Using Industrial Ethernet in the Oil and Gas Industry

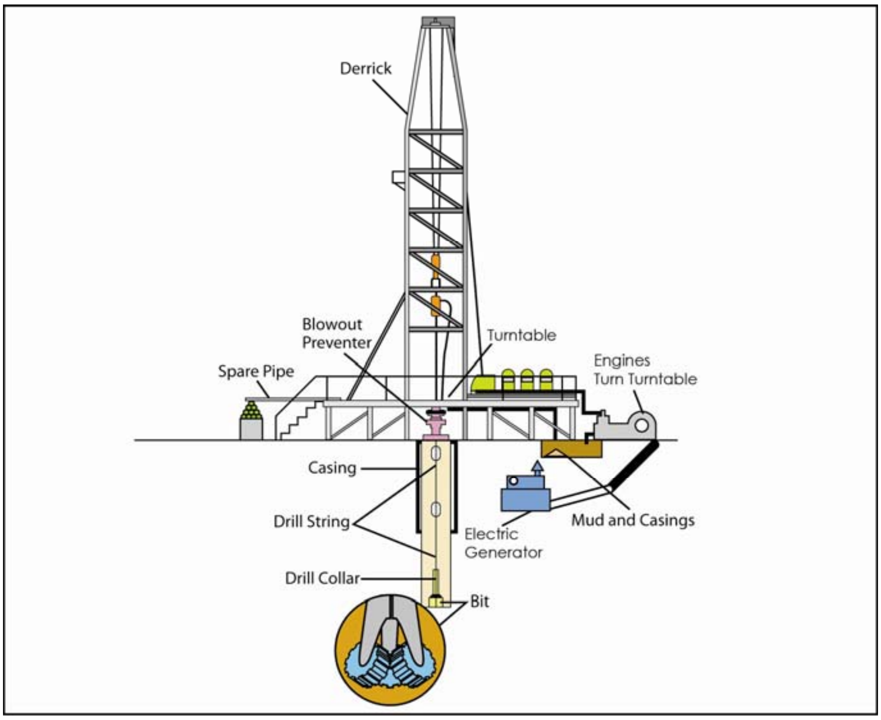
The oil and gas industry is experiencing a major boom around the world, thanks to the seemingly insatiable demand for fossil fuels in both developed and developing countries. However, drilling for, transporting, storing, refining, and exporting oil and natural gas remain incredibly complicated undertakings. These sophisticated operations require a great deal of industrial automation and industrial Ethernet solutions can play an important role.

How Drilling Operations are Monitored

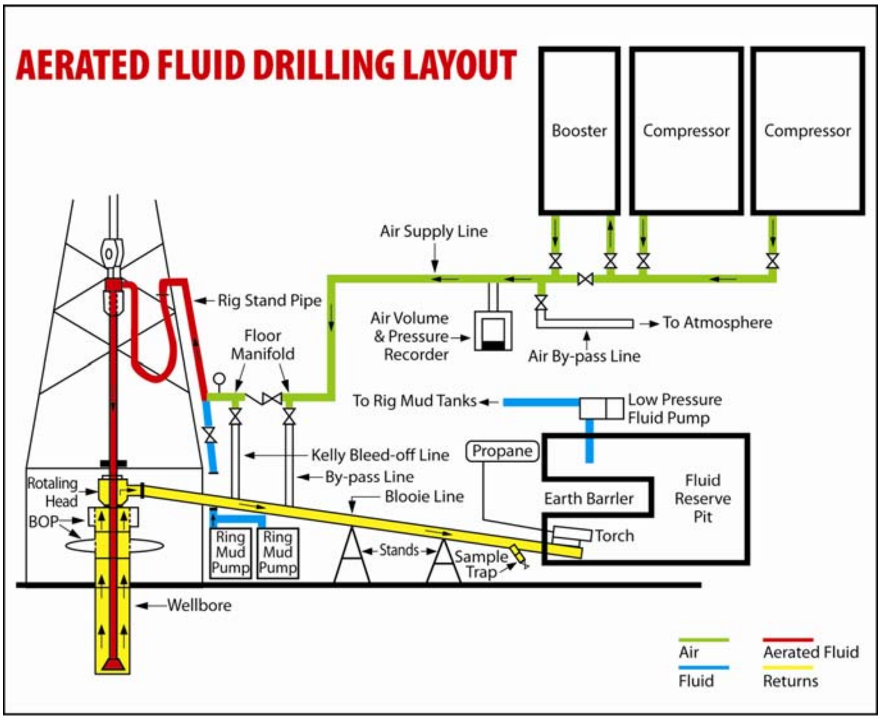
The Basics of Drilling

A drilling platform includes the oil rig, mud pump, drilling equipment, power supply, compressor, fire control equipment, and mud and water separator. If any of these fails, the drilling process will come to a screeching halt. In an effort to reduce the amount of downtime, oil companies have begun investing in monitoring devices to ensure that the production goes smoothly. With a good automation system in place, appropriate action can be taken immediately if an emergency arises.

