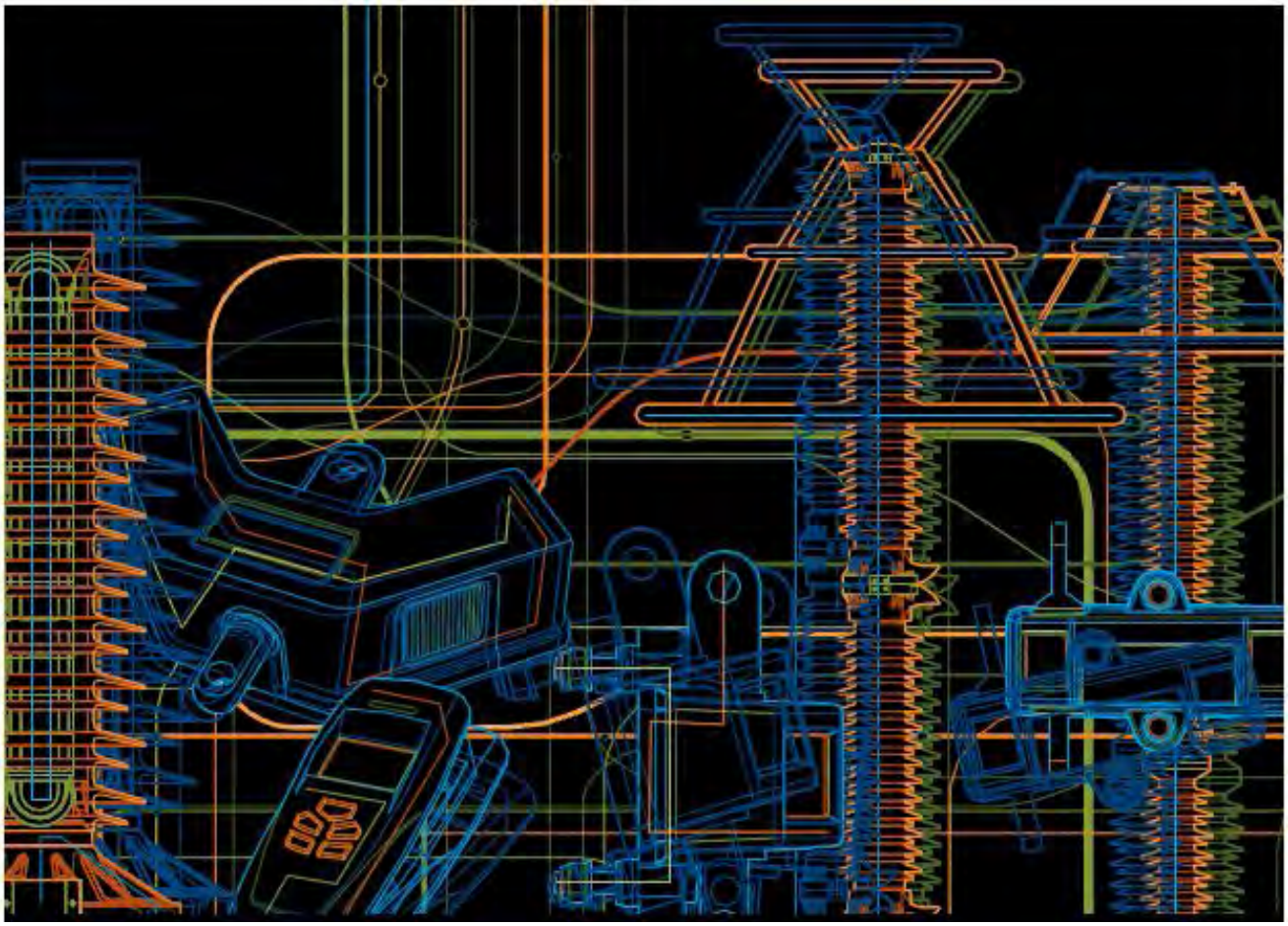
Energy Manager Management System

(with wireless energy data collection)



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1. Executive Summary

This report highlights ABB's energy management system with an exclusive focus on wireless networking to gather real time energy data. The material, intended for a business decision-maker audience, is organized into three sections followed by a brief conclusion. The first section describes cpmEnergy Manager and its main features. The second section is dedicated to wireless networking to collect energy data followed by the final section describing metering and measurement. Although some of the topics are technical by their very nature, every attempt is made to cover each in a non-technical way.

2. Introduction

Energy management is the overall concept which ranges from planning of requirement to selection, installation and operation of energy generation systems. The objective is to provide complete coverage of the energy needs of the consumer and to use the most minimum amount of energy at the given comfort or production levels (residential and commercial).

Energy management can be applied in every building where energy is required: Industrial buildings, office buildings, sports halls, residential buildings and apartments, etc.

- Reasons for energy management
- Guaranteeing the provision of an interruption free supply of energy or power
- Retention of the voltage or current quality
- Economic efficiency (favorable power or heat prices, conservation of energy)
- Environmental aspects (conservation of energy, energy recovery, independence of fossil based primary energy carriers)

2.1 cpmPlus Energy Manager

cpmPlus Energy Manager is a software product to help customers in all industries to monitor, manage and optimize their energy usage for maximum efficiency and cost savings. Focusing at the business side of energy management, it is a key element in any company's energy management program. The key is to be able to produce accurate energy demand plans and taking advantage of them in energy supply planning and optimization. Using this information both in regulated and de-regulated energy markets provide significant financial advantages, and ultimately lowers energy costs.

Energy Manager is a modular product to assist in the energy efficiency improvement and cost reduction of industrial facilities. It allows an implementation to start small and grow over time. The implementation process proceeds in three steps:

- Energy Monitoring and Reporting

  An entry level system built upon the cpmPlus platform makes use of the history database, user interface and calculation and reporting tools to provide an Energy Monitoring and Reporting package.

