SpireCapture™ Automatic Meter Reading System

Submetering is the most accurate method of recovering variable utility costs in the multi-family housing market. By measuring each individual resident's utility consumption and then billing them directly for their use, multi-family properties benefit from reduced variable utility costs, improved net operating income, and increased property value.

Unlike ratio utility billing systems (RUBS), a submetering system tracks each resident's monthly utility use, and a billing company provides a bill to each resident based on their personal usage. Submetering not only reduces a property's operating expenses, but also encourages utility conservation among residents. Research shows that submetering generally yields conservation savings of 20% to 40%. One example is illustrated in the figure on the next page.

Submetering not only saves money, but also improves the marketability of a property. Since residents are responsible for their own utilities, properties can offer more competitive rents, which in turn attracts more prospective residents. Since wireless submetering systems are compatible with water, electric, and gas meters, properties can recover virtually all utility expenses associated with individual apartment units. A property's operating budget is no longer affected by utility rate increases or spikes in resident usage.

With increasing customer service demands, legislation and the need to improve network efficiency and utility conservation as well as reducing costs, there is a growing need for flexible, efficient and cost-effective utility meter reading solutions.
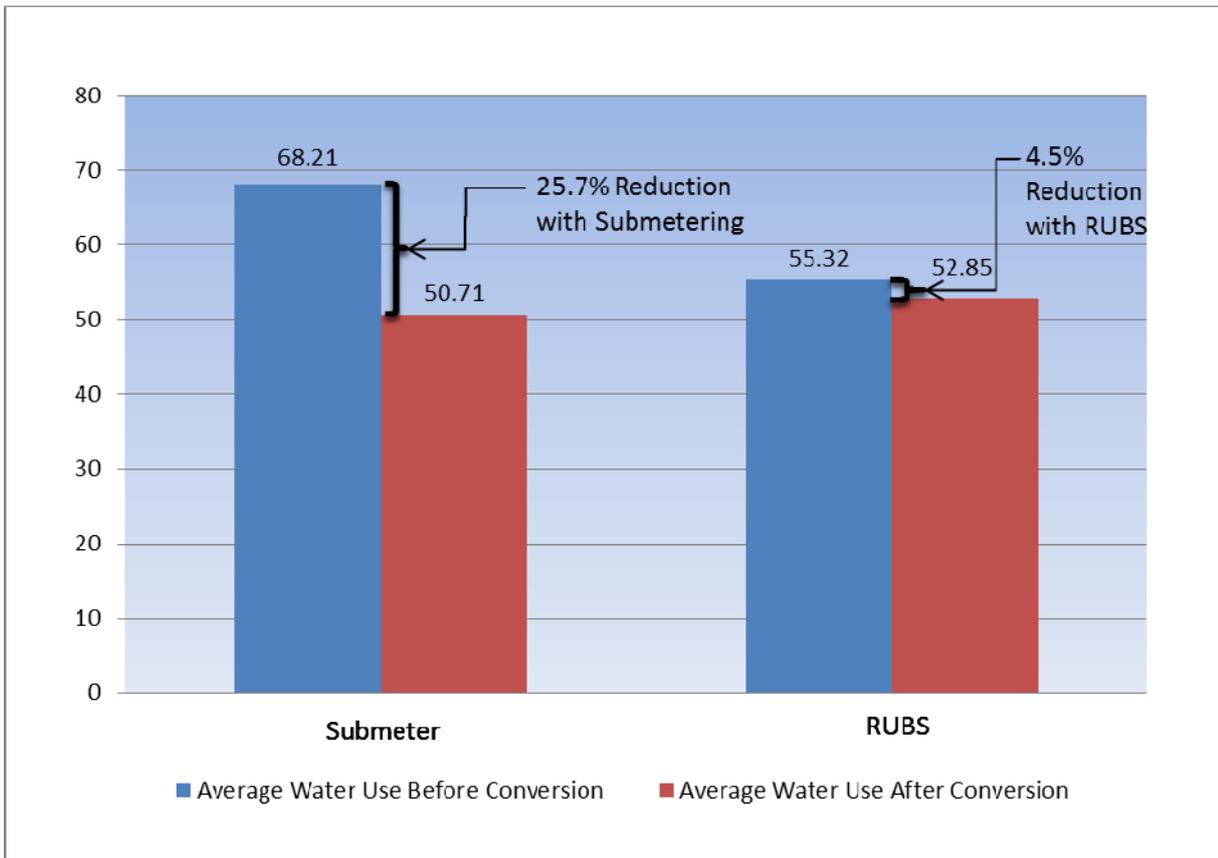
Figure 1. Water Consumption Reduction Comparison