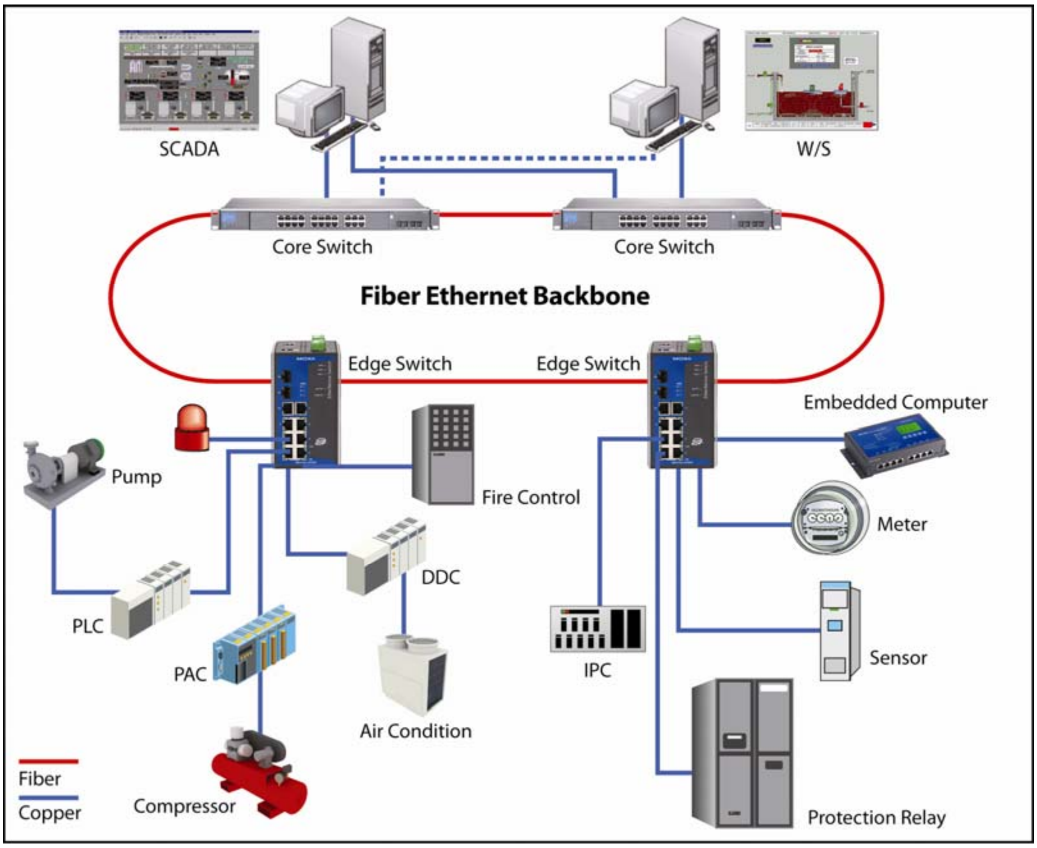
Industrial Ethernet is now used as the communication backbone for monitoring systems used in oil exploration. Ethernet is used to connect monitoring devices such as PLCs and sensors to the HMI/SCADA system, which is located in a central control room, to transmit essential device data including speed, temperature, pressure, flow speed, flow density, and other statistics for analysis or alerts.



Oil Rig



Fluid Drilling



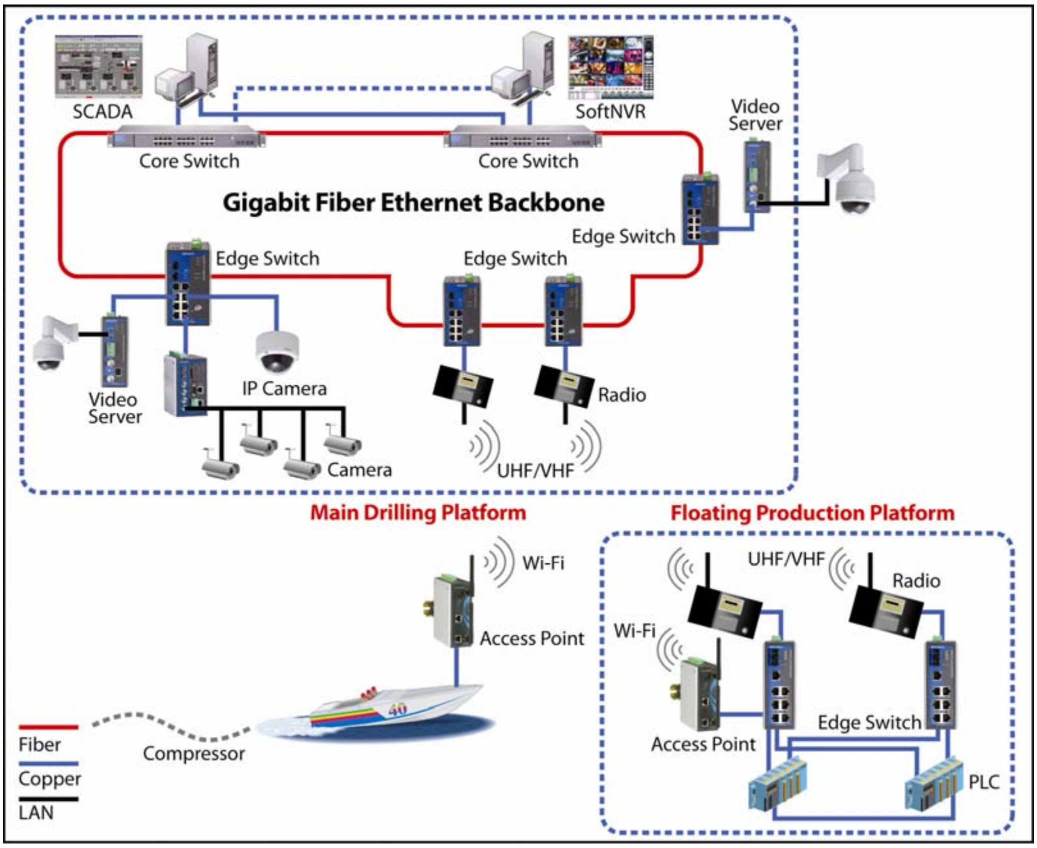
Ethernet-based Monitoring Network

Offshore Drilling Platforms

Offshore drilling platforms are substantially more complicated, and are more expensive to build and operate, compared with onshore drilling rigs. Part of the reason for the increase in complexity is because offshore drilling platforms require additional devices for monitoring and management in addition to automation devices for exploration. These include large scale cradles, ventilation equipment, air-conditioning systems, lighting facilities, drainage systems, and power facilities, which together turn an offshore drilling platform into a virtual city at sea.

