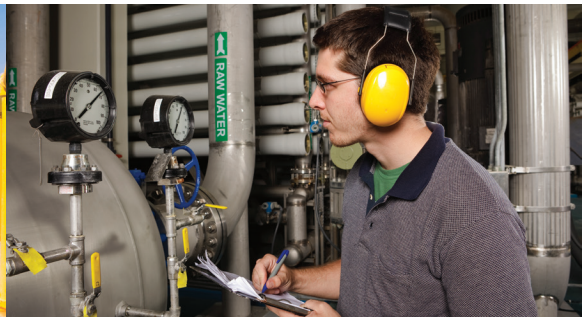
Cambium Networks™

BENEFITS OF WIRELESS COMMUNICATIONS NETWORKS IN

Water Utility Automation and Security

Availability of clean fresh water is becoming an issue of global importance on par or greater than that of petrochemical supplies. The World Wildlife Foundation predicts that by 2025 more than two-thirds of the world's population will experience occasional or constant water scarcity. This is impacting the economy today through increased water costs and government-imposed restrictions on usage.

This precious resource is under constant threat. Global warming is increasing the instances of natural disasters and extreme weather, causing floods and droughts that impact the availability of contamination-free water by triggering sewer overflows and discharges into freshwater supplies. The water distribution system from treatment, tanks, wells, and distribution lines is aging, and with limited budgets for repair and refurbishment, incidents of leakages are increasing. Threats to the water supply from terrorist activities is a new threat requiring constant vigilance. Some municipalities don't have a complete inventory of their assets, which makes it even more difficult to identify leaks. Locating these leaks and illegal connections can lead to an increase in revenue.



Many of the principles established in other utilities such as the electric grid and oil/gas infrastructure are being applied to the creation of a digital water meter network. Securing and optimizing this critical infrastructure is a priority of federal governments, municipalities, and, of course, the operating companies themselves. At the same time, there is the need to optimize OPEX and CAPEX spending.

The digital water meter network leverages real-time collection of sensor data and remote activation of controls to maximize operational efficiency and maintain high degrees of water quality and availability. SCADA sensors are deployed to monitor pressure, flow rates, and water levels to identify leaks and unexpected in-flows. Centralized pump and valve controls can enable rapid response to incidents of leakages or contaminations. Usage tracking at both the industrial and consumer levels through AMI and AMR infrastructures can reduce theft and improve conservation efforts.

In addition to water distribution and treatment, there is a need to provide security to the infrastructure through video surveillance, threat detection, and access control. The digital water meter network enables disaster recovery planning and rapid response to outages.

Efficiencies in cost and process improvement can be made by enabling remote office connectivity for water utility employees while they are on-site at infrastructure locations.

A wireless communications system is a key element in optimizing and securing the critical water infrastructures. This whitepaper outlines the use cases for wireless communications in the digital water meter network and then describes the key considerations when deploying a private wireless solution.

Further, it outlines the applications for wireless connectivity in water utility automation and then considers the benefits of a private wireless network compared to alternatives such as wireline networks or the utilization of the public 3G/4G network. It also covers the important aspects in selecting a wireless network technology.

Fixed Wireless Broadband Use Cases in Water Treatment, Wastewater Treatment, and Storm Management

SCADA Meter and Sensor Aggregation Transport

The traditional use case considered for water utility infrastructure is sensor data collection via SCADA solutions. SCADA solutions are characterized by relatively low data rates with sensors and data sources spread widely over a geographic area. As more network devices become intelligent, SCADA systems are becoming more important, not only for control and monitoring, but for end-to-end analytics applications. Security is becoming more critical and the protocols to carry SCADA traffic are increasing in the size of packets needed to carry this traffic. For example, a simple poll request consisting of an 8-byte command can expand to 70–80 bytes when sent over Ethernet using a secure DNP3 protocol. Wireless broadband solutions can easily handle this increased load, aggregate this SCADA data, and pass it over long distances with low latency back to centralized SCADA masters and network operations centers. System availability and security are table stakes for these applications.