Spire Metering offers a complete range of AMR/AMI solutions. Its SpireCapture™ system is a cutting edge fixed automatic meter reading system which integrates both wired and wireless AMR/AMI technologies. SpireCapture™ provides a unified platform for meter reading and data management through M-Bus networks, RF wireless networks, GSM networks, GPRS networks as well as TCP/IP networks. In addition, it works seamlessly with Spire Metering's billing software to make data exchange easy, fast and reliable.

SpireCapture™ is an advanced, highly robust meter reading solution that delivers comprehensive usage information as well as timely, high-resolution meter reading. This data enables gas, water, heat and electric utilities to eliminate on-site visits and estimated reads, reduce theft and loss, implement time-of-use billing, and profit from all of the financial and operational benefits of fixed-network AMI/AMR.

How the SpireCapture^{TM} System Works

SpireCapture^{TM} is based on a flexible, expandable, multi-tier architecture. It can accommodate a variety of metering networks, such as M-Bus, RF wireless, GSM/GPRS, and TCP/IP. The data center software communicates with those networks through a standardized platform, which allows you to start with a simple AMR system and gradually expand to a large metering system.

SpireCapture^{TM} AMR system communicates with utility meters using MBus protocol. It can also be extended to other protocols such as Modbus. This allows other brand utility meters to be integrated into the SpireCapture^{TM} system.

One SpireCapture^{TM} system, used as a reference, is illustrated in the Figure 2. It consists of the following parts:

- **A M-Bus metering network**
    - A number of 280W water meters with M-Bus interface
    - A number of 280C M-Bus concentrators with GSM wireless interface

- **A RF metering network**
    - A number of 280W water meters, 280T BTU meters and STE101 electricity meters with RF (433MHz) interface
    - A number of repeaters
    - A remote data logger with GSM wireless interface

- **A number of GSM-enabled wireless utility meters**

- **A data center with a computer, AMR Data Center Manager software suite and SQL/Access database**

The following sections explain the components of each metering network.

Figure 2. A typical SpireCapture^{TM} System – A hybrid AMR/AMI network.
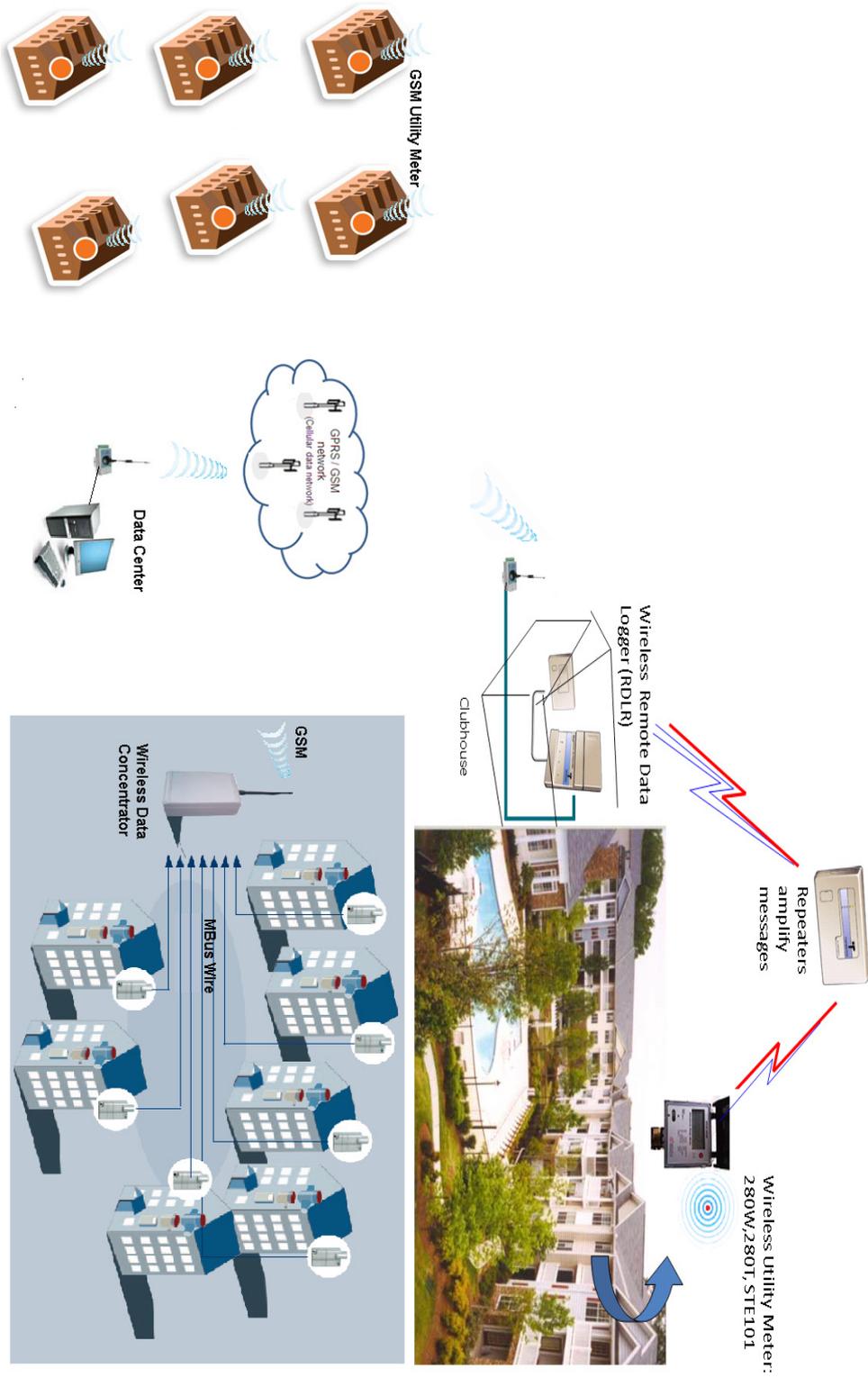
M-Bus Metering System

