Communicating Submeter Data Via BACnet®

By David Bovankovich

Electric submeters provide a cost-effective way to identify large amounts of energy savings (*Table 1*) that otherwise might be missed by the master utility meter at the main service entrance. Submeters are installed on the facility side of the main utility meter to shadow utility-metered energy consumption at the enterprise level all the way down to tracking a single device or circuit panel. In general, there are three common types of submeters in commercial use today (*Table 2*).

The first two types—feed-through and current transformer (CT)-based—are socket meters. CT-type socket meters typically are used with loads of 400A and above. In commercial applications, the extra space required for CT cabinets and meter bases diminishes available rental space. Additionally, socket-type meters are not UL listed. The third type is the solid-state electronic submeter, a non-socket device that provides several operational advantages, including space savings.[1]

Of Submeters and BACnet

It wasn't all that long ago that the only way we could access information from an electric submeter was to walk up to it and write down the reading. Now, the two most common ways of talking to submeters are through proprietary energy analysis software residing on the user's PC tied into open-architecture protocols or through a pulse output into an energy management system. The two basic methods of communication are through a "hard-wired" system or by means of a phone modem.

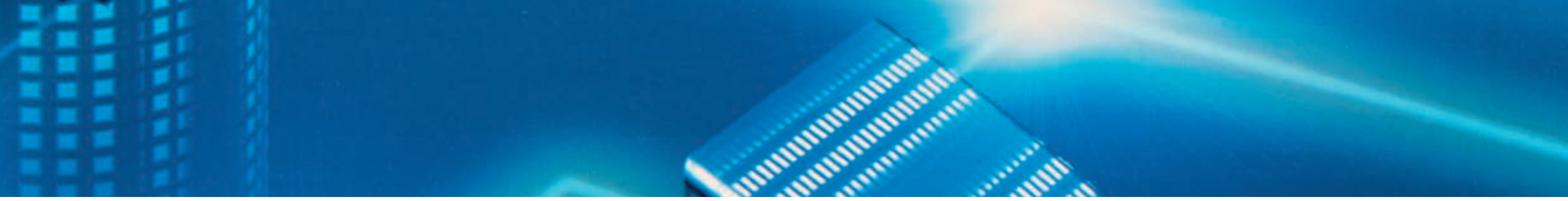
The hard-wired system works through dedicated EIA-485 (formerly called RS-485) cabling or through an Ethernet connection that uses an existing network. Ethernet communications do require an optional module and an IP address. Using the EIA-485 approach allows up to 4,000 ft (1220 m) of cabling to be run in the building. The manufacturer's software is happy to use all of these methods simultaneously and is easily set up to do this. One important thing to remember is that pulse meters have to be used with an IDR (Interval Data Recorder) to provide communication.

When using a phone modem, the meters and IDRs can be "daisy-chained" with the EIA-485 cabling and then converted to EIA-232 to connect with the modem. This provides access to the entire network of meters using a single system with only one modem. Hundreds of meters at a location can be read from a single modem through IDRs and meters from diverse equipment suppliers.

For communications, BACnet is useful for talking with submeters, especially for HVAC. BACnet-compatible meters can communicate over either an EIA-485 cable system or use Ethernet cabling. When used with EIA-485, the BACnet

About the Author

David Bovankovich is vice president of engineering for E-Mon in Langhorne, Pa.



Metering Strategy	Use of Meter Data	Typical Savings
1. Install meters only with software for data collection	Storing energy data from individual buildings	0%
2. Strategy 1, plus cost-allocation software	Monthly reports for all departments and monthly bills to all outside vendors / reimbursables	2-5%
3. Strategies 1&2, plus operational analysis and building tune-up	Above plus internal review/adjustments of building operations, time schedules, etc.	5-15%
4. Strategies 1-3, plus *continual on-going* operational analysis and building tune-up	Above plus continuous, on-going commissioning and adjustments of building operations, time schedules, etc.	15-45%

Table 1: A number of effective metering strategies may be implemented by facilities to achieve a sliding scale of savings based on the type of hardware and software systems employed. Source: FEMP Fact Sheet: "Facility Metering for Improved Operations, Maintenance and Efficiency," January 2005.

