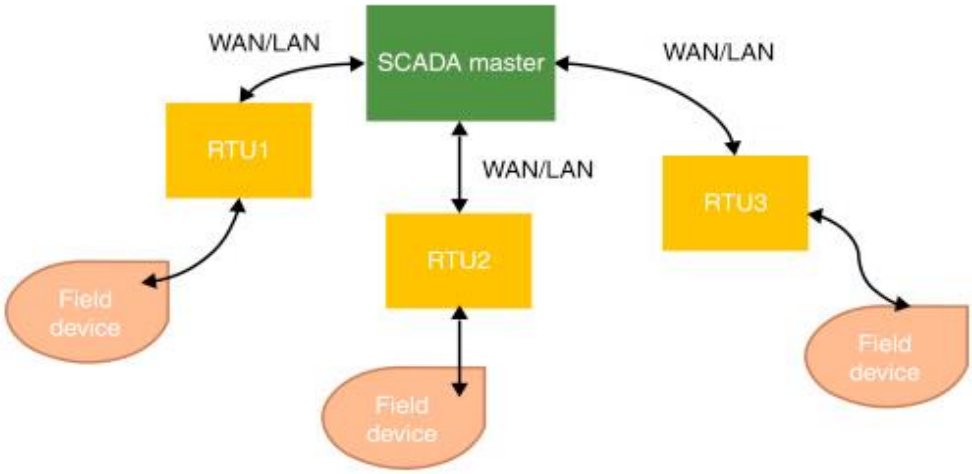
- **SCADA supervisory computers.** These control all SCADA processes and are used to gather data from field devices and to send commands to those devices to control industrial processes.
- Human Machine Interface (HMI): Generally, it refers to a screen or dashboard (لوحة القيادة) that communicates information, data and metrics (المقاييس) using graphics or visual representations (التمثيل البصري) of numbers. The screen is controlled by an operator who monitors and controls equipment and processes in factories and plants.
- **Communication infrastructure.** This enables SCADA supervisory systems to communicate with field devices and field controllers. This infrastructure enables SCADA systems to collect data from field devices and to control those devices.

SCADA system architecture

SCADA system architecture has been categorized in four type or generations:

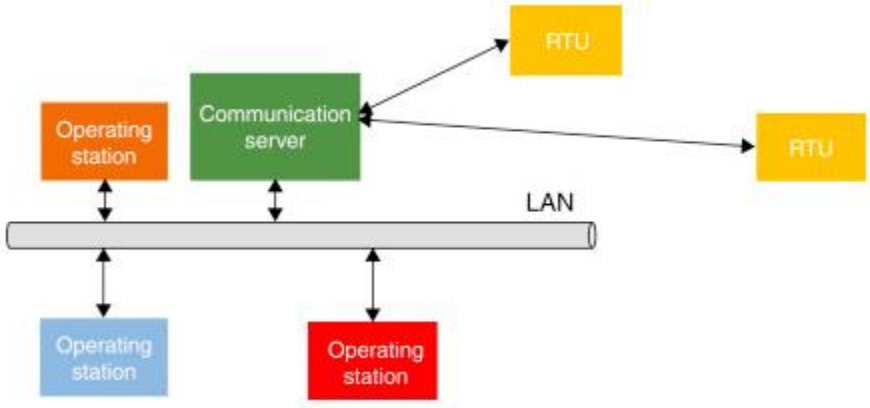
1. First generation – early SCADA

   An early generation of SCADA systems, based on mainframe systems, without no availability of networking and as almost "stand-alone (قائم بذاته)" systems, i.e., no direct connectivity to the other systems.



2. Second generation – distributed SCADA

An improved version with the advent (ظهور) of comparatively small sized computers, and mainly with a revolutionary change of networking, the LANs. The single SCADA system tasks were distributed among various small control systems, each was responsible to perform a specific task as a part of a complete process. Each station, (responsible for an individual task) was connected via LAN to perform information transfer among each other via LAN and the communication server in real time.