The M-Bus system is an European instrument 'bus' standard designed for domestic metering devices, such as water meters, heat/water meters, gas meters, etc., to communicate with data centers. The 'bus' simply uses two non-polarized wires to achieve a variety of options for reliable meter reading, remote diagnosis, remote control, incremental pricing, time-based pricing, batch service, prepaid billing, and more. This 'bus' system is both simple and economical to wire and implement.

A typical M-Bus AMR system (Figure 3) is consisted of a number of M-Bus utility meters, several M-Bus concentrators, a GSM/GPRS Data Transmitter Unit (DTU) for each M-Bus concentrator, and a data center.

The M-Bus Concentrator communicates with the data center computer through a GSM/GPRS network. The data center first issues a meter reading command and sends it to the network. The DTU receives the command and forwards it to the M-Bus concentrator. Then, the concentrator either replies to the command with requested data or passes the command to its submeters transparently.

Please note that you may not need the DTU unit if you can connect the M-Bus concentrator(s) to your computer directly. Alternatively, you may connect the concentrator(s) to your computer through TCP-IP network by using Ethernet-232 adapters. Similarly, you may connect the concentrator(s) to your BACnet or MODBUS network by using proper adapters.
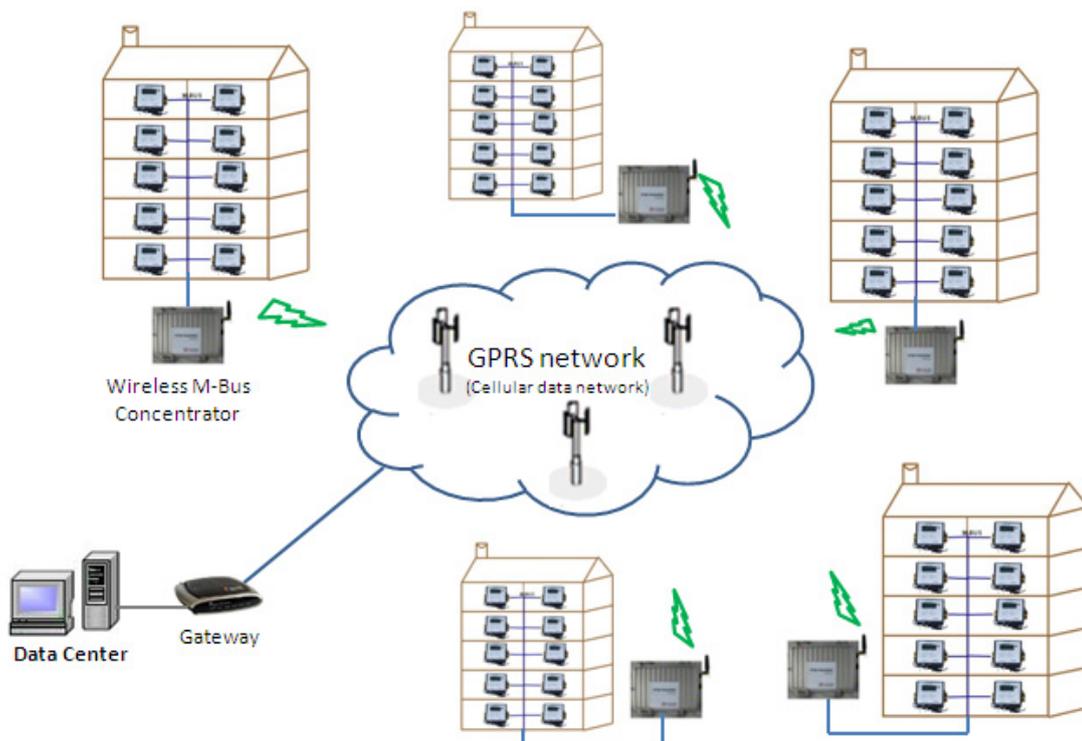
Figure 3. A typical M-Bus automatic meter reading system