- Energy Load Planning

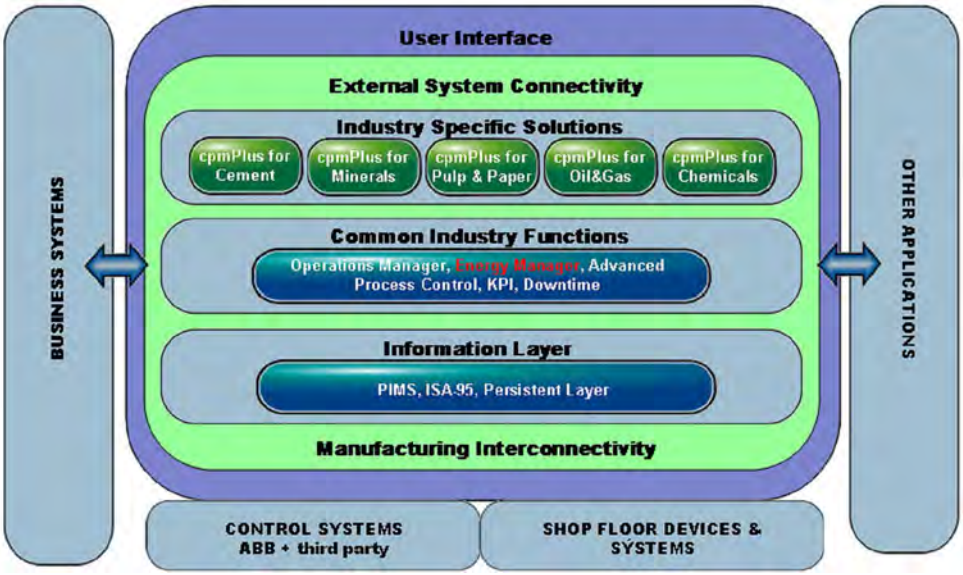
  Consumption schedules for major consumers are usually calculated based on the planned production schedule. To model interdependencies between time, weather etc. and energy consumption, Self Organizing Maps (SOM) is used.

- Energy Supply Planning and Optimization

  Energy Supply Planning and Optimization calculates the cost optimized mix of purchased electricity and own power generation facilities to meet the consumption schedules.

Energy Manager is completely scalable; this modular solution can start with basic energy monitoring and reporting at a single facility, and later expand to include multiple sites, or be implemented throughout the entire industrial facility to optimize energy use and manage energy supply costs. As a corporate wide solution, Energy Manager may span multiple regions and countries to serve hundreds of users at different sites.

Energy Manager is a core component of cpmPlus (www.abb.com/cpm), ABB's Collaborative Production Management suite of applications. cpmPlus provides process and production management, advanced optimization and connectivity solutions for the process industries (see the figure below).



2.1.1 Energy Monitoring & Reporting

Measuring of the energy consumption of equipment and processes is the basis for efficiency improvement. Energy Manager collects all the necessary energy data from multiple sources using both wire and wireless networks in order to calculate energy efficiencies and provides easy to use visual tools for monitoring and targeting. Monitoring and targeting is the basis for economically profitable investments in energy efficiency improvement. The system helps reduce energy consumption by comparing the actual consumption against targets and identifying targets where improvement is required.

2.1.2 Energy Consumption Planning

Energy Manager calculates the consumption unit specific energy consumption schedules based on the production planning information. The consumption schedules are cumulated to the total plant energy consumption schedule, which can be sent to the energy suppliers or used as the basis for energy supply planning.

The consumers are classified into a number of types, and the prediction method depends on the type as follows:

1. Constant load

   Energy consumption is constant

2. Weekly load profile

   Energy consumption varies according to a weekly profile representing the average power values. Period length of the profile depends on the billing period of the power market. Typically it can be 5min, 10min, 15min, 30min or 1 hour. The profiles may be automatically adapted to approach the actual measured consumption.

3. Cyclic profile

   Energy consumption varies according to the cycles of the process. The profile is specified at a resolution of 1 min for some typical product grades. The prediction is synchronized with actual operation of the process at cycle start and end.

4. Product grade dependent load

   Energy consumption depends on product grade and rate

5. Self-adaptive profiles

   Energy consumption varies according to the day of the week and the hour of the day. Consumption is related to some other measured variable, like outdoor temperature, air humidity or wind speed. The method of Self-Organizing Maps (SOM) is used to adjust the profiles based on the measured data.

The Load Planning function can handle up to five separate utilities for each consumer, e.g. electric power, steam, gas, water, oil.

2.1.3 Energy Supply Planning and Optimization

Energy Manager's Resource Optimization (RO) serves as an optimization engine to select the appropriate supply resources to meet the consumption schedules at minimum total cost.

RO is also the key element for the official balance settlement procedure needed for electricity balance providers and grid operators. In the balance settlement procedure the actual electricity generation, consumption and purchase and sale transactions are settled for each billing period, and as a result the power balance

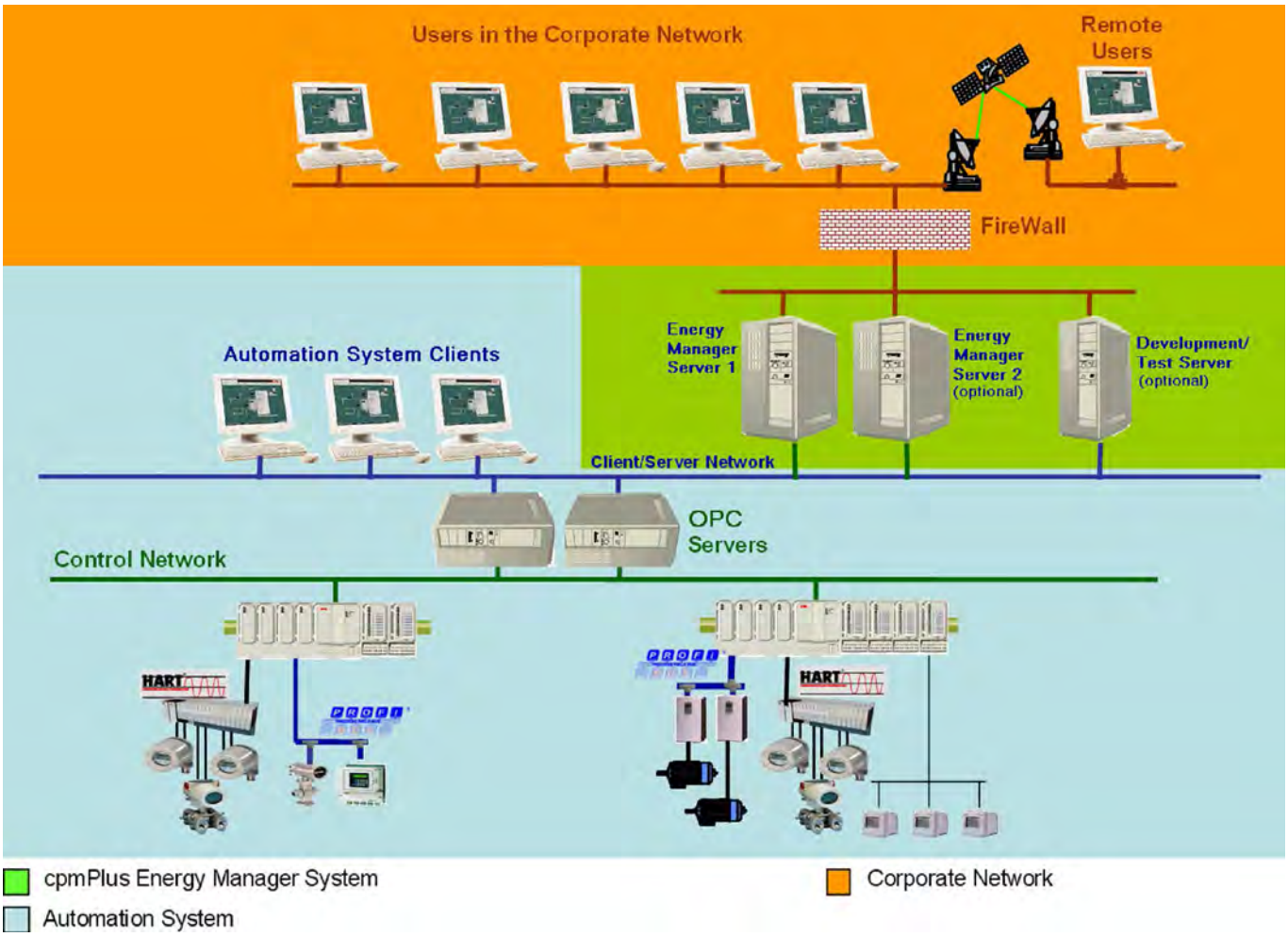
for each party in the electricity market is known. RO includes a general-purpose integrated LP/MIP optimization environment for on-line execution of optimization tasks.