Safety rules for offshore operations are based on extremely strict standards. A first line of defense is the CCTV surveillance system, which is used to monitor the overall safety of the platform and operators. Most offshore drilling platforms have independent CCTV surveillance systems, and some even integrate the CCTV system into the existing network backbone. However, IP surveillance solutions such as IP video servers and IP cameras are emerging as the new trend to replace traditional DVR systems, since the IP solutions offer greater installation flexibility and easier maintenance compared with traditional CCTV and DVR systems. PTZ cameras also make security monitoring and control more feasible and safer.

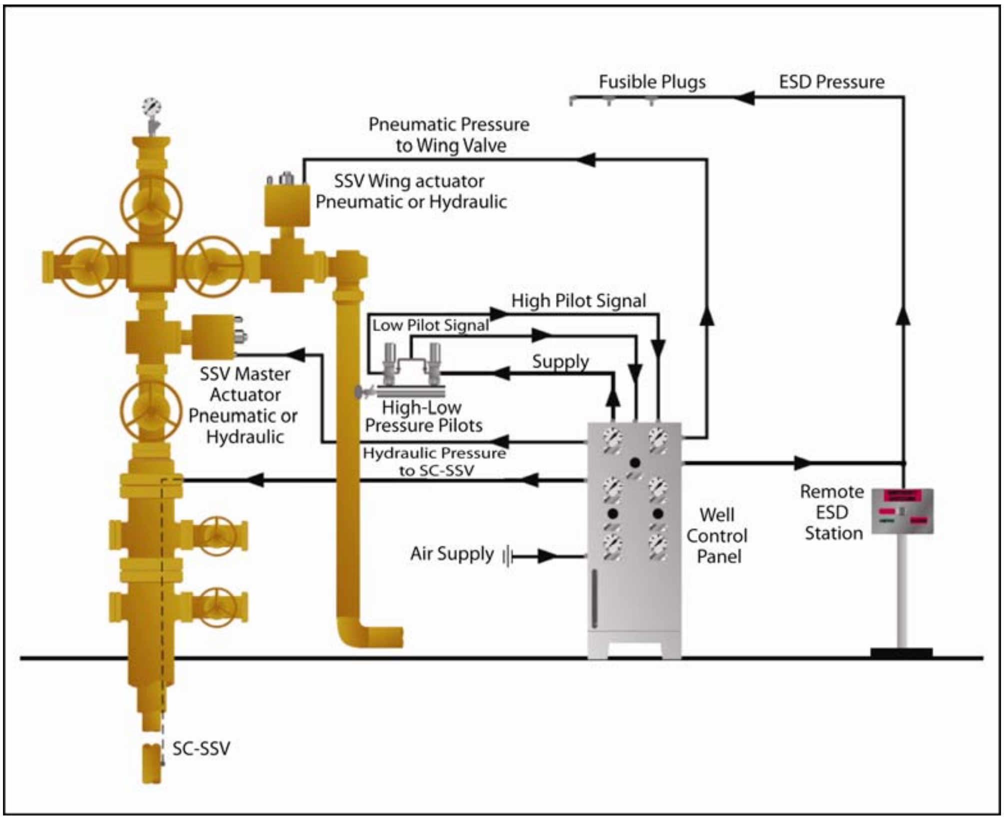
Industrial Ethernet devices such as switches and converters can be either used as the communication backbone of an offshore drilling platform, or installed on floating production platforms to bridge facilities between different platforms. Wireless networks can be used to connect devices at sites with environmental constraints.



Drilling Platform Communication & Video Solution

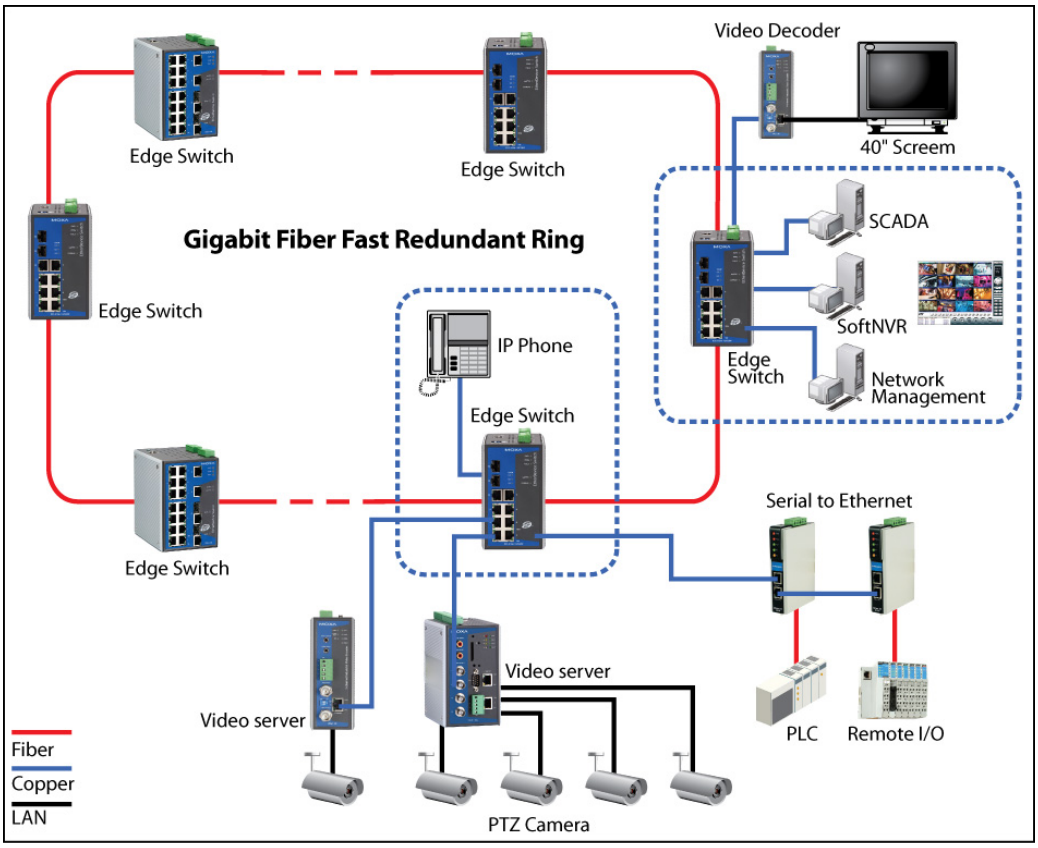
Well Head Monitoring for Onshore Operations