M-Bus Concentrator

The 280C Concentrators are used for an AMR system to facilitate the communication between the data center and the M-Bus utility meters of the AMR system. These concentrators support Spire Metering's 280T BTU meters, 280W water meters and STE101C electricity energy meters.

The 280C comes with several variations. Here are three examples:

(1) 280C-0: This is a transparent M-Bus concentrator. It provides M-Bus power to M-Bus meters, and passes the M-Bus protocol between M-Bus meter and upper layer device.
The interface to the upper layer device could be M-Bus (280C-0-0), RS232 (280C-0-1) or Ethernet (280C-0-2).

(2) 280C-1: This is an intelligent M-Bus concentrator. It has a microprocessor and large storage for scheduled meter reading. It not only provides M-Bus power to M-Bus meters, but also automatically reads data from these M-Bus meters, stores this data, and transmits this data to upper layer upon request.
The interface to the upper layer device could be M-Bus (280C-1-0) or RS232 (280C-1-1).

(3) 280C-2: This is a BACnet concentrator for M-Bus meters. It not only provides power to M-Bus meters, but also coverts M-Bus protocol to BACnet protocol and vice versa.

280C-0 M-Bus Concentrator   280C-1 Intelligent Concentrator   280C-2 BACnet Concentrator
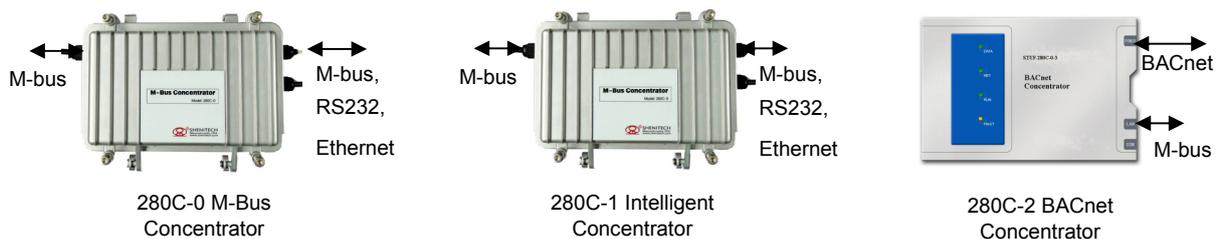
Note: we also supply economical M-Bus concentrators. Please contact us for more information.

Wireless M-Bus Concentrator

A wireless M-Bus concentrator simply means the M-Bus concentrator is affixed with a GSM/GPRS data transmitter unit (DTU).

Data Transmitter Unit (DTU)

A DTU is a GSM/GPRS modem which provides a wireless interface for the concentrator. Spire Metering's EP280 GSM modem and EP260 GPRS modem are specially designed for this application. Both EP280 and EP260 have the following features:

- Support GSM900/1800M dual band or GSM850/1900M dual band
- Transmitting power: 2W (900MHz) or 1W (1.8GHz)
- Receiving sensitivity: <-102dBm
- Frequency error: < +/- 0.1ppm
- Low power consumption
- International standard interface
- Standard RS-232 interface
- Provide SMS services , meet GSM07.05 standard
- DTU device for transparent communication
- Auto reset after power off or manual reset

For more details on the M-Bus AMR system, please contact support@spiremt.com.