The optimization supports parallel and distributed computing, where the whole term of the problem can be divided into shorter time slices and solved in parallel in a set of interconnected computers.

2.2 System Architecture

The figure below illustrates the system architecture. Energy Management System consists of an Energy Manager server (including the database) and user client computers. The Energy Manager Server collects data from automation and SCADA systems and other external systems.

Examples of such external systems are production planning systems, web-pages and energy management systems of other parties. Energy Manager Server can also send set points or communicate actual or forecasted volumes of procurement or production to other participants on the electricity market.



For energy management applications requiring high availability the Energy Manager can run in a redundant server configuration. In such case there are two or multiple instances of databases replicating their content in real-time and providing redundancy for the system applications and users (see the figure above, optional EMS server 2). The redundancy provides the following benefits:

- Reliability of the system is much higher than achieved with e.g. Windows cluster based configuration. Also the price of the system is lower, because there is no need for special equipment, but standard computers can be used to build the redundant system. The system can be setup in a multiple server configuration to increase reliability further.

Data collection is secured without any interrupts in the case of hardware or communication failure. Software upgrades can be carried out without any interrupts in system operation. Missing or obsolete configuration and data in a single node is restored automatically in a short delay by replicating the data from the other Energy Manager servers.

Load sharing for applications and users. Any of the servers can be set to serve the users or run the applications as specified.

2.3 Software Architecture

The foundation of the Energy Manager is ABB's cpmPlus Knowledge Manager (KM) database, which is located in the EM server computer.

KM is a relational database that is designed and optimized for process information management and extensive history recording. High performance and reliability, together with maintenance-free operation, provide a solid platform for mission-critical systems. KM combines the benefits of easy-to-use relational desktop database with industrial reliability, performance, and real-time functionality to provide an excellent platform for process information management.

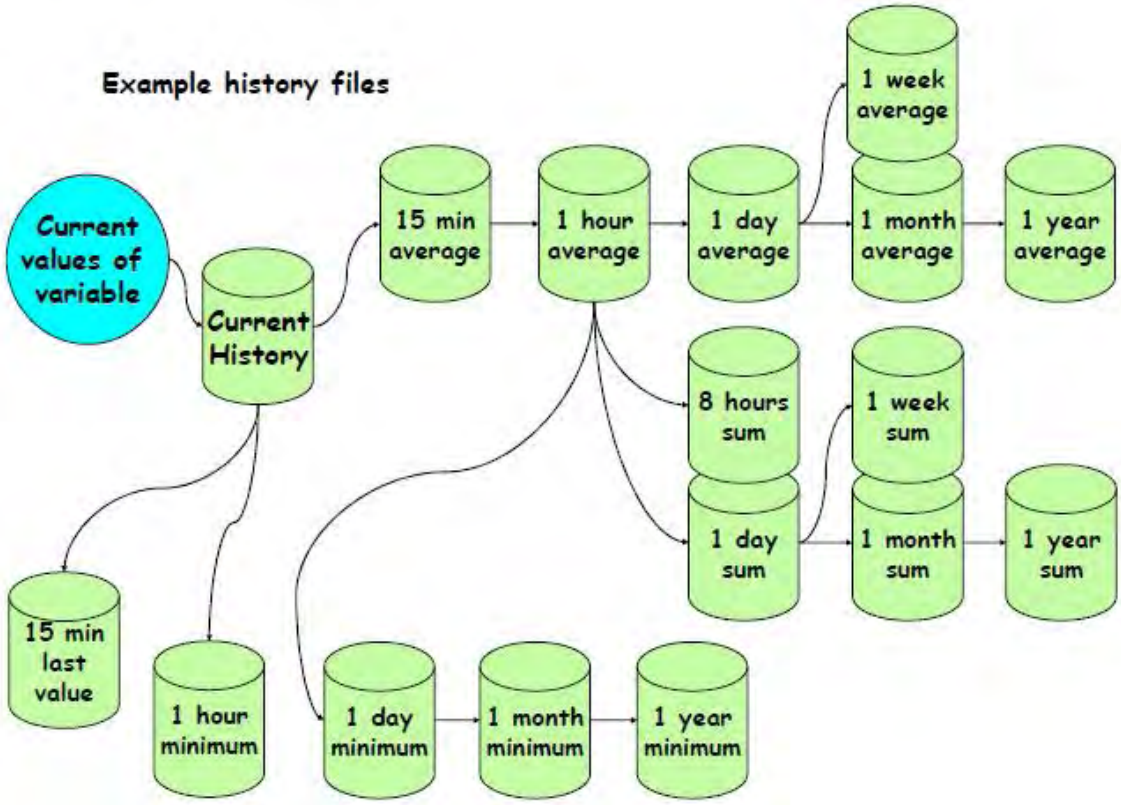
2.3.1 Variable

Variable is a basic concept of the database, and it can be used to refer process measurements, calculated variables as well as parametric values. Variable is identified by its name (tag name) and it has a set of engineering attributes, current value, and typically also time based history of the current value, calculated aggregate values (averages, sums, minimums, maximums, standard deviations, time integrals, operating times, change counts) and forecasted values. Variable types can be binary, integer, floating point, or text.

2.3.2 History Database

The system collects current values of measured and calculated variables and records them into a current history file in a compressed form. This enables users to examine recorded current values retrospectively at specified accuracy. The system also generates and stores various aggregates of the values of the variables over configurable time intervals, e.g. 1min, 15 min, 30 min, 1 h, 8 h, 24 h,

1 week, 1 month, 1 year (see the figure below). The data collection cycles, aggregate types, time levels, and time spans of the histories are configurable using system administration tools, as part of the initial system setup.



Within the limits of the available disk memory space, the storage capacity can be configured to cover the desired time histories. An example history table configuration and the corresponding disk space requirements are given in the following table.

