Remote devices for Automatic Meter Reading (AMR) have many common characteristics but vary depending on what kind of communication system is in place. A partial list of communication systems that current technology supports includes the following:

- Telephone dial-inbound
- Telephone dial-outbound
- Cellular
- Mobile radio
- Fixed network radio
- Pager systems
- Power line carrier
- Cable
- Satellite
- Hybrid

Remote devices that are supported by the above mentioned systems include:

- Pulse accumulators
- Serial data meters and instruments
- Encoded indices

**PULSE ACCUMULATORS**

These remote field units count pulses generated from a meter or an instrument mounted on the meter. The version for domestic meter applications usually has one channel but can have more than one. Commercial and Industrial versions have two to four channels. The channels can be used to read several meters or multiple pieces of information from the same meter. The remote field device only collects and stores data and the host computer will label and weigh the units for conversion to engineering units. Most applications have the pulse accumulator tracking the meter read and/or energy consumption over a programmed time interval. Most domestic devices only require meter reads. Commercial and Industrial devices require consumption over a time interval. This Time Tagged Interval (TTI) data is very valuable for the customer, utility, and marketer in deregulated markets. Natural Gas consumption is usually tagged in one hour intervals. Electric consumption is usually stored in fifteen minute increments. Data stored in this manner can be loaded to the host software where it can be converted to Daily Meter Reads, billing data, load profiles, rate making cases, nominations, penalties, consumption alarms, etc. The interval in which data is stored can be programmed from a minimum of one minute to sixty minutes. This feature will affect the amount of storage being kept on-site.

Memory capacity varies with the number of channels being used and the TTI data versus profile reads (a profile read is a summary of data, i.e. a meter reading). The Commercial and Industrial devices commonly store thirty to forty days of hourly data and the residential device will store approximately 80 days or more of meter reads. Storage capacity is critical depending on the frequency the units are downloading data. Memory is important in case communications are disrupted or the data base is lost or corrupted. A good practice is to run backups on a routine basis of every week or every other week. The field units could then reconstruct the last month or so by downloading all data.

Alarms are also common features of the remote field units. The pulse accumulator units can have preset interval consumption alarms. This prompts the unit to call in an alarm if consumption exceeds the preprogrammed limit. Another alarm common to all types of field units is the tamper detect alarm. The unit will call in and download data when the door or cover to the enclosure is opened. Some models also provide additional channels for customer alarms. These channels will report anything the customer wants to monitor that can be switch activated. This would include pressure, building or vault entry, water levels in pits, etc.

Clock resynchronization is important with pulse accumulating devices. This is especially important for Daily Meter Reads. All the field units must be in sync with each other and the host computer in order to ensure consumption data is assigned to the time interval when it was actually used. Whenever communication is established between the unit and the host computer, time is compared and the clock in the field device is synchronized. If the field unit’s clock varies by more than ten seconds then a resync alarm is reported. This alerts the user to a possible overlap or gap in the data. It is important that the clock at the host does not drift from the local time standard.

Prior to the year 2000 clocks in the remote field units were being examined to ensure Y2K compliance. If the units had clocks that used the Julian calendar then there was no cause for concern since they track seconds, minutes, hours, and the Julian day. No year is involved. If the field unit used the day, month, year in its time keeping function then it needed to be checked for Y2K compliance. Today if field units use day, month, year in keeping time they will use four digits to identify the year i.e. 2001 versus '01.
Power options for the remote field device can be quite diverse. AC power is common for electric metering applications and don’t require battery back-up only for memory unless communication is necessary to support outage reporting since no energy is being consumed. Battery back-up may cost more but it can easily be justified for large gas monitoring applications where gas would continue to flow despite a power outage. Electric applications also find benefit in having batteries so the unit can report a power outage. Some field units are powered by batteries only. The two most common types of batteries are alkaline and lithium. Pound for pound, lithium will power the unit over a longer duration. They are more expensive than alkaline and they are considered hazardous waste under certain circumstances (size and discharge are key issues). The alkaline batteries are readily available, less expensive and have few disposal issues. They are readily available but do not operate nearly as long as a lithium battery. Other units draw power from the telephone or the power line. Solar power is also an option on some manufacturers devices.

SERIAL DATA METERS AND INSTRUMENTS

Electric meters are now available with many AMR features built into the unit. Many units have modems, clocks, and memory integral to the meter. On the gas side, meter mounted instruments are being built with AMR functions. A great deal of data is available through RS232 ports downloaded into a laptop computer or into a host computer via a communications link. The data is much more detailed than that available in a pulse device. Communications time is longer and should be considered when units are being installed. The trade off for detailed information is speed, power and cost. Serial devices also allow multiple party access. Many pulse units are tied to the host system protocol. Security issues must be evaluated. Units with multiple levels of access are the most desirable. Early versions of serial devices are not Y2K compliant and need firmware upgrades. Current versions are designed to handle all Y2K issues.

ENCODED INDICES

Encoded indices have been used in the water industry for over 15 years yet they are relatively new to gas and electric. An encoded index is designed so that direct electronic transfer of meter reading information is provided from a residential meter to a remote meter display or to an AMR device. These indices directly read the actual position of the index odometer wheels when interrogated. There are no pulse outputs or memory modules to program. They have no battery. All necessary power is provided by the reading device.