Oil production is made safer and more efficient by constructing a valve system to monitor the operation of well heads. In case of an emergency, the system triggers the Emergency Shutdown Device (ESD) to shut down the well head automatically when emergencies such as pipeline explosions or fires occur. Recently constructed well heads are typically outfitted with valve systems that optimize monitoring and control, whereas old well heads can be upgraded by installing additional monitoring devices.



Well Head Valve System

Industrial Ethernet is crucial for well head monitoring. Industrial Ethernet is needed to provide a high availability solution and to accommodate the harsh desert conditions, such as dramatic temperature differences, and high volumes of sand and dust. Integrating data from PLCs, voice, and video is particularly easy for IP network architectures. Remote control and data exchange between remote and central sites can be achieved with fiber optic cables that are usually wired to the sides of oil pipelines.

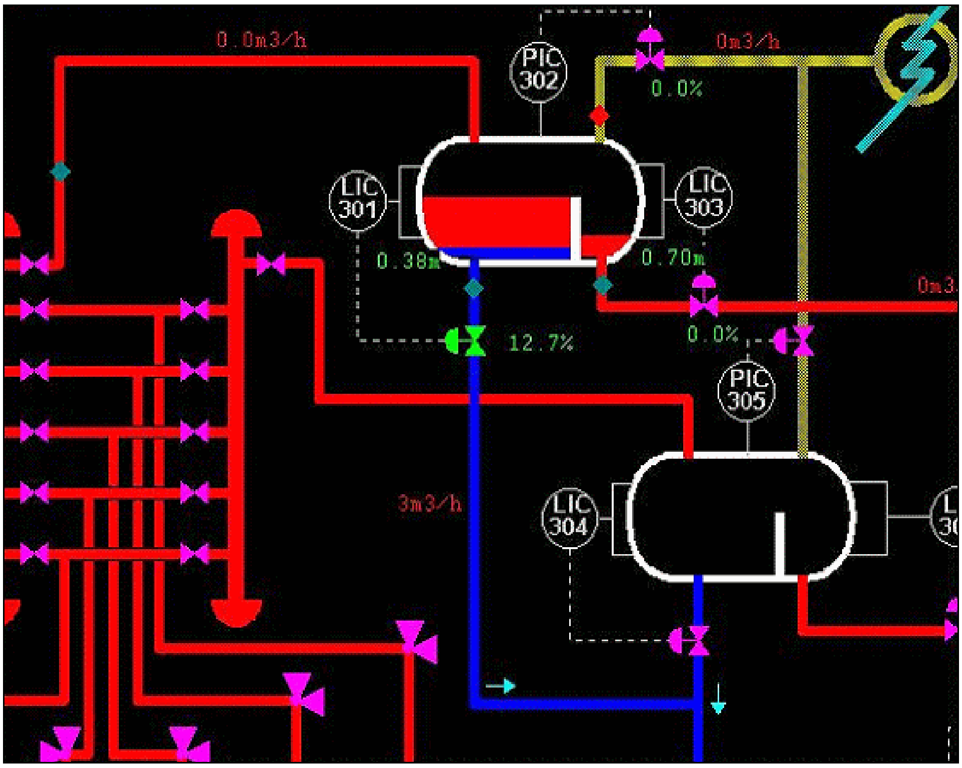


Well Head Monitoring

Transportation and Storage

Control and Monitoring of Pumps for Separation Stations

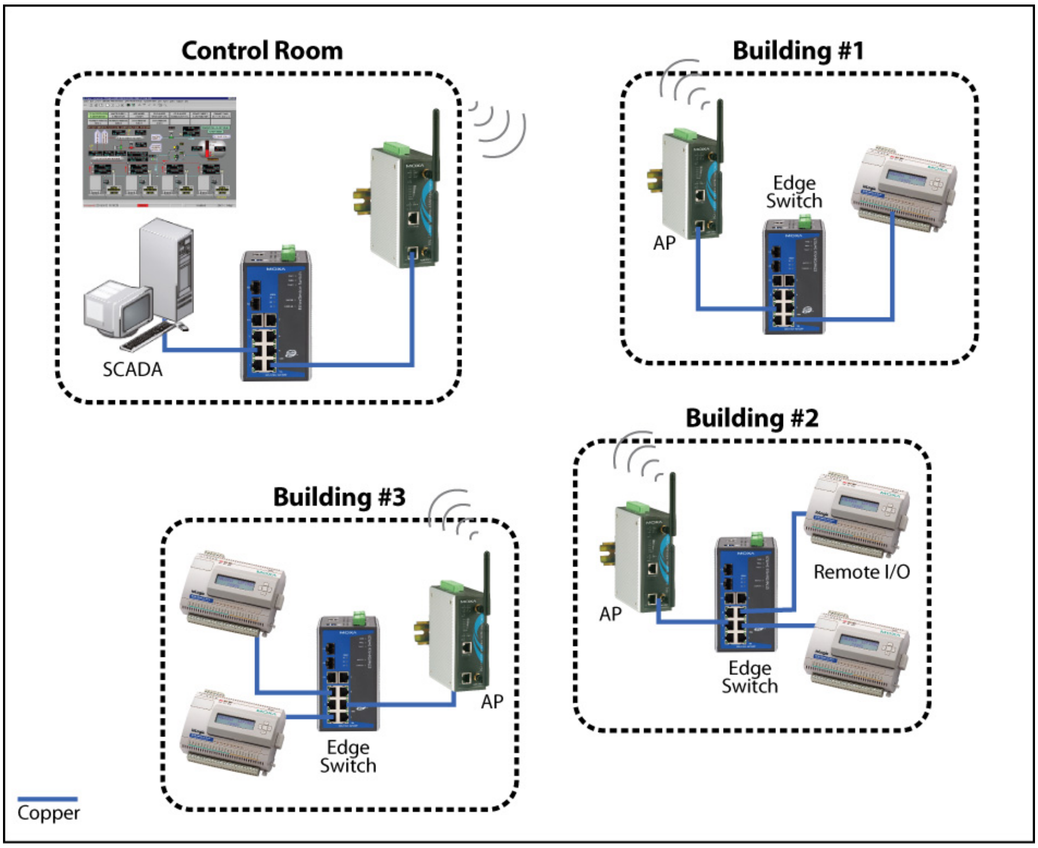
After a successful drilling, crude oil springs up from an underground reservoir and is immediately transported by pipeline to a 3-phase separation station. The separation station works like a front-end processor that separates the crude oil into oil, gas, and water before forwarding the fluids downstream to the next processing station.



Oil / Gas / Water Separation Process

Data from numerous valves and separation devices in the station must be collected and monitored over the network. One option is to daisy chain different devices in separate sectors to a fiber redundant ring topology, and use PLCs or remote I/Os to collect data.