History table	History span, months	No. of variables	Disk space, GB
Current values	3	1000	12
1 min averages	12	1000	11
15 min averages	240	1000	14
1 hour averages	240	1000	2
8-h averages	240	1000	0,2
24 h averages	240	1000	0,1
1 month averages	240	1000	0
1 year averages	240	1000	0
15 min forecasts	240	200	3
Total disk space required, GB			42

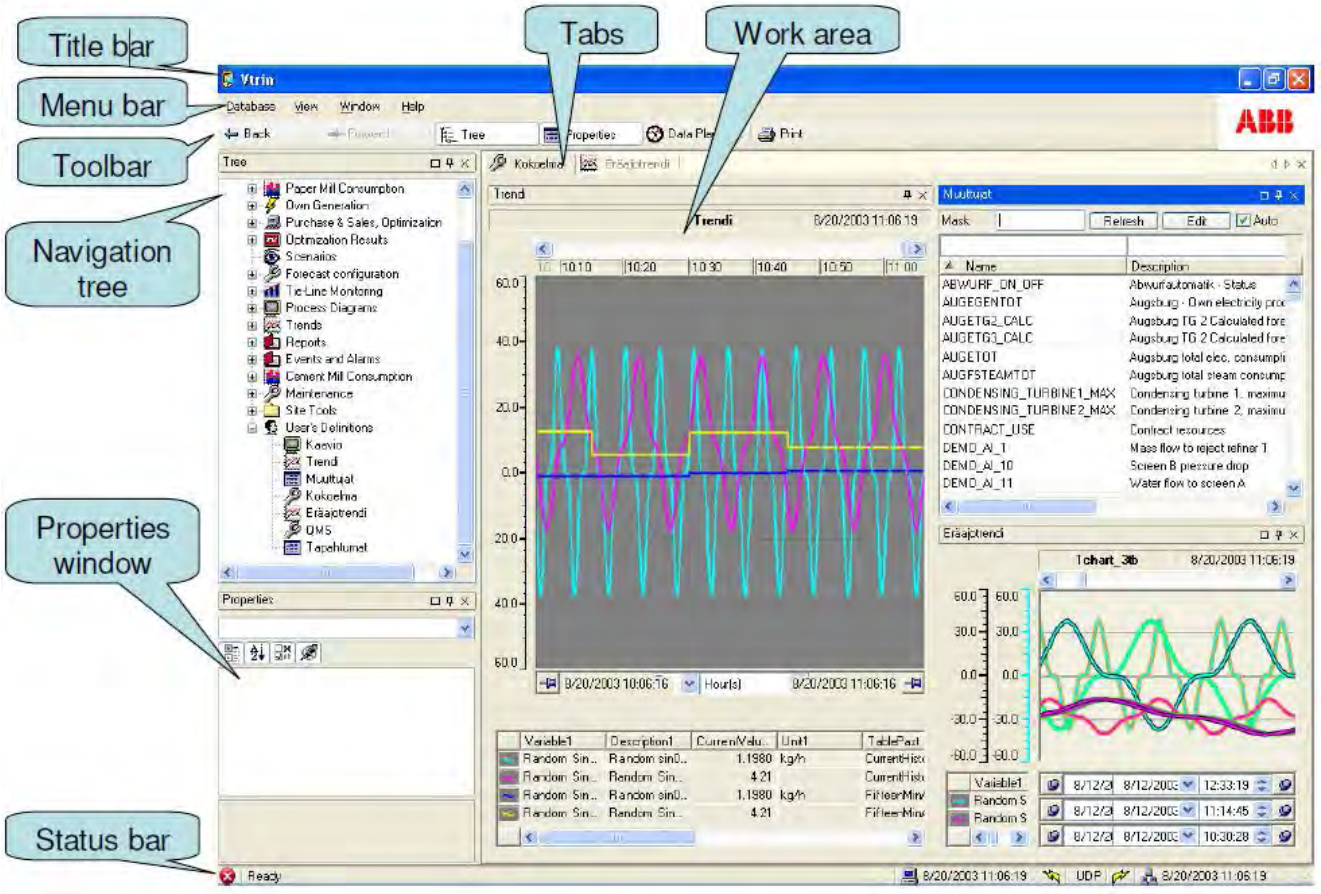
2.4 User Interface

The user interface is based on the techniques and principles commonly used in the Windows operating system. This enables an operating environment that is easy to use and easy to learn by all users from the operators to the engineering personnel and plant management.

The following figure shows the desktop layout of the user interface, which includes

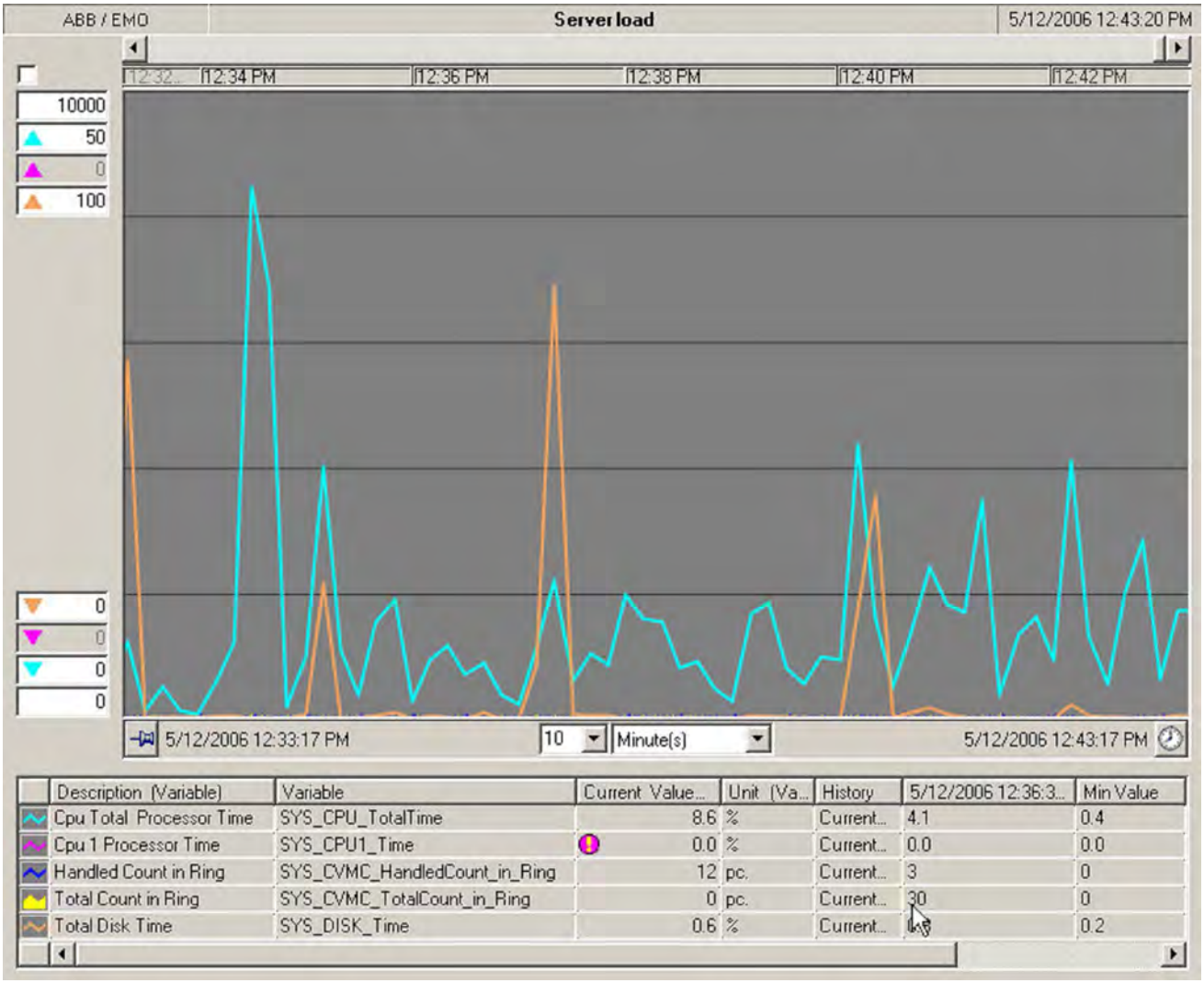
- Navigation window with menu tree
- Main window, where the displays called up from the navigation tree are presented
- Title bar
- Menu bar with pull-down menus
- Toolbar
- Tabs for quickly switching between the displays in the main window
- Status bar
- Properties window