Specifications	Submeter Type		
	Socket Type Electromechanical/Solid State		Electronic Non-Socket Type
	Feed-Through Type	Current Transformer Type	
INSTALLATION			
Installed Cost (estimated)			
Stand alone, up to 320A, 3Ø	$1000	Not Available	$800
Stand alone, over 320A, 3Ø	Not Available	$2000 – $5000	$900
8-Meter Unit, 200A, 3Ø	$16,000	Not Available	$6500
Installation Time	2–3 Hours	6–8 Hours	1 Hour
Power Interruption	2–3 Hours	6–8 Hours	None
Amperage Limitations	320 Amp, Max.	None	None
Space Requirements	2 ft^2	11.7 ft^2	0.25 ft^2 (single); 2.0 ft^2 (8 m)
Installation Location	Utility Room	Utility Room	Anywhere
FEATURES			
Multiple Meter Units (MMU)	Yes	Yes	Yes
Size of 8-Unit Cabinet	18.1 ft^2	18.1 ft^2	2 ft^2
Digital Readouts	Optional/Yes	Optional/Yes	Standard
Reset Capabilities	No/Yes	No/Yes	Standard
Multiple Load Monitoring	No	No	Yes
Subtractive Load Monitoring	No	No	Yes
Monitor Specific In-Panel Circuits	No	No	Yes
Amperage Modification in Field	No	w/ CT Change	Yes
Meter UL listed	No	No	Yes
ENHANCEMENTS			
Digital-to-Analog Profiles	Yes	Yes	Yes
Pulse Outputs	Yes	Yes	Yes
Timed Metering	Yes	Yes	Yes
Software Monitoring	Yes	Yes	Yes
Upgradeable in the Field	No	No	Yes
Power Quality Functions	Available	Available	Yes
Net-Metering Capability	Yes	Yes	Yes
Form C Control Relay Output	No	No	Yes

Table 2: Non-socket-type electronic submeters are less expensive and offer superior performance and options compared to other types, making them a cost-effective means for measuring and verifying facility energy program goals. Source: E-Mon.

How Meters Help Save Energy

HVAC&R systems, lighting and plug load together account for nine-tenths of the facility's energy consumption and for that reason provide a significant opportunity for bottom line impacting energy-efficiency measures aimed at optimizing performance, reliability and service life of:

- Boilers and steam traps
- Chillers and cooling towers
- Air compressors and air-handling systems
- Fans, pumps and motors
- Lighting systems
- Office equipment
- Energy management and other automated building systems

Once meters are installed and commissioned, they may be used to control costs, diagnose equipment problems, allocate usage costs, set resource efficiency goals and many other uses. Meter data information can lead to large economic savings by allowing facilities personnel to:

- Profile real-time energy demand (kW) and consumption (kWh) patterns
- Compare energy demand and usage trends by day, week, month or year
- Monitor all utility services, including electricity, gas, water, steam and more
- Schedule energy data collections to occur automatically
- Evaluate, in real-time, the impact of critical load-shedding activities
- Determine specific processes that are not energy-efficient
- Identify poor equipment performers by benchmarking energy levels at multiple facilities

MS/TP (master-slave/token passing) protocol is used. When Ethernet is the communication choice, BACnet/IP (Internet Protocol) is used.

Energy managers can monitor all of their facilities from a single location. When tied to the Internet, meters anywhere in the world can be read without the long distance charges incurred by using phone modems. Access time is also quick, an especially valuable feature if the meter data needs to be seen in real-time.

Breaking down the percentages of HVAC&R, lighting and plug loads provide the user with a foundation for analyzing what energy savings steps are appropriate for a given reduction plan. As that plan is implemented, meter data can be used to judge the success of each step. BACnet ties the metering network into the data gathering system and into a load management system when automated (proactive) features are introduced into the savings process.