Wireless Ethernet is an alternative to a wired network. By installing an AP (Access Point) at a high elevation at each station, data can be broadcasted over the wireless network to the control site. Wireless transmission efficiently eliminates cabling hassles. However, bandwidth is a critical factor that needs to be taken into careful consideration when deploying a wireless infrastructure. Using low bandwidth or transmitting video data can slow down your transmissions, and as a result affect the accuracy of data and make real-time control impossible.

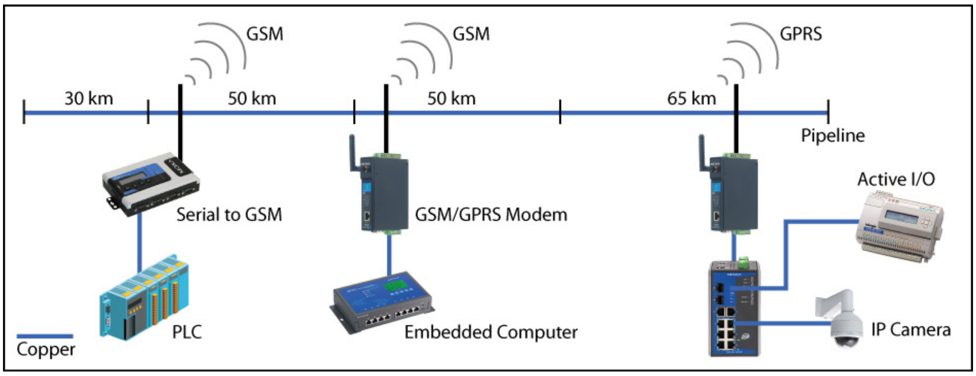


Station Wireless Network

Pipeline Monitoring

When oil and gas are separated, the crude oil is transported to remote storage sites or the nearest harbor area by pipelines or tankers. Pipelines can cover enormous distances and sometimes even cross the borders between countries. "Pipeline monitoring" now means providing easy-to-use and real-time management systems to decrease the risk of explosion, leaking, and sabotage, and as such is now an extremely critical issue in the oil and gas industry.

True pipeline monitoring is much easier to attain if it is possible to set up an optical fiber network infrastructure. In this case, monitoring devices can be installed directly alongside the pipeline. However, using long distance wireless transmission, such as GSM/GPRS, is a viable alternative if it is not feasible to set up a fiber infrastructure. In this case, the monitoring system connects directly to serial-based or Ethernet-based devices and data is transmitted through the GSM/GPRS network.