The sizes and visibility of the different areas can be controlled by the user.



2.5 Standard Displays

User Interface provides a set of standard displays for data presentation and tools to implement application specific displays. The displays provide functionality for context sensitive parameter exchange that allows e.g. drill down functionality. User can open aspects, i.e. displays, from a data item on a display with the current data context as parameters for the new display.



2.6 Other Interfaces

2.6.1 OPC-Client

An OPC interface is normally used to input process data into the EMS. The OPC-client transfers data (measured values with status and time stamp) between a data acquisition system (DAS) and the EMS by communicating with the DAS's OPC server.

The OPC-client interface is compatible with OPC DA version 2.0 and 1.0a. The input data to the EMS is retrieved cyclically through the interface. The cycle rate is configurable. The signal types are either analogue signals or binary signals.

2.6.2 Application Specific Interface

Application specific interfaces are specifically designed and implemented for the particular system, for instance:

- Weather forecast reception via FTP/email/web-interface
- Sending forecast to power utility using Excel or txt format
- TCP/IP interface to send commands to the control system

3. Energy Data Collection

The recording of energy data is continually gaining in significance. The demands placed on recording and evaluation as well as on billing and charging in commercial buildings, in industrial systems, and residential properties has increased significantly over recent years.

Energy Manager offers a wide range of industrial interfaces, explained under section 2.6 specially designed for these applications.

What is Automatic Meter Reading (AMR)?

Automatic Meter Reading (AMR) is the process of remote reading of data from meters. AMR allows the suppliers of electrical energy, as well as water, gas and district heating to improve the handling of their contracts and services. The ongoing costs involved in manual reading of the meter are eliminated and the consumption data become transparent.

Wireless communications is transforming the energy industry by connecting consumers to providers, and power generation to more efficient distribution networks. Electricity, water, gas, and oil utilities are deploying Smart Grid and Smart Metering solutions with the objective of improving customer service, meeting usage demands, increasing efficiency, reducing costs, and meeting environmental targets.

Wireless communications are critical to building end-to-end energy management infrastructures. From intelligent meters, transmission and distribution networks, and remote monitoring to improved management applications

The following sections highlight wireless data collection schemes.

3.1 Wireless Energy Data Collection

A wireless energy management system consists of flexible configurations of sensors, controls, and sub metering devices. Wireless communication significantly reduces the time, cost and disruption involved in deploying sub-metering installations

- Affordability

Wireless is significantly more affordable to install than a hard-wired solution. It eliminates the hours of labor needed to pull miles of wire, often reducing costs to a quarter of what a hard-wired installation would run.

- Speed and Convenience

With higher ease of installation come not only lowered costs, but also reduced to no downtimes for building occupants' daily operations.

There is a trade-off between speed and distance

- Slow speed for long distances
- High speeds for short distances

- High speeds provide low latency
- Low speeds result into high medium access time

Multi-hops can bridge long distances at higher speeds and consequently provides better co-existence with greater reliability

- Flexibility

With the growth of wireless technology over the past several years, applications can now fit a wide range of buildings and business goals. The strongest feature of wireless mesh networking in an energy management application is its scalability: a few sensing devices and a single control module can be installed in a small retail store, or hundreds of nodes and scores of controls can be used throughout a big complex (e.g. college campuses).

- Reliability

Advances in technology and long battery life mean that wireless mesh can function with reliability in structures of all sizes. Mesh networking's noted ability to self-form and self-heal further enhances this reliability. Wireless mesh has performed reliably in virtually every type of commercial building, including hotels, restaurants, transportation facilities, commercial offices, health care facilities, and historic structures.

Most energy management systems being planned today are retrofits; wireless is the technology that often makes these installations possible. Installing a wired energy management system is frequently prohibitive in terms of costs, as well as disruption to business.

Wireless sensors and controls make energy management installations feasible in a number of buildings where nothing else would be possible.

As wireless technology becomes more widely adopted, the potential exists to dramatically reduce the energy consumption of commercial buildings.

3.2 Main Components of a wireless network

A wireless network consists of several components that support communications using radio or light waves propagating through an air medium. Some of these elements overlap with those of wired networks, but special consideration is necessary for all of these components when deploying a wireless network.

Two main types of energy meters are normally part of the wireless energy management network.

- Conventional Meter
- Smart Meter

Conventional meter requires additional transducer and radio to transfer data wirelessly to the nearest data gathering station or (node).

Smart meters have built in electronic to transmit data wirelessly to the nearest data gathering station.

