WIRELESS
ADVANCED METERING INFRASTRUCTURE

The following explanation extends an understanding of the current state of Wireless Advanced Metering Infrastructure (AMI) and its use of Automated Meter Reading (AMR) systems.

Problems facing Utilities:

For years, Utility's have been aware that there is a significant loss of revenue as equipment ages and degrades. Whether water, gas, or electric, municipalities throughout the country are seeing rising costs and are seeking ways to reduce any negative impact to their bottom line. Contributing factors which reduce revenue are: outdated equipment and inefficient collection and recording methods. One estimate is that the average rural municipality collects only 80% of the "true" water usage that should be billed. Some communities are "under billing" their customers by 30%, 50%, or more. While less pronounced, these same issues apply to both the gas and the electrical utilities as well, where the dollar amount is significant due to higher cost of these utilities. With the drive to conserve natural resources, there is a need for a more reliable and accurate method of collecting meter readings. The solution is commonly called an Advanced Metering Infrastructure **(AMI),** which improves the efficiency and effectiveness of the utility. Thus achieving the dual goals of lowering overhead costs while increasing revenue.

An important hurdle facing utilities is the increasing costs associated with manually reading meters. Labor costs include; reading the meter and the handling of the readings once collected. Vehicle cost include; increasing fuel prices, maintenance, and insurance. Less visible costs are; workman's compensation premiums, benefits packages, lost work due to accidents, and insurance. Even dog attacks contribute to these hidden, but significant, costs.

One often underestimated cost is the costs associated with re-reading a meter. Any system other than a fixed based AMI system (including drive-by systems) will have a percentage of meters that are re-read each month. The cost to handle these re-reads typically includes the costs associated with 3 duties; a customer service person, the meter reader, and the billing clerk. It is estimated that when all the "hidden costs" of these three duties are included, it costs at least $75 to re-read a meter. Re-reading a meter is a function that is virtually eliminated by having daily information available to the customer service representative while still on the phone with the customer. The customer can either be reassured through information available or inconsistencies are spotted immediately and can be further investigated.

Previous AMR Options:

Automated Meter Reading **(AMR)** solutions have been around since 1962 when telephone land lines were used to transmit meter information. Technological advances have been made since that time and until recently, the latest innovation was drive-by AMR. Since these drive-by systems still require human interaction at many data transfer points, they suffer from accuracy and efficiency issues. The 1st generation of a fixed wireless solution relied on above ground antennas to transmit the data from the meter. With water meters this created problems with locating the antenna. To avoid being in the way of the homeowner it was necessary to provide underground wiring to move the antenna to a less obtrusive location. Power sources for water data transmissions were an added flaw in 1st and 2nd generation systems.

Current AMI Solutions:

The solution to this problem came from the use of solid state technology to form a wireless network creating what is referred to as an Advanced Metering Infrastructure (**AMI**). This is accomplished through the use of long lasting battery-powered wireless AMI units with an "in-the-pit" antenna. This technology is paired with wireless collection devices that use industry recognized data transfer methods and database capabilities to store and report meter data collected. Technological advances allow for the placement of antennas below ground, in the case of water meters, and in the housing of the meter in the case of electric meters. These new electric meters are (usually) solid state digital meters with no moving parts. The radio transmitter is easily added to the existing circuitry and draws its low voltage from the meter itself. In the case of gas meters, a small unobtrusive battery powered antenna is attached to the meter. In all cases, it is still possible to manually read the meter if the occasion should arise.

Primary Benefits

- To the utility company, the main benefit is an ongoing operating cost savings through accurate and efficient automated meter reading. This cost savings is achieved through the use of a fixed based network system utilizing existing technology.
- The system requires little, if any, disturbance to the user's property. For water meters the changes are invisible to the property owner. This is achieved through the use of a transmission system, which is capable of transmitting from an underground environment. Electric meters have built-in antennas, and gas meters require only a minor addition of a transmitter to the register.
- The latest AMI solutions are stable and use redundant techniques. The communications protocol between the meter transmitter and the wireless collection system is designed to minimize disruptions caused by power outage or component failure.
- Readings are available ranging from "real time"to12 hours increments-- a vast improvement over a once a month read.

System Overview:

An AMI system consists of three sections: the meters equipped with radio transmitters, a network of collectors, and a main server. The collectors receive the different transmitted readings from the meters and then forward the data to a main server. The number of data readings and transmissions in a 24-hour period may vary according to the city's needs. To maximize technology innovations the collectors are connected to the server through a Wireless Broadband network stationed throughout the city. Software provides the city utility with a variety of reports and information that were previously unavailable.