Remote Connectivity to the Home Office

As these systems become more complex and the availability of information for troubleshooting, planning, and installation increases, field engineers are in need of connectivity back to the home office as well as to the Internet. Wireless broadband can deliver Internet and Intranet access over long distances and rugged terrain to areas not covered by the public 3G/4G network or reachable by fiber. Combine this with secure industrial-grade WiFi hotspots, and field engineers can access the corporate infrastructure and all the resources they would have access to while on the corporate LAN regardless of where they are in the field. All while using the tools they already have, such as laptops and smart phones, and reducing the cost and dependency on the spotty coverage and availability of the public 3G/4G network in these remote locations.

Physical and Operational Security

When the water treatment facility or pumping stations have a broadband data connection, new security capabilities can be brought on board including perimeter security with video cameras. Whether the requirements call for local storage and on-demand access or constant streaming, wireless backhaul can deliver the bandwidth required. Additional capabilities, such as license plate readers and facial recognition for site access, can provide positive confirmation of personnel on site. Private wireless broadband solutions are especially well suited to video surveillance because cameras can be located where they are needed rather than where it is convenient to reach the wireline network, and there is no recurring expense of the bandwidth consumed.

Analog Circuit Replacement

Many water utilities are currently using wireline services purchased from the local telecommunications operator. These leased lines have recurring monthly operating costs and typically have limited capacity. Changes to increase capacity can take a long time to activate. Many of the low-capacity analog leased lines are also being phased out by the telephone service providers in favor of more expensive digital circuits that aren't suitable for utility operations.

Disaster Recovery / Network Resiliency

Many water utilities are deploying communications using wireline communications such as fiber or copper. As these communications become more mission critical, availability becomes more visible and system outages costlier. The ability to continue operating or to restore communications after a natural disaster or man-made attack can differentiate utility companies and ensure that the public is protected. Wireless broadband is a natural fit for disaster recovery applications. Whether deployed as an always-on, real-time backup solution or kitted as a rapidly deployable tactical response system, wireless communications can be counted on for the fastest way to restore communications.

Why Private Wireless Networks Are Best Suited for Water Utility Automation

Water utility operators have three high-level options when selecting a communications infrastructure:

a) Leased services networks

b) Public wireless networks such as the 3G/4G mobile infrastructure

c) Private wireless networks

In most cases, the best answer is a combination of these, but here are some important areas to consider why a private wireless network delivers the best overall total cost of ownership.

Private wireless networks can be deployed quickly and placed exactly where the data is needed. There are no trenches to dig or cables to run, which can mean months between the time the need is identified and the network is operational. Wireless sectors can be installed covering broad areas over long distances providing flexibility in remote node placement and re-use of the infrastructure. Maintenance costs and on-going OPEX are lower as there are no wires to break or be cut.

With a wireless infrastructure in place, the capacity can be leveraged for many different applications, and using quality of service, the most important data can be prioritized. Private wireless broadband networks have very low recurring costs especially when compared to accessing the 3G/4G mobile network or leasing lines from the carriers. The 3G/4G mobile network has the benefit of existing coverage in some areas, but it is important to note that there is no provision for prioritization of mission-critical traffic or even ensuring that capacity is available. Providing field engineers with 3G/4G data access can also be large recurring expenditure that could be avoided.

Private wireless network operators have control over access and how the traffic gets prioritized. Combining rapid deployment, low initial cost, and virtually no recurring costs, private wireless broadband networks are clearly the total cost-of-ownership leader, providing a rapid return on investment.

Key Considerations in Choosing a Technology for Private Wireless Networks

There are many networking technologies being deployed by water utilities today, each with different capabilities. Here are some key considerations when discussing these different techniques.

Capacity vs. Range: Several factors impact the amount of data capacity that can be delivered at a particular distance. Those factors include spectrum, channel bandwidth, transmitter power, terrain noise immunity, and antenna size. In general, capacity comes down, the longer the distance to be covered. The longest propagation would be in a low-frequency, narrow-band channel with a high-gain antenna, while higher capacities could be had by selecting wider channels. Cambium Networks has a free software tool called LINKPlanner that makes it easy to create test scenarios to select the best combination of channel size, antenna, and radio to achieve the desired capacity with the necessary availability. Cambium Networks offers capacities of more than a Gbps and link distances from a 2 meters up to 245 km.