3.2.1 MODBUS Multidrop Converter

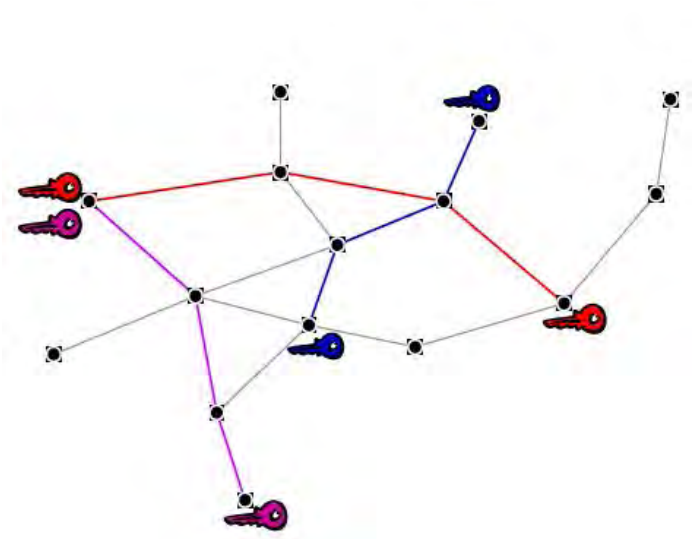
These converters provide serial links to conventional energy meters without any ‘Smart’ functionality built in.

Limitations:

- For two wire device the number of devices should be limited to 16 when using 20 gauge wire
- For a four wire RS-485 device which can be stretched up to 1000 ft. It also depends on the data traffic too

3.2.2 Wireless Network

A Mobile Ad hoc Network (MANET) is a collection of mobile devices (often referred to as "nodes") that form a self-configuring network. The devices communicate wirelessly by relaying data across the network through a sequence of transmissions. In a true MANET configuration every node can communicate with every other node enabling true peer-to-peer connectivity. This is in marked contrast to the far more common mesh network design, in which a series of stationary access points connect end users only to the Internet. The system detects changes in connectivity and, using a revolutionary routing protocol, elegantly adjusts the pathways in order to maintain the most efficient route between them.



MANET Characteristics

- MANET is a self-configuring group of wireless routers designed for mobility that forms an arbitrary topology that adapts to the environment. The topology may change rapidly and unpredictably.
- Provides multi-hop routing via alternate paths, and cross spectrum bridging for fault tolerance, coexistence, and jamming avoidance.
- Rapidly adapts in the presence of interference, and will coexist with other devices that occupy the spectrum.
- Security is equally challenging requiring sophisticated, scalable, and efficient key management.
- It can serve as backhaul for wide range of converged services including process control.

Wave Relay™

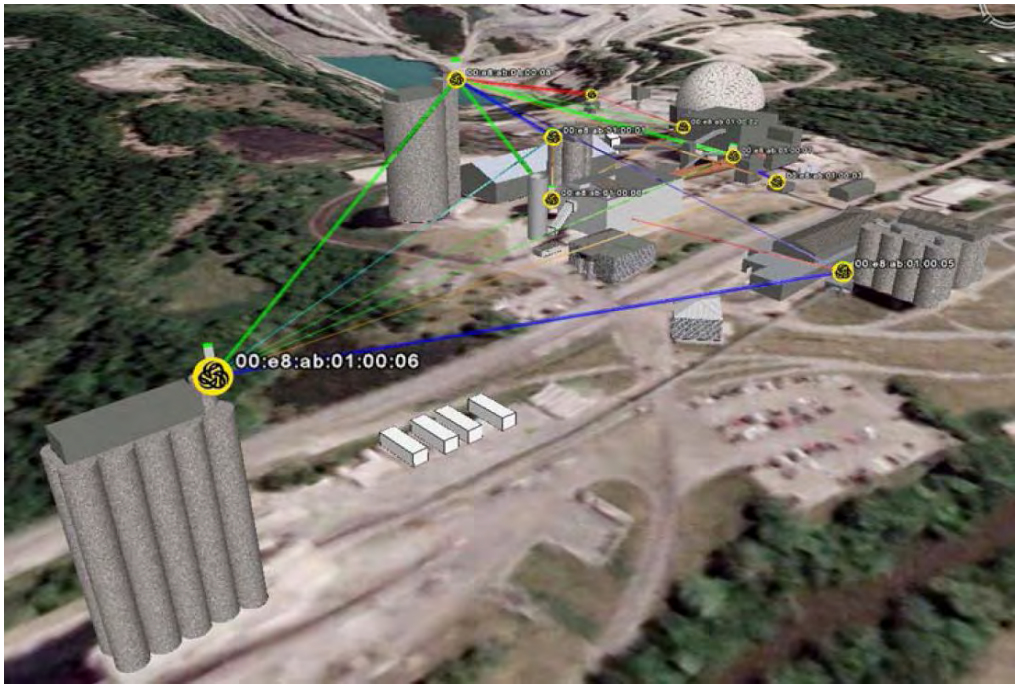
The Wave Relay™ Quad Radio Router provides a scalable high performance wireless solution for deploying large mesh or Mobile Ad Hoc Networking systems. The router can contain up to four separate wireless radios, all of which participate in the routing. By utilizing four radios, the Wave Relay™ Router can simultaneously provide a multi-channel, multi-hop backhaul and provide connectivity to client devices. This configuration offers a single solution to all mesh networking needs.

Wave Relay™ is a mesh based wireless communications system designed for mobility:

- Provides the ability to seamlessly connect users, devices and networks over large geographic areas and in challenging RF environments.
- Provides ability to secure data and routing traffic over multiple hops on an end-to-end basis.
- Provides use of multiple IP protocols on multiple radio spectrums over multiple active routes simultaneously with an aggregate bandwidth greater then a single channel providing assured availability

- Provides a secure, scalable, high performance extended network that can leverage an existing wired and/or fiber infrastructure
- Contains up to four embedded radio modules. The standard radio modules operate in the 2.3 – 2.5 GHz and 5 GHz frequency bands, also available in customized configurations to support other frequency bands such as the 4.9 GHz Public Safety Band.
- Capable of forwarding up to 70 Mbps of TCP throughput across multiple wireless hops.
- FIPS 140-2 Certified AES-256 bit encryption
- Provides an advanced key management capability to validate all nodes
- No central server for routing or security information means there is any single point of failure. All nodes provide active routes over any spectrum simultaneously and will failover instantly.
- Redundancy is accommodated effectively via spectrum diversity providing jamming resistance.
- The Wave Relay system has been used by the DoD, DHS, and others within the US federal government. It has been used for industrial applications for many years providing a robust, highly resilient network infrastructure without constraints allowing any IP protocol to be used.
- Possible to connect any Ethernet enabled device including *Smart Meters directly or via MODUBS RTU Multiplexers* which convert to MODBUS/TCP. If the field devices support OPC then they can be connected directly.
- Also accommodates Non-Line-Of-Sight (NLOS) or Line-of-Sight (LOS) with the same technology.
- Wave Relay can also leverage the existing wired or fiber infrastructure since it is implemented at the ISO/OSI Layer 2 (Data Link Layer).
- Devices can be managed from any node and can be updated easily from a web browser. The diagnostics for checking link quality and data throughput are built-in as well as help files.
- Additional benefit: Devices can also be viewed with Google Earth with either static or dynamic coordinates from the built-in GPS receiver. This allows the links to be viewed dynamically and change color with the data rate of the link.