Pipeline Monitoring

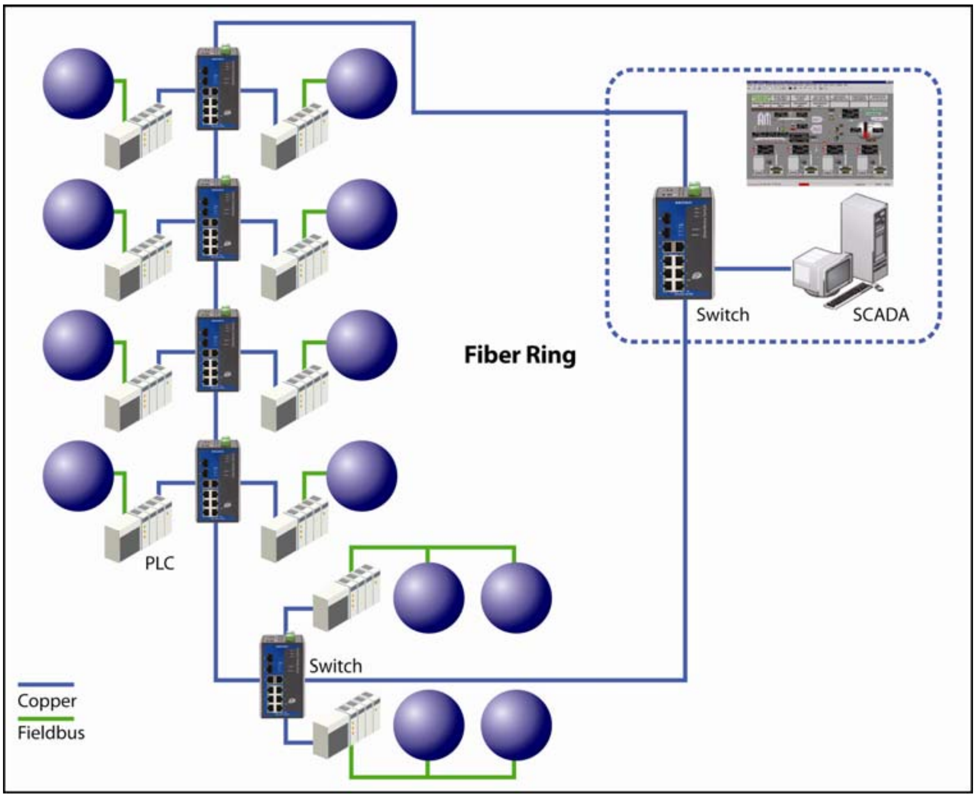
Tank / Storage Monitoring

Crude oil and natural gas are transported downstream for storage and further processing. Crude oil is often stored in either subterranean or harbor area storage tanks; natural gas is either liquefied for storage or transported to mid or downstream plants. These storage utilities or transport pipelines need to be monitored cautiously to prevent leaks and excessive gas tank pressure, which endanger the plant's safety.

Data including fluid volume, pipe pressure and temperature are critical information. Tanks, valve and pressure pumps in the storage sites are frequently connected and monitored through fiber mode or Ethernet switches to the central management systems.

Gas Tank

Oil Tank



Oil Tank Monitoring

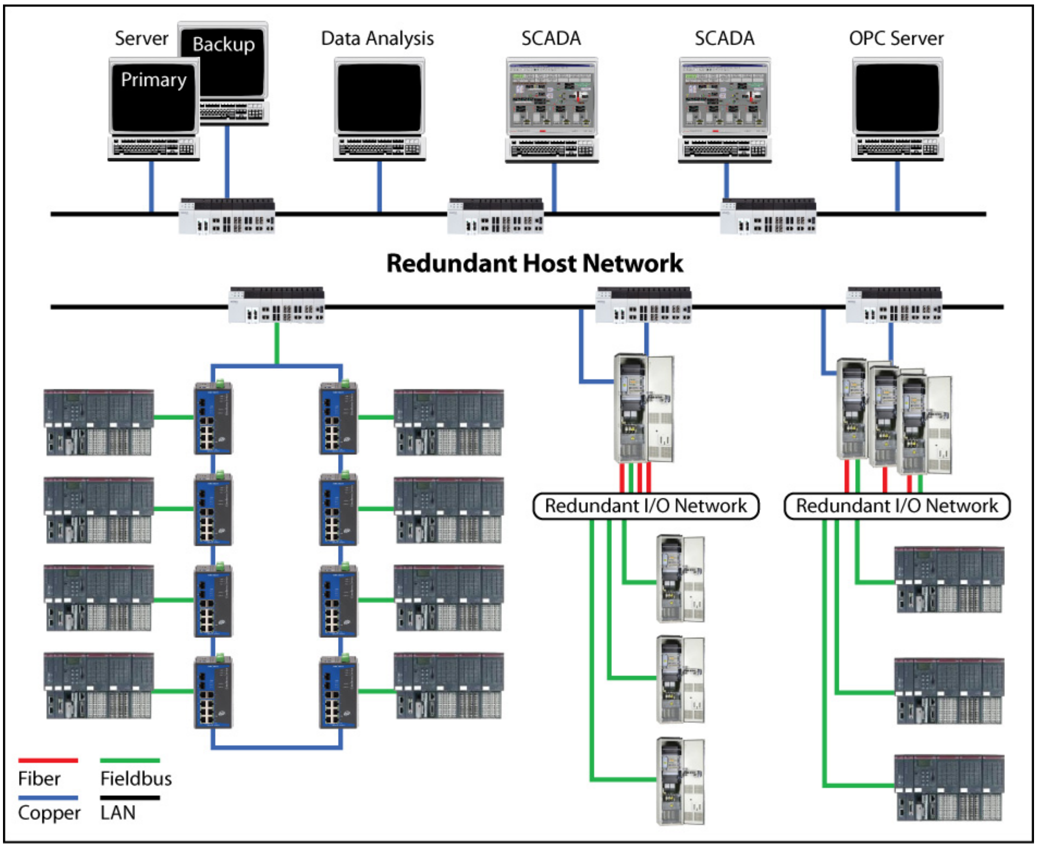
Oil Refineries

Distributed Control Systems

Suffice it to say that the refining process, which converts complex molecules into substances with simpler chemical structures, is extremely complicated, in part because a variety of different processes are required to refine the different end-substances. The distributed control system, or DCS for short, is the main control system used in the refining process to manage a plant's output and performance. The DCS is a vital part of the plant's architecture, and as such the system cannot be allowed to shut down unexpectedly during operation. The boiler, for example is a typical DCS application that creates heat and steam, and also handles the processing and draining of water. The complete production process cannot be interrupted requires extremely stable operation—24 hours a day, 7 days a week.

One of the biggest fears of plant managers is that the plant's DCS will shut down because of a failure at a single seemingly inconsequential point in the system. For this reason, redundant systems are an essential part of the design of any

DCS. All devices and facilities (including the main and backup control stations, main and backup controllers, hot and hot standby devices, dual LANs, dual communication modules and interfaces, and dual detecting devices) must be backed up by a redundant system. In some cases, multi-redundant systems are required to realize higher system reliability. For example, when Ethernet is used as the communication backbone, it is common to set up two independent networks, which we could call LAN 1 and LAN 2. When the default network crashes, devices can continue to transmit data through the backup network. In the same respect, all controllers, servers and HMI/SCADA systems are always equipped with dual communication interfaces, and data is transmitted simultaneously through both interfaces to prevent data loss if one of the networks goes offline.