RF Wireless Metering System

This fixed network Advanced Metering Infrastructure (AMI) system utilizes a Remote Data Logger (RDLR) to receive and transfer meter data from transmitters located at each utility meter on to the utility computer (Figure 4).

The SpireCapture^TM data management software suite allows easy access to system information and a variety of customer service tools. In addition to providing meter data to the utility's billing system in a flexible and compatible file format, the meter data management software also monitors and controls system performance, manages data, and remotely reconfigures the RDLR as needed.
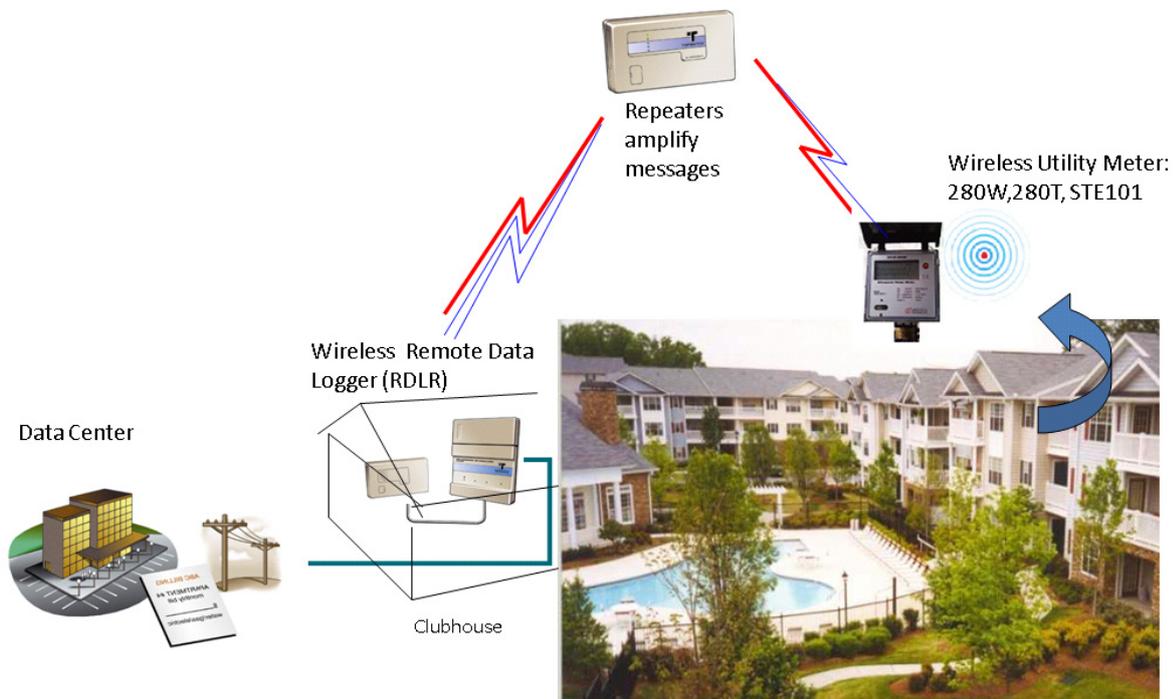
Figure 4. A typical RF automatic meter reading system

1. **RF transceiver**

   Each utility meter has a built-in RF transceiver. The frequency of the transceiver is 433MHz, a free frequency band.
   From a networking point of view, each RF transceiver is an endnote.

2. **Repeater**

   The repeater is an intelligent transceiver that identifies signals from the endnote transceiver and rebroadcasts those signals. The repeater transmits at a higher power than the endnote, so the endnote radio transmissions need only reach the repeater, not the Remote Data Logger (RDLR). This extends the life of the battery in the endnote and creates an accurate, reliable, and cost-effective wireless system.

   The repeater is a high power repeater with a transformer that intelligently amplifies transmission from an endnote

transmitter while ignoring background noise. The repeater is perfect for large facilities such as multi-floor buildings, multi-building sites, shopping malls, campuses and other open-air installations. Virtually any number of repeaters can be added to a system, scaling the system size as needed.