Example:



- Provides link statistics to view the network performance. The devices are powered by Power-over-Ethernet (PoE).
- Software updates can be applied to the whole network or to a single node via the web browser or the nodes configuration can be downloaded easily.
- Designed to rapidly adapt to network changes so in network and environmental conditions.
- No network expansion constraints

Wave Relay™ is deployed by DoD contractors on both Unmanned Aerial Vehicles (UAV's) and Navel Unmanned Sea Surface Vehicles (USSV's). It is being used through some of the most challenging deployment scenarios, which benefit industrial and municipal customers through the deployment of the most sophisticated MANET technology for their civilian applications.

Specifications

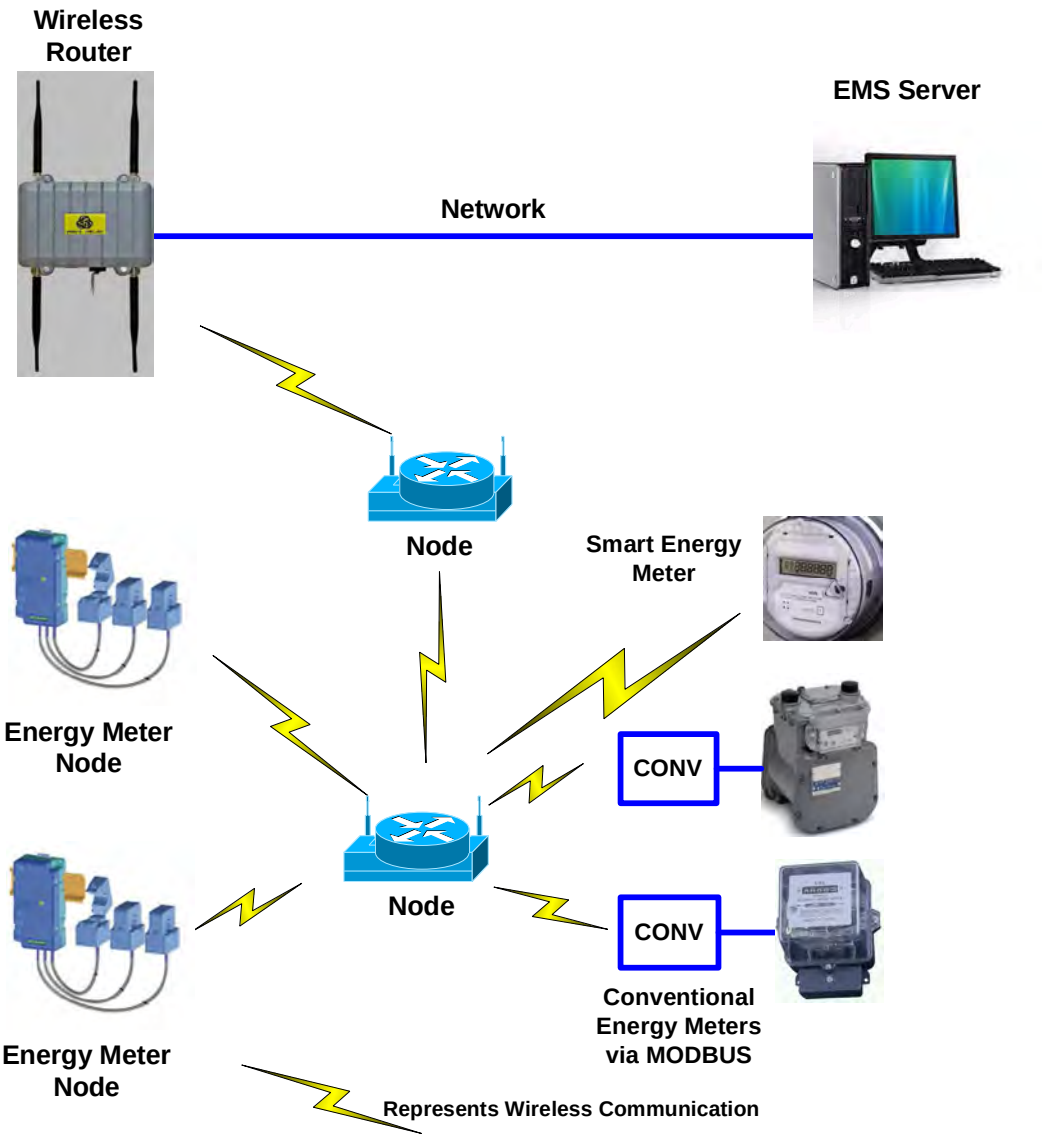
Radios:	4
Peak TX Power:	600 mW
Channel Access:	CSMA/CA
Channel Width:	5, 10, 20, or 40 MHz

Radio Configurations

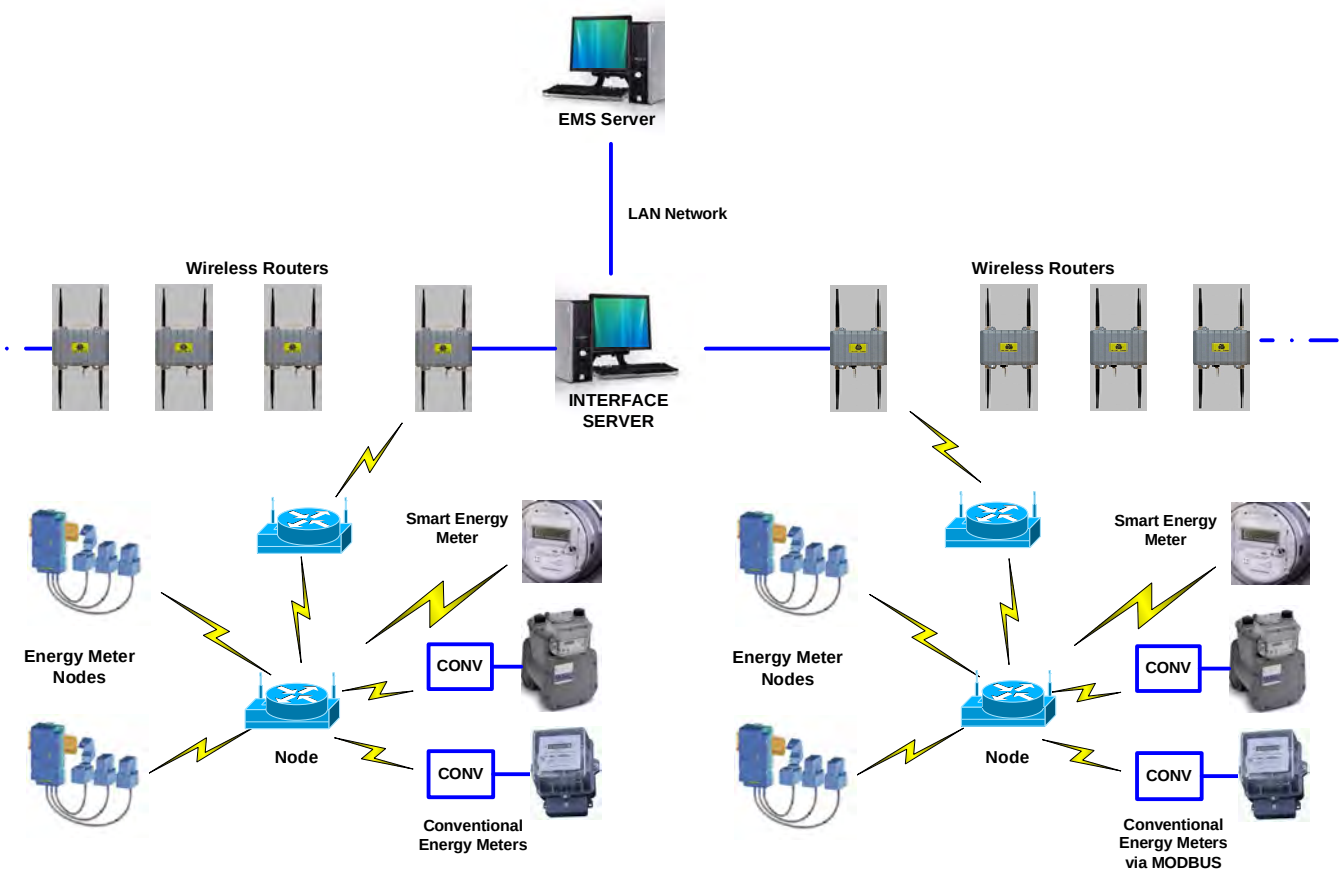
Standard	(3) 5 GHz Radios – (1) 2.3 – 2.5 GHz Radio
Customer	700 MHz, 900 MHz, 2.3 – 2.5 GHz, 2.4 GHz, 2.6 GHz, 3.5 GHz, 4.9 GHz and 5 GHz