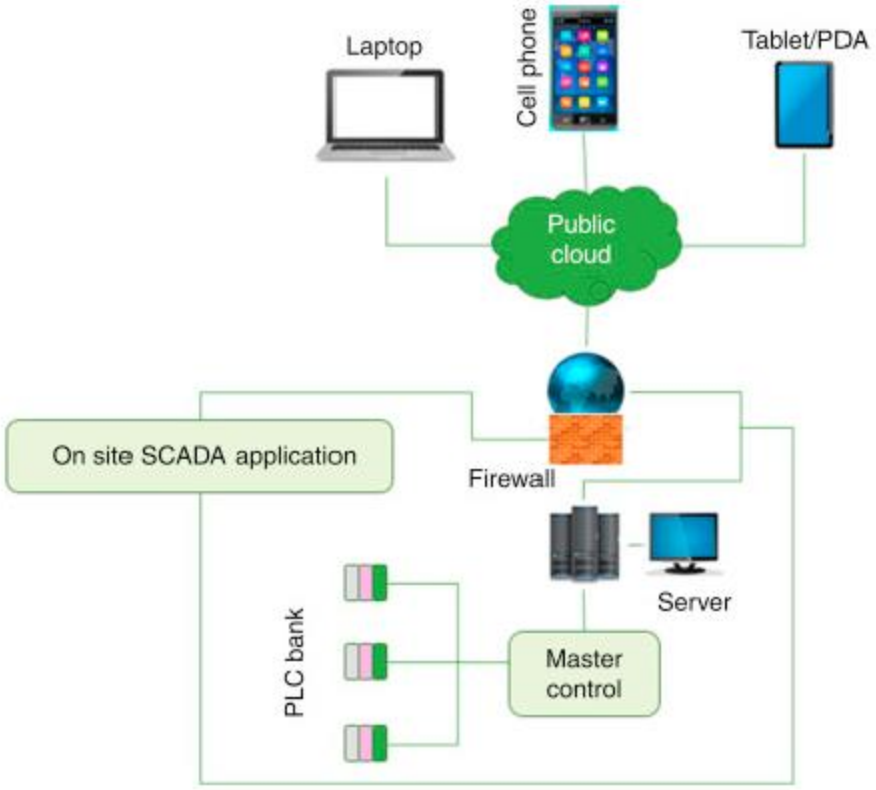
3. Third generation – networked SCADA

Much like second generation distributed SCADA, with a revolutionary change of standardized communication protocols. With the integration of many LAN networks, for example, a process control network (PCN) and the SCADA control made possible over a wide spread separated geographical location, where several distributed SCADA systems worked under the supervision of a single and centralized master SCADA system.

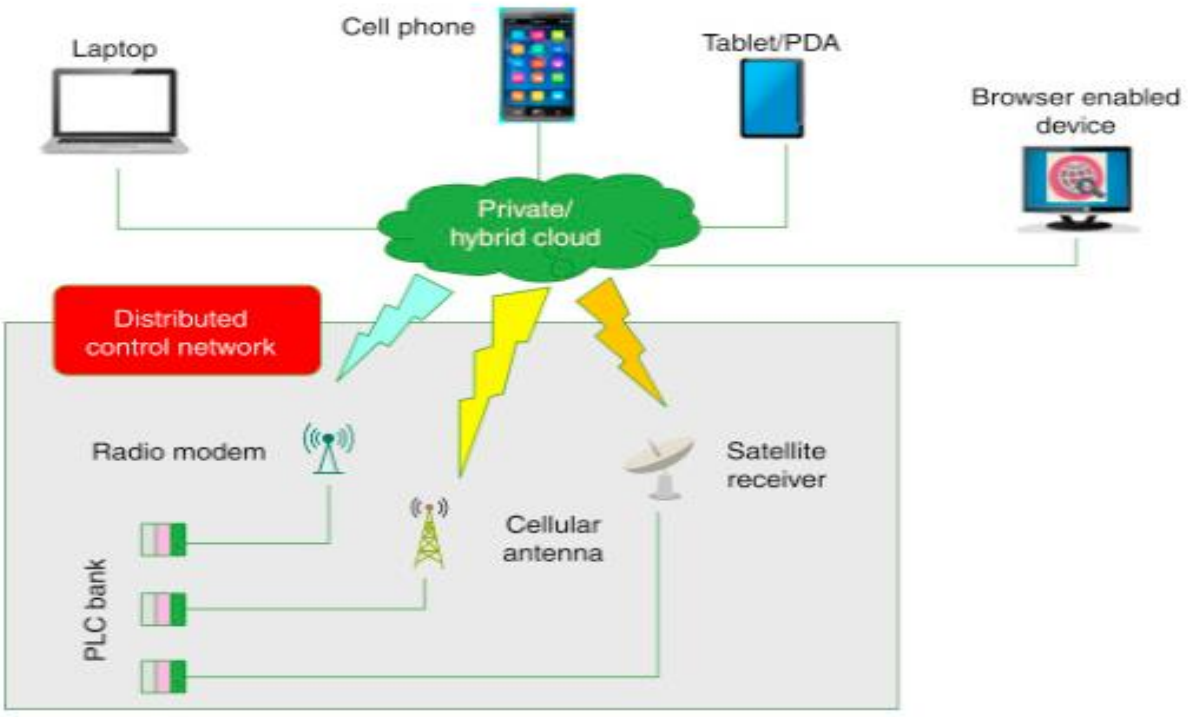
4. Fourth generation – "internet of things" SCADA.