3. **Remote Data Logger**

The Remote Data Logger (RDLR) is a data logger for the AMR submetering system. The RDLR interfaces to the wireless network for collection of utility consumption data, stores the collected data, and transfers the data to a remote billing server for bill generation. A single PC running AMR software is used to access the RDLR.

The receiver, which is part of the RDLR, receives the radio signals from the endnotes and repeaters. The data logger can store meter readings from up to 2000 meters for 99 days. At any time, the billing company can contact the RDLR and download the readings along with site information and any system notices.

GSM Wireless Metering System

For remote locations where wired metering networks or RF networks are not suitable, Spire Metering offers GSM-enabled utility meters. This allows the utility meter to communicate with the data center directly.

One example is illustrated in the following figure 5. A 280W water meter has a built-in GSM modem (EP280). When the EP280 GSM modem is powered up, it starts to establish a wireless link with the GSM wireless network.

On the data center side, another GSM modem (EP260) is connected to the computer. When this modem is powered up, it will also start to establish a wireless link with the GSM wireless network.

The data center software sends a query command together with the destination's phone number and address to its modem, EP260. EP260 then packs the command in SMS format and sends the SMS package to the GSM/GPRS cellular wireless network via SMS service. The SMS service routes this package all the way to the destination modem EP280 which phone number matches that in the command.

When the EP280 receives the SMS package, it strips off the SMS packing information and extracts the original command. Consequently, it sends the command to the meter whose address matches the one in the command. In this way, a number of utility meters, such as water meters, electricity meters, gas meters and valves,

can be connected to the same EP280 GSM modem, as long as they have different addresses.

Figure 5. AMR system reads GSM-enabled water meter directly.

When the water meter receives the command from its EP280 modem, it executes the command and responses with the requested data. The data will be sent to the GSM/GPRS cellular wireless network via SMS service. The SMS service routes this data all the way back to the data center computer.

After receiving the response from the water meter, the Data Center Manager software will process the data, save the data to SQL database.

For the specification of the GSM/GPRS modem, please refer to the previous section.

Data Center Manager Software

Based on many years of meter reading experiences, we established a hierarchy utility management system architecture which is **flexible**, **scalable**, **reliable** and **robust** (Figure 6.) This architecture has been fully implemented in our Data Center Manager (DCM) software.

There are four layers in this software topology, the top layer is district or area management, the second layer is for building management, the third layer is for client management, and the last layer is for utility meter management. A district or an area could be defined as having many buildings, with

the buildings potentially having many clients, and a client having one to four utility meters.
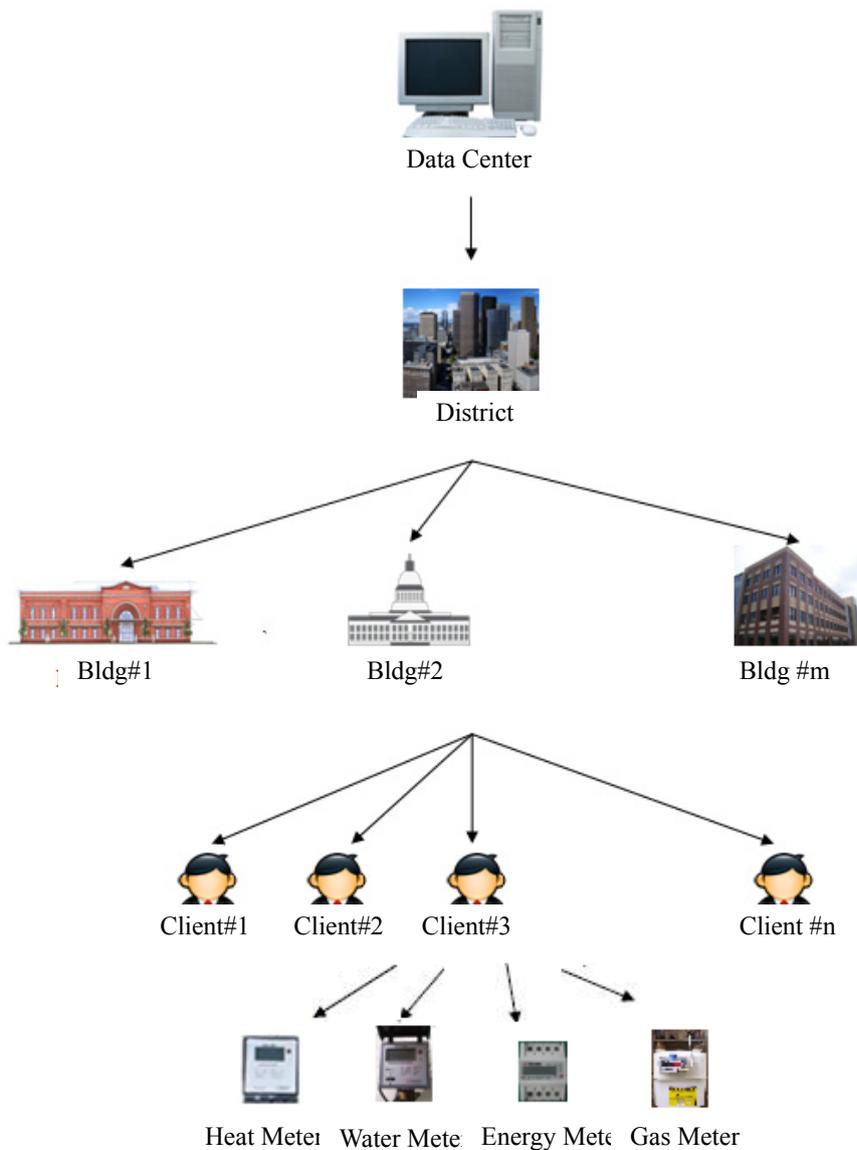
Figure 6. Layered customer/meter management system