In demand response applications, submeters communicating via BACnet can be placed on the dispensable loads, in addition to the master point, to report data on the total and individual loads. This not only provides assurance that the curtailment requirements are being met but eliminates the possibility of penalties and proves compliance.

In mixed-use buildings, submeters with BACnet communications can be used to separate the commercial and residential tenants to comply with recent benchmarking regulations, such as those in New York and Philadelphia. This allows only the commercial aspect of the building to be reported in compliance with regulatory requirements—an advantage over the utility master meter that is incapable of providing the necessary breakdown of user types.

Aggregated meter data from multiple points/tenants in a facility can be used to determine the billing demand peak and then be broken down by the individual meters to locate the root causes of that peak. Analysis of these details will be the reference point to see where demand cost savings can be initiated either through a curtailment process, equipment update, or through possible load shifting.

BACnet Object Types

BACnet defines several standard object types that can be used to define load characteristics of various electrical measurements. A BACnet object is simply a collection of information related to a particular function that can be uniquely identified and accessed over a network in a standardized way. Each object is characterized by a set of properties that describe its behavior or govern its actions. Objects may represent single physical points or logical groupings that perform a specific function.[2] Typical BACnet object types used to characterize electrical consumption include:[3]

Accumulator—pulse-accumulated meter characteristics used for peak load management and high-accuracy billing functions.

Analog Input, output and value—instantaneous electrical consumption, typically used by submeters.

Averaging—calculation of the min, max and average values of another BACnet value.

Load Control—used for managing load shedding to reduce demand peaks or when responding to real-time pricing.

Pulse Converter—used in peak load and account billing applications.

Trend Logging—used to collect and store time-series data for managing utility consumption trends.

In *Table 3*, BACnet analog input objects illustrate the granularity of energy information in meter communications via BACnet MS/TP and IP applications.

Conclusion

Submeters with the ability to collect, store and automatically report hourly, daily, monthly and/or annual energy consumption data will play an increasingly important role in measuring and verifying the aggressive energy management goals of sustainable standards, and other energy initiatives.

References

1. George, J. 2011. "Fine-Tuning Green Building Performance Measurements with Electric Submeters." IEEE Chicago

Units	Description	Analog Input Value(s)	BACnet Property
kWh	Kilowatt Hours	Energy delivered and received	Present Value
kVARh	Kilovolt-Ampere Reactive Hours	Reactive energy delivered and received	Present Value
kW	Kilowatts	Real power, average all phases; real power phases A, B and C; peak demand	Present Value
kVAR	Kilovolt-Amperes Reactive	Reactive power, average all phases; reactive power phases A, B and C	Present Value
kVA	Kilovolt-Amperes	Apparent power, average all phases; apparent power phases A, B and C	Present Value
%PF	Percent Power Factor	Power factor, average all phases; power factor phases A, B and C	Present Value
A	Amperes	Current, average all phases; current phases A, B and C	Present Value
V	Volts	Voltage line-to-neutral, average; line-to-neutral phases A-N, B-N, C-N; line-to-line, average; line-to-line phases A-B, B-C, C-A	Present Value
Hz	Hertz	Frequency	Present Value
Degree	Phase Angle	Phase angle, average; angle phases A, B and C	Present Value

Table 3: BACnet Objects are primarily confined to the Analog Input category for submeter applications, although Device Objects are used to characterize the equipment used to collect the data. Source: E-Mon.

Section: "Today's Engineering Challenges – Tomorrow's Solutions" Conference Paper.