The latest available generation of SCADA-based system, much like third generation, with a use of cloud computing termed as "internet of things technology." The concept of cloud computing is very popular these days at all levels of users, from professional to home individuals, the concept of using it with SCADA is relatively new to the field.

Cloud computing: is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the internet ("the cloud") to offer faster innovation (ابتكار), flexible resources, and economies (اقتصادي) of scale.



In the above figure, Public cloud SCADA, public cloud formation in which the SCADA system is running onsite and delivers data via the cloud. PDA, personal digital assistants; PLC, programmable logic controller.



In the above figure, Hybrid SCADA, a private/hybrid cloud in which the controllers are connected via wide area network (WAN) links to the SCADA application running entirely (بالكامل) in the cloud.

An example: Alarms and events in SCADA systems

Being able to react quickly to alarms and events can be vital (حيوي) for industrial plant operations. A typical scenario will be that the SCADA system notifies the plant operator in the HMI if something is not running correctly. Like a notification on your phone, the plant operator receives a message that he needs to react and assess the situation. If he makes the judgment that the equipment needs to be stopped, he can do that directly in the HMI, which sends commands to the PLCs or RTUs, which also sends through the commands and stops the equipment on site.

Why is a SCADA system important?

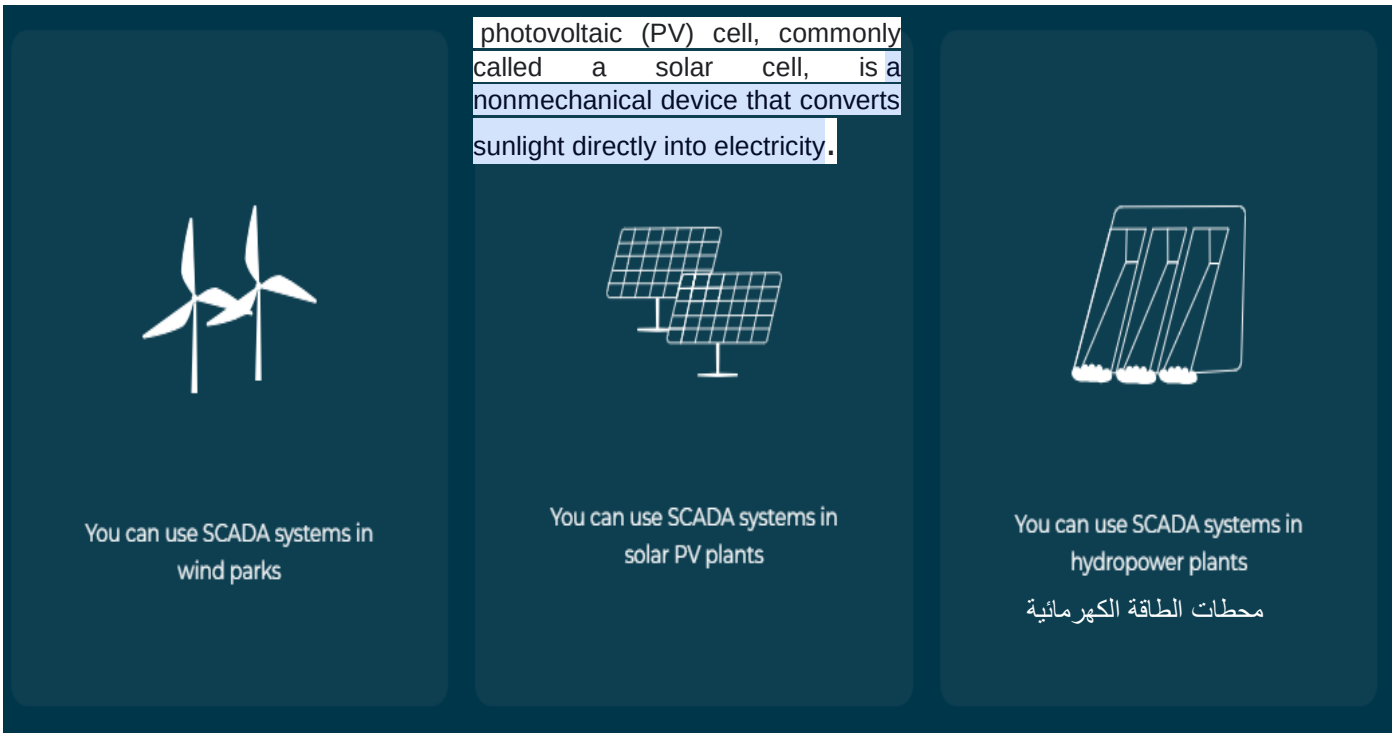
Overall (بالمجمل), SCADA systems help:

- optimize production (تحسين الانتاج) and control the production according to regulations (اللوائح) within the industry.
- In many cases, SCADA systems are also used for troubleshooting (استكشاف الأخطاء وإصلاحها) purposes, as maintenance has become a big part of securing a continuous production flow without too many errors.

To fully understand the importance of a SCADA system, we need to go back to when industrial plants were monitored manually and relied on personnel to be on site during production. The personnel had to oversee and control operations and react to emerging issues. This was not only costly but could be dangerous for the personnel. However, as industrial sites scaled up and became more remote, the need for more automatic solutions came about. Fast forward to today, the initial need for more automation (اتمتة/تشغيل الي) is still driving the SCADA development.

SCADA systems used with renewable energy sector

SCADA systems are today used at any wind power plant as they allow for remote monitoring and control of the wind turbines. As wind power plants or wind farms have grown in size, it is no longer possible or favorable to visit every wind turbine to collect data for monitoring and control purposes.



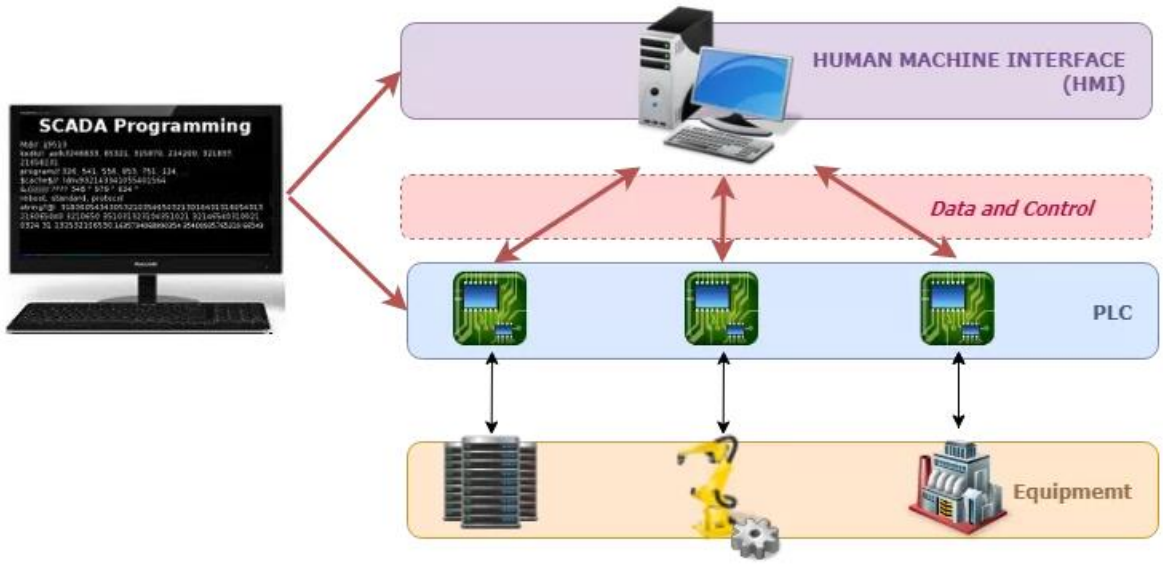
Offshore (البحرية) wind parks are also on the rise these years, which means remote access to the wind turbines becomes even more crucial. With a SCADA system, a lot of tasks can be performed without even visiting the wind turbine.

Other renewable power plants such as solar PV (Photovoltaic) or hydropower plants also rely on SCADA systems to gain remote access and control. These plants are often placed in remote areas, where it is both difficult and costly to bring personnel on site.