The DCM software can run in a Windows XP (or higher) version computer. It allows the user to discover the utility meters in the network by a simple click (Figure 6). It also allows the user to build their client database (Figure 7), and sign the discovered utility meters to the corresponding clients. After building up the meter base and client base, the user can set up the meter reading schedule (Figure 8) so that the software will automatically read the selected meters at the time specified, with all data being saved in a SQL database. The user can review the meter data or generate reports on the

utility usage during a specified period of time (Figure 9). Together with Spire Metering's billing software, the user can get all of the bills ready for clients quickly and easily, with an option for bills to be automatically emailed to clients.

Spire Metering can customize the software according to our customer's specifications. For other software, such as the billing software, please contact Spire Metering at support@spiremt.com.
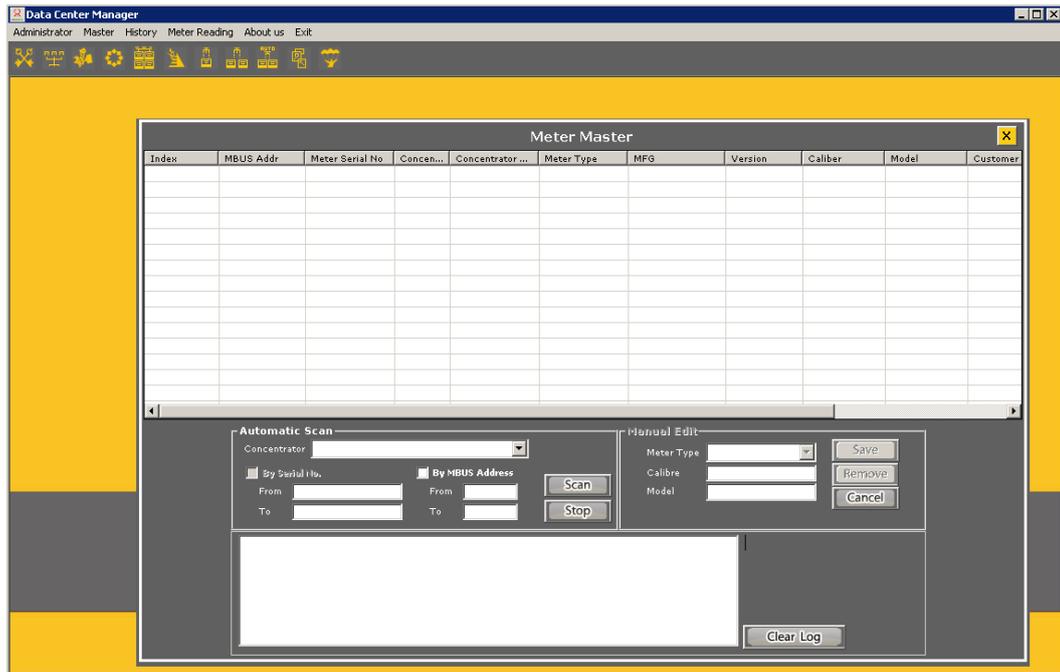
Figure 7. AMR Software is able to discover the utility meters installed on the network.
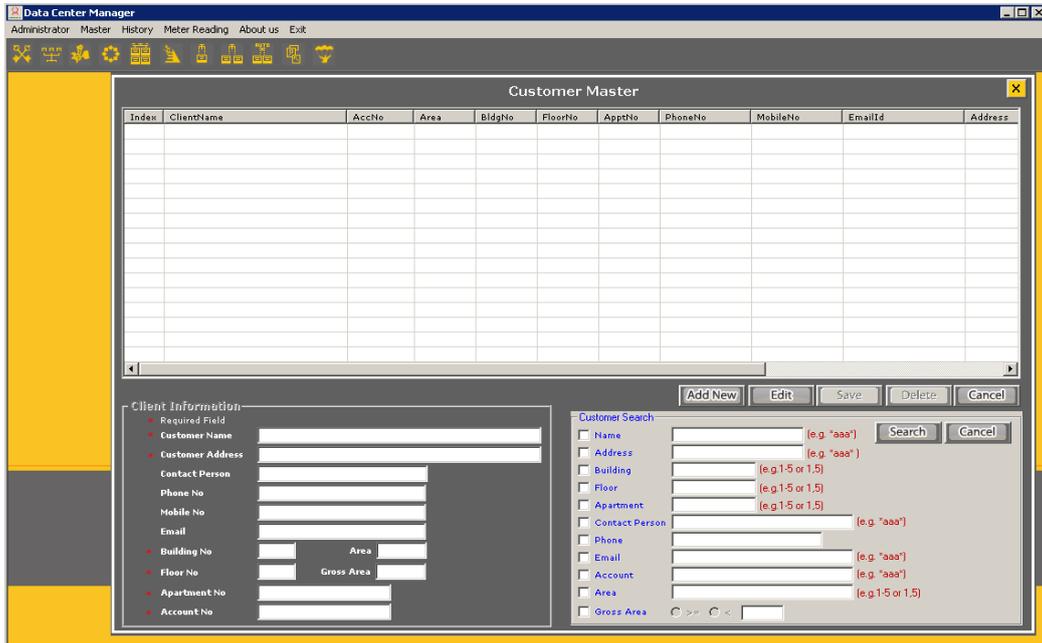
Figure 8. AMR software allows user to build client data base easily.
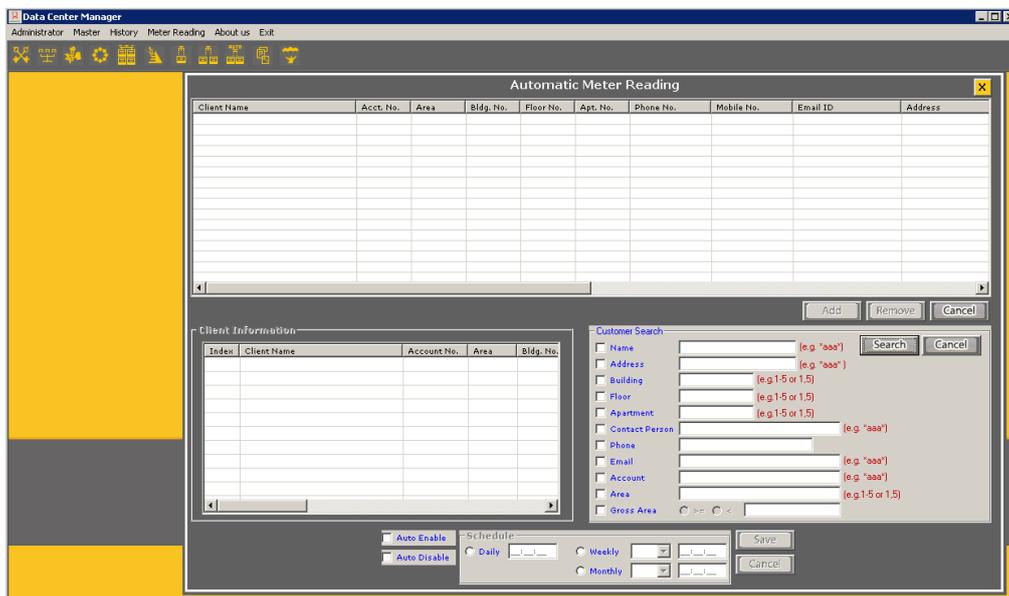
Figure 9. AMR software allows user to set up a schedule for automatic meter reading.