Advanced Packet-Switched AMR Communication

Since the first communicating electricity meter, utilities have used circuit-switched communication where the server connects directly to the meter to retrieve registers and profiles. With circuit-switched communication a communication circuit is dedicated to transactions between the meter and the metering master. Once this circuit is established the master and meter can exchange a series of messages that typically follow an interrogate/response sequence. An example of circuit switched communication is the use of a dial-up phone circuit (Public Switched Telephone Network or PSTN) to connect the metering master to the meter.

Circuit-switched communication has served us well for many years, but it has brought some baggage with it that is less than optimal. Communication protocols that are designed for circuit-switched communication are not entirely compatible with packet-switched networks. This paper describes a technique for using these protocols while providing communication processes that are very efficient and conform to utility communication standards.

Circuit-Switched Communication

With circuit-switched communication establishing the connection may take as long as 20 seconds. However, once a circuit is established, many small messages can pass back and forth over the circuit with very low overhead, and this is exactly how meter protocols work. Rather than using high-level messages with heavy content, the meter protocols use very primitive messages that each performs a very simple operation. An example is seen on the next page of a typical demand read of a meter using a modern C12.19 Meter Protocol. It can be seen that 24 individual messages are required to perform this task.

Packet Switched Communication

All modern wireless and land-based networks use Internet Protocols, which are packet-switched communication. With packet switched communication each message is encapsulated into a packet and sent through the network for eventual delivery to its destination. Interrogate/response protocols like meter protocols are very inefficient when using packet-switched communication for the following reasons:

- Latencies (the time between when a message is sent and when it is received) can be higher for packet-switched communication than for circuit-switched communication once a connection is established.
- The minimum allowable packet size is much larger than a meter protocol's typical message
- The user is billed based on the total data volume sent (including almost empty packets) not total connect time like circuit-switched service

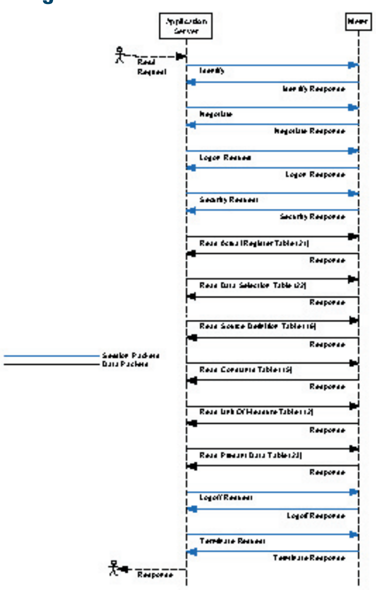
When using packet-switched communication, the best way to communicate is to use a few very high-level messages verses many low level messages. Indeed, the exchange shown (see reverese, figure 1) can be accomplished with two messages - a very detailed description of the required data, and the return of that data.

The Solution

The solution is obvious – use a high-level protocol as described above. But which protocol? Are all existing meters obsolete? The "which protocol" question will be answered in the next section, and the answer to the second question is "no". Comverge has implemented an architecture that allows all existing meters with their existing protocol to be retained. This is achieved by moving the software module that communicates with the meter to the meter's location. This is shown in the diagram on the next page (figure 2).

There is a gateway (Maingate C&I) next to the meter that communicates with the meter using the meter's native protocol. The profile and register data is then stored in the database. When a request is made for specific data, the gateway updates its database by communicating with the meter (if required), and then sends a single message back into the Internet. For a normal daily read, the master does not even interrogate the gateway. At a scheduled time the gateway sends the data into the Internet for delivery to the master.

Figure 1



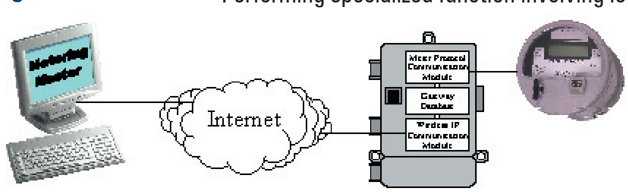
In some tests we performed with a popular polyphase meter the total amount of data sent through the Internet using the standard meter's protocol was 12,034 bytes per day. The Comverge high-level protocol reduced this to 1,321 bytes per day, a reduction of almost 90%.

Other Advantages of a Local Gateway

The local gateway has significant computing recourses, and thus can perform tasks related to improving the availability of the metering, communication and ancillary functions. These include:

- Interrogating the meter every few minutes for operational anomalies and immediately reporting these back to the master if they occur (for instance power quality alarms or a failure to respond)
- Modifying meter parameters or firmware via downloads – this can be done en masse (for thousands of meters) for generic problems or changes
- Performing specialized function involving local I/O

Figure 2



Which Protocol?

Since there are no high-level protocols as described above defined by the metering industry, you might expect that this protocol would be proprietary. Even though the metering industry has not defined such protocols, the electric utility industry (specifically EPRI) has.

In 1988 EPRI launched the Utility Communication Architecture project to define a standard set of architectures and protocol recommendations to allow simplification and interoperability among utility systems and intelligent devices. This ultimately resulted in a set of recommendations generally referred to as UCA-2.

UCA and MMS

IEEE SA TR 1550-1999 (attached) describes this process: "The Utility Communications Architecture is a standards-base approach to many utility communications that provides for wide-scale integration at reduced costs and solves the most pressing communication problems for today's utilities. The UCA is designed to apply across all of the functional areas within the electric, gas and water utilities. These functional areas include customer interface, distribution, transmission, power plant, control center and corporate information systems."

Under Section 4.3, UCA Version 2.0 for Field Devices, it says: "Modeling efforts within the customer interface area are in progress. These include metering and interfaces to residential and commercial customer devices… The device models developed within the UCA Version 2.0 effort make use of a common set of services to describe the communication behavior of the devices. A standard mapping of these services into the UCA application layer protocol (MMS), when used in conjunction with the device models, completely specifies the detailed interoperable structure for utility field devices."

MMS (Manufacturing Message Specification) is an internationally standardized, object-oriented messaging system for exchanging real-time data and control information between networked devices. MMS is an international standard (ISO 9506). The messaging services provided by MMS are generic enough to be appropriate for a wide variety of devices, applications, and industries.

MMS History

In the early 1980s a group of numerical controller (NC) vendors, machine builders and users came together with the objective of developing a generic and non-industry specific messaging system for communications between intelligent manufacturing devices. This eventually resulted in the MMS effort begun under ISO Technical Committee Number 184.

Conclusion

Comverge has taken the lead in using MMS for AMR. We are committed to following the standards process and being compliant with the recommendations as they evolve. The advanced packet-switched communication technique used by Maingate C&I provides much lower communication loading resulting in lower communication costs and provides other operational benefits.

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