2. Newman, H.M. "BACnet, A Tutorial Overview." www.bacnet.org/Tutorial/HMN-Overview/sld001.htm.

3. Holmberg, D.G., Bushby, S.T., Butler, J.F. 2008. "BACnet for utilities and metering" *ASHRAE Journal*, April.■

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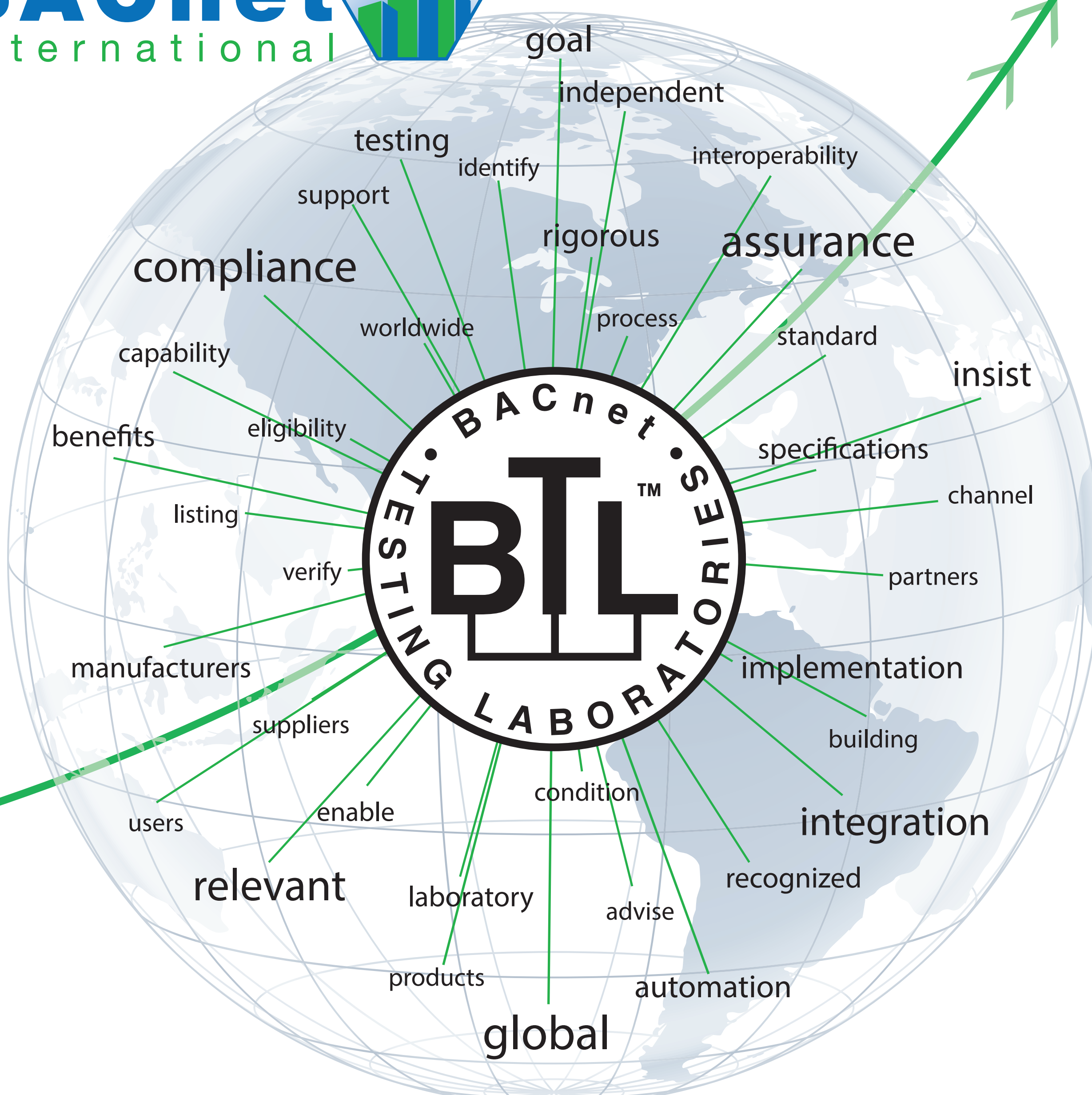

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