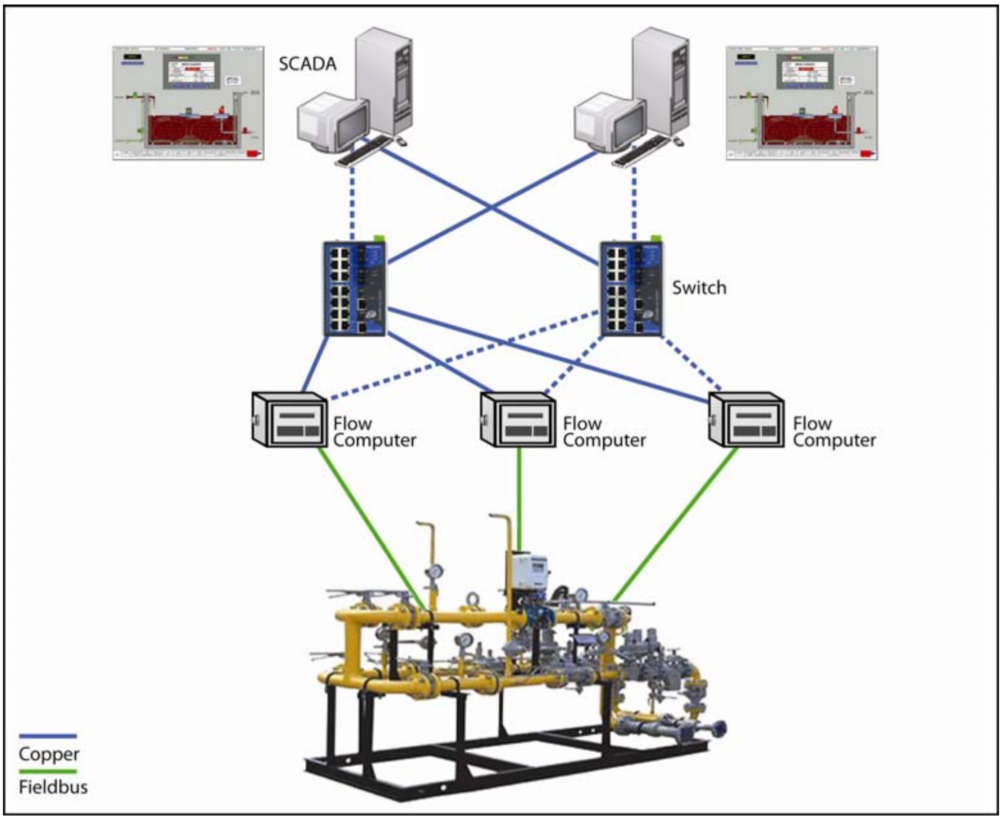


Distributed Control System

Metering System

A metering or valuation system controls a refinery's performance and the use of materials. Flow rate, flow speed, and flow density measurements are critical to maintaining the safety and efficiency of the plant. All of this data is collected and transmitted through the metering system to the server host where it is compiled and analyzed. The data must be available to the DCS in real-time (keep in mind that for Ethernet networks, "real-time" implies a small time delay) to optimize the output and operation of the plant.

As with the DCS, the metering system also requires a redundant backup architecture to ensure that cost calculations for the refinery are accurate. Refinery costs are based on data collected by the metering system. The system is normally equipped with at least two redundant backup solutions to guarantee 100% data accuracy and prevent unexpected errors. The flow computer is one of the system's essential components. It can be regarded as a DCS sub-system that intercepts fluid data and transmits the data to a DCS center to facilitate the operation of the plant.