Water Meter AMI:

The water meter AMI starts with the use of a water-proof sensing device that attaches to registers specifically designed for this purpose. Typically, due to cost efficiencies, new water meters already equipped with the register and transmitter are used to replace the old meter. Readings taken by the AMI system is based either on the position of the "odometer" wheels on the meter or by counting the revolutions of the wheels or dial through a magnetic reed switch. A miniature microprocessor records the meter reading at user-specified intervals, storing the data until time to transmit via a radio frequency. The transmission may be read by any collector within range, creating a level of redundancy to improve system reliability. The collectors then send the data through the network to the server. The server automatically removes duplicate readings. It then passes the information to both the billing system and a separate program that is normally used for customer service purposes or to assist the administration of the utility. Having multiple readings on a daily basis, displayed in both numerical and graphic formats, gives the city a wealth of information never before available.

Using a combination of long lasting batteries and technology that places the unit in a "power save" mode when not needed enables the unit to maintain a battery life of up to 20 years. Many brands can be configured individually, allowing for special circumstances where readings are desired on a more frequent basis, although battery life is shortened.

Water meters placed in an underground housing, or vault, historically have used cast-iron lids. Although new installations are now being done using vaults and lids made of composite materials. Typically, a cast-iron lid requires replacement with a composite material lid, or for some models of AMI transmitters a hole can be drilled for the installation of a flush mounted antenna. This is needed in order to increase the transmission range to assure the signal reaches the collector. The transmitter itself is attached to the underside of the lid (or flush mounted) to prevent the transmitter being covered by water, again allowing the signal to reach its destination in these situations. It is recommended that an existing pit which allows more than an inch or two of water to accumulate above the lid should be raised to match the grade of the surrounding area to allow for proper drainage.

Gas Meter AMI:

The AMI technology for Gas Meters is virtually identical to the Water Meter AMI. Attached behind the existing register and using the same battery power and design, the transmitter delivers the data in the same way as stated earlier. However, there is a vast improvement in signal strength, and distance the signal can travel, due to having the antenna above ground.

Electric Meter AMI:

Most electric meter manufacturers are now providing solid state meters with no moving parts. The solid state electric meter can be built to add a transmitter through a simple connection directly to the circuit board. A small antenna mounts under the glass of the meter. For electric applications, the AMI transmitter can serve a dual role and act as a collection unit, forming a mesh network that improves the gathering of data and extends the range between collectors. Systems vary, but typically, when Electric Meter AMI is used the Water Meter AMI and Gas Meter AMI utilize this mesh network to transmit their data as well. The data is kept separate and flows seamlessly to the appropriate billing systems.

The addition of a simple collar can allow the utility company to remotely turn meters off and on from their office, if desired. Some manufacturers are providing this feature as a built-in option as well. Cost vs. benefit is important in deciding when and where to utilize this feature. A collar mounted remote disconnect, for example, can be easily moved from place to place without changing the original meter, eliminating the need to adjust for the readings of a changed meter.

Collector

Collectors, as the name implies, collect meter reading data via a wireless interface. The latest generation of collectors provides a wireless connection that is low bandwidth, highly reliable, and is non line-of-sight, which allows for robust communications in many environments. Characteristically, a collector receives transmissions from multiple meters and passes that information along the network back to the server where it is compiled.

Collectors are low power devices often requiring less than 1 Kilowatt per month to operate. They can be powered by a wide range of both AC and DC powering devices. The low power requirements of this device also allow for the possibility of solar power, when wired electrical power is difficult to provide.

Collectors are designed to be mounted outdoors on utility poles or on other city owned infrastructure, where they can be elevated so as to have the least possible obstruction to the AMI transmissions. Even though several AMI systems are available, the more promising are systems that operate on a licensed 450 MHz channel. The low frequency

greatly increases the distance of the transmission which lessens the number of collectors needed. Thus, improving the overall system and improving aesthetics by reducing the number of antennas throughout the city. The use of a licensed channel increases available power for transmissions and assures the prevention of interference as the city is the only one allowed, by the FCC, to use that frequency in their area.

No matter the frequency used, current systems have come a long way in reducing the instances of interference from other sources, which was a common failing with the earlier generation of AMI.

Server:

The server platform runs standard AMI software. The server being the final collection point of the meter reading process. The server gathers the data sent to it by the collectors over the Wireless Broadband network. Once it receives the readings via the network, it converts and stores these readings in a database. This database serves a dual purpose; it sends the information directly into the existing billing system and it is used to access a greater amount of data that can be used to spot leakage points, handle customer queries, and provide more information for better management of the utility system.

Summary

Today's AMI systems provide proven reliable meter data collection and reporting. It achieves a high accuracy by utilizing the advantages of a fixed wireless system. Thus keeping human involvement to a minimum. This not only eliminates errors, but saves money as well by freeing resources for other purposes. In addition, the system seamlessly integrates into any existing billing system. The advantages of an AMI system are so significant that more and more cities, of all sizes, are implementing variations of this technology world wide.