Another reason why SCADA systems are so essential in the renewable energy sector is that SCADA systems enable monitoring and control of the power production and power production loss. The demand for electricity from renewable power plants is growing day by day as the industry moves away from harnessing energy (تسخير الطاقة) from fossil fuels (الوقود الاحفوري) to more green alternatives.

How Do SCADA Systems Work?

Supervisory system gathers data on the process and sends the commands control to the process. The main goal of this supervisory system is to monitor and control equipment in the industrial processes for companies in the public and private sectors. As a matter of fact, in today's world, there are SCADA systems almost everywhere. This includes industrial plants, manufacturing, transportation, oil and gas, power distribution, water control and etc.



SCADA Diagram Example System with Main Components

Industries That Use SCADA Systems

Some of the industries that use SCADA in their daily operations include water and wastewater systems, electric generation, transmission and distribution systems and oil and gas systems. Manufacturing plants, food production facilities and mass transit systems also rely heavily on SCADA.

Modern SCADA systems are able to do more than simply collect data and operate devices. They use artificial intelligence (AI) to analyze data and make decisions without the help of humans. They are able to operate in a cloud environment so that SCADA monitoring and control can be accomplished remotely by using tablets and smartphones. Here are some additional details concerning what you can do with a SCADA system in various industries:

Water Systems

Water SCADA systems monitor and control the water being pumped at well sites and treated at water treatment plants. They also use it to fill overhead storage tanks. Additionally, water SCADA systems control booster pumps to regulate water pressure being delivered to customers.

Wastewater Systems

Wastewater SCADA systems monitor and control lift stations that are used to pump wastewater to treatment plants. Once the wastewater reaches the treatment plant, the treatment process is controlled step by step using SCADA. Wastewater SCADA

monitoring is also used to document operations and prepare reports that verify compliance with governmental regulations.

Electric Generation, Transmission and Distribution Systems

Electric generation SCADA software is used to monitor every phase of generating electricity from fuel input to electrical output. Such plants have to be able to respond instantaneously to fluctuations in demand. Electric transmission utilities use SCADA to monitor and control the amount of electrical power being transmitted over long distances.

SCADA is also used for safety and protection purposes. When a transmission line experiences a fault, the system will quickly attempt to clear the fault and restore power. Electric distribution systems also use SCADA to monitor and control electrical substations and distribution lines.

Oil and Gas Systems

Unlike electric and telecom systems, oil and gas SCADA systems move a physical substance through their infrastructure over a vast area. Oil and Gas SCADA is used to monitor well and pumping sites plus distribution pumping pressure and pipeline flow. In addition to using SCADA to monitor and control compressor stations, SCADA software is also necessary from a safety standpoint because it is used to detect anomalies and prevent catastrophic events from occurring.

Manufacturing Plant Systems

Manufacturing plant SCADA precisely control all plant operations. For instance, SCADA can be used to monitor and control temperature, pressure and humidity. It can also be used to monitor production lines to ensure that output goals are being met. SCADA can also control assembly line robots and monitor parts usage so that just-in-time inventory control can be implemented.

Food Production Systems

Food production SCADA applications are used to ensure food quality and meet production goals. All phases of food preparation are typically monitored and controlled. SCADA can be used to control the exact mix of ingredients as well as the time and temperature required to process foods. This prevents foods from being spoiled due to a heating process that was off by a few degrees. SCADA applications are also important in food production to document the fact that the production process meets industry standards and complies with governmental regulations.

Mass Transit Systems

Mass transit systems also rely heavily on SCADA. Railways, subways and tramways use it to time their operations and control their switches so that engines and cars can safely pass each other. Railroad crossing signals are also controlled remotely. Traffic control systems also rely on SCADA to improve traffic flow and maximize safety.

Buildings, facilities and environments

Facility managers use SCADA to monitor and control HVAC, temperature sensors, refrigeration units, lighting and entry systems.

Traffic signals

SCADA regulates traffic lights, controls traffic flow, and detects out-of-order signals.

Other processes include telecommunications, agriculture/irrigation, healthcare, pharmaceutical, and many others.

SCADA Vs. Industrial IoT (IIoT)

SCADA is sometimes compared with the industrial internet of things (IIoT), and while there is considerable overlap (تداخل), the two terms are different. SCADA vendors tend to provide more complete, monolithic (متجانس) systems with tight integration across levels and devices, while IIoT vendors are likely to provide greater interoperability (التوافقية او التشغيل البيني) and more options for deploying systems and devices across an organization.