Topologies (PTP, PMP, Rings, Mesh): Point-to-point (PTP) topologies are best suited for delivering lots of capacity over long distances. PTP links are also ideal for short-range spurs connecting a single location to the wireline backbone. PTP connections cover longer distances and are less susceptible to interference as the antenna patterns are narrower so the energy can be focused in the direction of the transmission. Resiliency in a PTP link can be provided by deploying in 1+1 or 2+0 configurations with parallel sets of radios.

PTP radios can also be deployed in rings or mesh configurations to provide additional resiliency by providing multiple paths to each node. Ring topologies are excellent for resilient operations of high-capacity links covering a large area. Mesh networks can be built using multiple PTP links or with specialized meshing protocols to enable multiple paths from point A to point B. Mesh networks have the down side of each packet traversing multiple hops so can lead to lower capacity given the infrastructure investment.

Point-to-Multipoint (PMP) networks provide scale and capacity over a geographic area. PMP networks are typically deployed to cover sectors or cells. The key capability to look for in PMP networks is their ability to scale both in the number of nodes per cell but also the ability to place cells next to each other without interfering. Cambium Networks radios use synchronization techniques to ensure that adjacent PMP radios do not interfere with each other.

Licensed vs. Unlicensed

Wireless spectrum can be classified as either licensed or unlicensed. Access to licensed spectrum is typically purchased to provide an organization exclusive access to a particular channel in a particular location. Operation in that channel should be largely free of interference from competing radios. The downside is that the spectrum may be extremely scarce or expensive to access. Even when spectrum is more easily accessible, it can take weeks to gain the approval to operate so licensed bands are not very well suited to rapid deployments.

Unlicensed spectrum is generally open and available to anybody to use with no exclusive rights granted to any particular organization or individual. The tradeoff is that competing systems may occupy the same channel at different power levels, leading to interference. Unlicensed radio manufacturers include capabilities in these radios to cope with this potential interference. Cambium Networks uses features such as dynamic spectrum optimization, adaptive modulation, automatic transmit power control, and out-of-band filtering to minimize the impact of this interference.

Line of Sight vs. Non-Line of Sight

A radio link can be described as being line of sight (LoS), that is, there is an optical path between the two radios making up the link, or non-line of sight, meaning there is some obstruction between the two radios.

Near line of sight (nLoS) is simply a partial obstruction rather than a complete obstruction. In general, lower frequency solutions have better propagation than higher frequencies. In fact, above 6 GHz, wireless solutions must operate in line of sight. From 1 GHz to 6 GHz, the capabilities will vary, and below 1 GHz, the propagation becomes much better. Cambium Networks has many techniques in 5 GHz radios to maximum the propagation of these signals including OFDM, multipath, ARQ, and radios designed to work at very low receive sensitivities.

Security

With ongoing cybersecurity threats, the security of wireless communications is growing in importance. Techniques to look for here include the ability to encrypt the over-the-air link, secure management interfaces such as HTTPS and SNMPv3, and multiple user accounts with password complexity rules. Cambium Networks radios are deployed in mission-critical infrastructure solutions around the world, including military deployments and public safety missions, so security is built in our products from the start. Selecting a solution with strong security features makes it easier to comply with corporate IT standards. For the most security, Cambium Networks also offers solutions validated to FIPS 140-2, which is a US Federal government standard for security.

Quality of Service

Operators need to make the most efficient use of available spectrum by deploying multiple services on the same channels and also making sure the most important information is transmitted with highest priority. Solutions should have multiple Quality of Service (QoS) levels and the ability to sort traffic based on both layer 2 and layer 3 standard traffic classifiers. In this way, the source of the data can mark the class of service or priority, and the end-to-end network will ensure that the traffic is delivered with the desired level of urgency and criticality.

Network Management

The ability to manage a network has a direct impact on the total cost of ownership. Systems that allow centralized management of configuration, fault detection, performance/trend monitoring, and security validation minimize the effort and also reduce the opportunities for unplanned outages. Cambium Networks radios support both local web-based interfaces as well as a centralized management system called cnMaestro™.

Cambium Networks has deployed more than five million wireless broadband nodes around the world. We are experienced in mission-critical communications in areas such as electric utility infrastructure, federal military deployments, digital oilfields, and public safety operations. Cambium Networks offers the industry's most complete end-to-end solutions including transport, backhaul, distribution, and WiFi access all managed from a common set of tools.

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4, Mitchell House,
Woolley Barns, Woolley,
Wantage
OX12 8TA