During interrogation the unit provides an actual meter reading and an ID number back to the interrogating unit. Any error or non-reads are immediately indicated to provide virtually error free readings. They are sealed to keep moisture and other debris from entering. They can be retrofitted in the field and require no programming at installation. They usually cost more than pulse devices but require virtually no maintenance and are extremely reliable and accurate. One manufacturer has a ten year warranty on their encoded index. Versions are now being made for commercial gas meters and electric meters.

COMMUNICATION SYSTEM TYPES

Telephone dial-inbound: These systems have the ability to share an existing voice grade telephone line. They are programmed to call in to the host at a specific time. Multiple unit calls will be spaced such that when one unit is finishing its call the next unit will be calling. If the phone is in use the unit will wait and go into a recall mode. When the phone is picked up during a call the unit will relinquish the line back to the user. Alarms are reported when they occur. These systems are very efficient and inexpensive to start and operate since the communication structure is already in place and there are no additional monthly fees. Maintenance of the system already exists, wide area network rests with the phone company.

Telephone dial-outbound: Calls are initiated at the host computer and call out to the field units. The phone lines are unshared which allows the units to be contacted on demand. Alarms are retrieved at the time of call or in real time by remote unit call origination. A monthly service fee is required by the phone company. The speed and efficiency is determined by the amount of resources dedicated to the system. More phone lines and computers are needed to reduce the total time needed to poll all of the units in the field. Third party access to remote units is available with this system.

Cellular: A few totally cellular AMR systems exist but for the most part they are used where telephone land line is not available or costs to make it available far outweigh the added expense for cellular phones. They are almost exclusively used for commercial and industrial class customers. Cellular does have several positive features. They are very easy and inexpensive to install. They are very reliable since there are no wires to be broken or corroded. The units can be easily moved to an alternate site without much trouble or time. Off peak rates can sometimes be negotiated such that cell calls are actually less expensive than land line calls.

Mobile radio: A vehicle transceiver unit is a portable radio-based meter reading device installed in any vehicle. The operator simply sets up the system in the vehicle, loads the desired meter reading route into the computer and drives along the meter reading route in proximity to the meters to be read. The meter reading data is collected while the vehicle traverses the route. The system uses two-way data communications between the vehicle transceiver and the meter transceiver units connected to compatible meter units. When reading meters, the vehicle transmitter transmits an alert signal to all the meter transceivers within range (blind reading mode), or to individual meter units (geographic reading mode).
When the alert signal is received, each meter responds by transmitting its data. The vehicle receives the data and acknowledges by sending the meter a message to return to its low power sleep mode. The advantage here is more meters can be read in a matter of minutes than a typical meter reader, using a manual entry system, can usually read in a day.

**Fixed network radio:** These systems typically use a wireless Local Area Network (LAN) to collect the data from all the endpoints (meters) within a geographical area. This is performed by a Controller or Base Station Repeater. The LAN repeater transmits to a base station master which is part of a wireless Wide Area Network (WAN). Finally, the base station will typically connect to a central database via a public carrier, i.e. wired or wireless phone companies. This connection will be a wideband one in order to aggregate the large volume of data and transmit it in a short amount of time.

**Pager System:** Using an existing wireless infrastructure has tremendous appeal to deploying AMR devices. Motorola and Worldcom Skytel Two-Way Pager have developed such a system. Collected data is transmitted via the pager system to the Skytel Network Operating Center (NOC). Each remote unit has its own “mailbox” where the data is sent and stored. The data can be retrieved via e-mail or the internet and then placed in a database. Installation costs and communication costs are drastically reduced. Pager systems are notoriously robust and extremely reliable. This method should prove to be very popular because of all the inherent advantages. System Controller Network collects the data from the system and loads it into a relational database for access via application gateways using standard TCP/IP protocols.

**Power line carrier:** Using power lines as communication corridors these systems provide continuous data reporting from various endpoints (meters and voltage monitoring) to receivers located in substations or metering points. The data is accessible on demand at the utility’s office for billing, quality monitoring and fault isolation. The available data includes kilowatt-hours, peak and minimum kWh, and short term outage counts. The key to successful transmission is to allow the signals to travel unimpeded through transformers or capacitor banks.

**Satellite:** A message sent from a remote unit - either stationary or mobile - is received at the satellite and relayed down to a gateway station that connects the ground system with the satellites. The gateway relays the message via satellite link or dedicated terrestrial line to the network control center. The network control center routes the message to the final addressee via e-mail, dedicated phone line or facsimile. Often, the satellites for this type of application are Low Earth Orbit (LEO) types.

**Cable:** Utilizing the same cable wire that television providers use, meters can be read.

**Hybrid:** One system usually does not give full coverage or is not economical therefore several methods will be used and combined. High density areas are ideal for fixed network or mobile-radio but it is not practical in rural areas where telephone may be used.

A great source for additional information on remote meter reading is Synergistic Services, Inc. Visit the web page www.thescottreport.com where you will find links to a multitude of organizations, publications, and active vendors.

**ORGANIZATIONS**

**AMRA**

**RELATED PUBLICATIONS**

AMRA News
Electric Light & Power
Metering International
PowerValue
Public Utilities Fortnightly
Rural Electrification Magazine
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**ACTIVE AMR VENDORS**

ABB (electric)
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American Innovations Ltd.
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