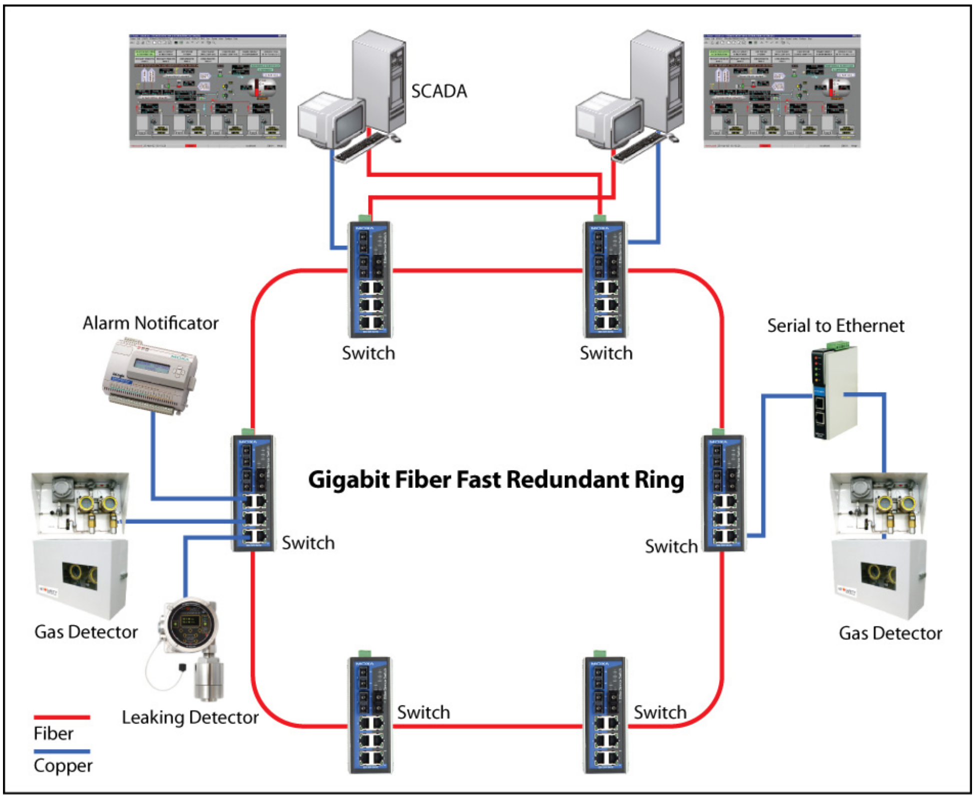


Metering System

Detecting Gas and Liquid Leaks

An auxiliary system in refinery plants is used to detect gas and liquid leaks. Although the auxiliary system is not directly involved with production, it forewarns plant and field operators of potentially unsafe leaks in the pipes used to transport gases and liquids. The leak detection system is simpler than the DCS. Leak detectors are connected by a multi-mode fiber optic network, whereas a SCADA system at the control center monitors devices through the Modbus protocol. When a leak is detected, the central control system immediately notifies field operators to take precautions, and may even shut down the system. To ensure the quickest possible response, it is essential to use appropriate real-time monitoring and management devices.

Active alarm systems have emerged as the newest trend for providing comprehensive and critical data for leak detection management. Active Ethernet I/O products can instantly report events via e-mail, SMS, or real-time messages. By informing operators of the situation in the field in real-time, the response time can be cut substantially.



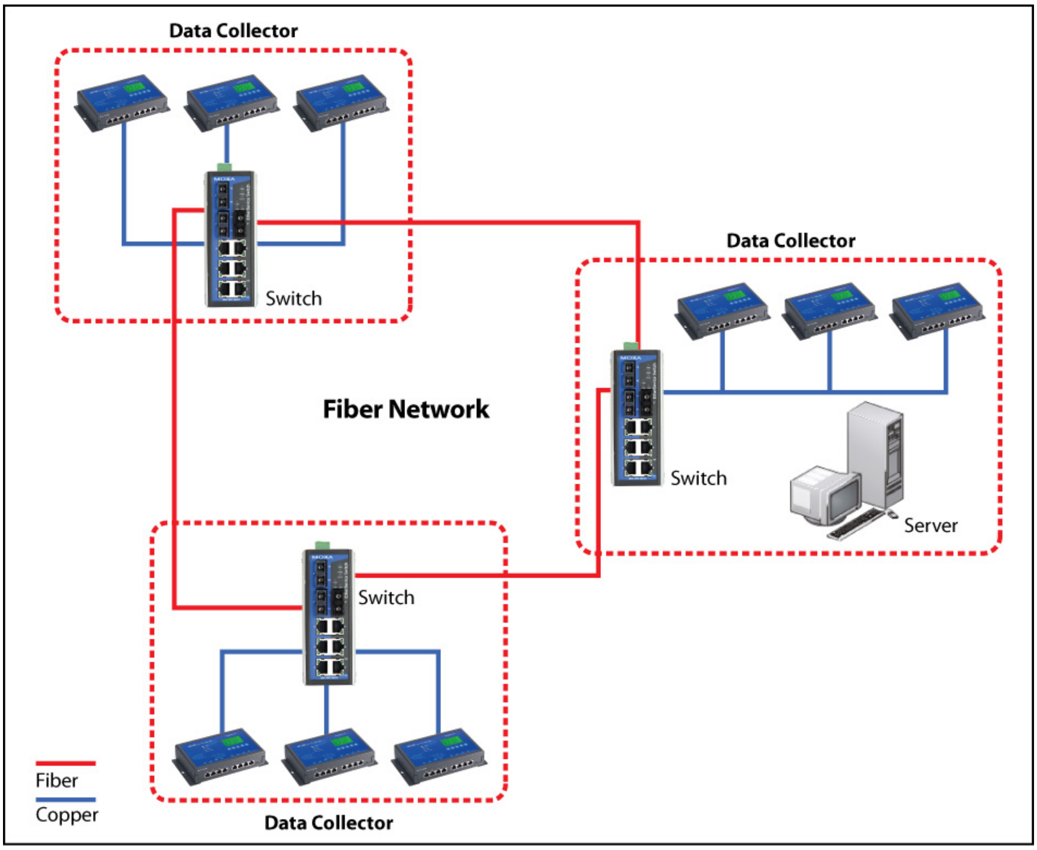
Gas and Liquid Leak Detection

Exporting Oil

Gas Stations

Refinery end-products include gasoline, petrochemicals, lubricants, and plastics, all of which we see and use daily. Gas stations, for example, now rely heavily on automation for a number of important functions.

Automation helps make the operation of gas stations more secure by connecting the gas pumps at a station directly to a POS system. In fact, gas stations can operate independently by using an embedded computer in each pump. However, large gas stations need to interconnect multiple gas pump islands and machines before transmitting data through the communication backbone to a remote management center. In addition, multiple gas stations that are all managed by the same company may need to be interconnected to cross check customer information, or provide transaction data for further analysis.



Data Collection for a Gas Station

Summary

The reliable procurement and delivery to market of oil and natural gas is a critical issue given the global economy's continued dependence on these resources. Oil and gas operations are highly complex and often take place under harsh environmental conditions. Each stage of oil and gas production involves a great deal of industrial automation and requires reliable networks to provide data collection, PLC monitoring, and environmental control. Industrial Ethernet can play an important role in oil and gas automation during the drilling, transporting, storing, refining, and even exporting phases of production. The above scenarios demonstrate how industrial Ethernet devices, such as serial-to-Ethernet device servers, Ethernet switches, video servers, remote I/Os, etc., bring convenient and cost-effective integration benefits to oil and gas automation applications.