3.2.3 Configuration of Wireless EMS networks

A small network of few meters located in a small area may have the following simplified network configuration.



A large network containing several nodes, distributed in a wide area, may have the following configuration.



Multiple routers form a mesh network to connect various nodes (or areas) with the EMS server.

Interface server is mainly responsible to collect and streamline data, for the main EMS server, in a large application. There could be multiple interface servers with multiple interfaces with third party systems.

Additional nodes can be added with an appropriate antenna and point the antenna toward another node that is operating in the spectrum and add the node to the node list which is replicated to all of the other nodes. It is possible to isolate multiple networks via the node list which provide cryptographic segregation of data traffic.

The capacity of the network can be as high as 30+ Mbps by utilizing directional antennas between the locations with sufficient future expansion capability without complexity.

4. Metering & Measurement

Metering and measurement represent a key component of the overall energy management system (EMS). Timely measurement of utility consumption, ambient conditions and process variables allow plant or facility to

- provide cost-centre accounting
- identify problem areas before they become out of control
- verify utility billing
- assist in energy purchasing
- assist in maintenance and troubleshooting
- aid in identifying and monitoring energy projects offer meaningful data toward sizing and design for capital installations and improvements

Reliance on main utility meters, except in the cases of small plants or facilities, is inadequate for determining utility consumption profiles in these areas. Sub-metering allows for energy use accountability to be introduced at the level of the end-user, who has the greatest influence on driving operating costs downward, unlike plant or facility utility personnel.

Having established the need for metering and measurement, the next step is to develop a measurement plan that outlines a road map for installing monitoring equipment. This plan should identify

- all monitoring points
- types of sensors and their locations
- signal cable routes and wireless communications
- necessary documentation

The measurement plan precedes the preparation of a data acquisition plan and subsequent analysis. The end-user must ultimately define the frequency of measurements (e.g., 15 minutes, hourly, etc.) and whether monitoring will be for a short or long term.

The following sections highlight different type of energy meters which could be used to poll energy data.

4.1 Electrical Metering

In many cases, power quality and feed protection issues represent the driving force for sub-metering electrical power instead of energy management considerations.

Power meters owned by the site for monitoring total power to a major load centre

would typically be located at the point of delivery (sub-station) and monitor the watts and Q-pulse from the utility revenue meters. Total kVA, kW and kVAR readings would then be calculated from these signals.

A typical digital power meter for this application would offer a digital readout display and a maximum sampling rate of 128 Hz. A standard version may allow for a maximum of four channels. In comparison, a premium, more advanced version of this power meter would include most of the same features but have a video display terminal and allow for a maximum of 42 channels. The premium version is generally more suited to revenue grade metering and would offer power quality analysis, event-triggered data storage and logging.

An economical power measurement unit for sub-metering could typically offer a digital readout display and a maximum sampling rate of 32 Hz. Typical power measurement would include apparent power (VA), reactive power (VAR) and power factor (PF). This unit would typically be ideal for use as a power transducer for DCS, EMS, SCADA and PLC systems.

Deregulated power users need to comply with their regional power system providers' certain special metering requirements.

4.2 Natural Gas Metering

In most cases, natural gas sub-meters with dial indicators are used. Larger areas of natural gas consumption may have meters that make use of the utility's pulse signal.

Natural gas meters range in size and capacity from 2-in. (50-mm) flanged connections at 800 CFH (22.6 m3/hr.) capacity to 56 000 CFH (1600 m3/hr.) rating. For small commercial loads of up to 15 psig (1 bar), compact line-mounted meters with a dial-face or odometer-type index can be purchased. For higher-volume industrial loads, a full range of meters that are rated for working pressures of up to 300 psig (24 bar) are available.

Thermal-dispersion-type flow meters offer relative simplicity of measurement through a single-pipe penetration, thus eliminating temperature and pressure transmitters and density compensation calculations required by differential pressure, vortex and turbine type metering. As such, less hardware is needed for a metering system, and this flow meter offers an alternative and accurate means of gas-flow measurement. Communication between the flow meter and signal processor assembly is over two-wire pair. Linear output signals of 0-5 V DC or 4-20 mA can interface with either RS 232 or RS 485 communication.

4.3 Steam Metering

Orifice plate meters are in common use throughout plants. Calibration data would have to be obtained either from the facility's calibration records or from a meter's nameplate data. Steam flow is proportional to the square root of the pressure difference across the measuring orifice plate.

Vortex flow meters, although more costly, offer greater accuracy compared with orifice plate flow meters and have over three times the “range ability.”

Another alternative to flow measurement by orifice plate is offered by annubars, which consist of diamond-shaped sensors that are inserted in the flow stream.

4.4 Water and Condensate Metering

Existing turbine, rotating disc, vortex and magnetic flow meters can usually be retrofitted with a pulse head. Final confirmation of this should be made with the meter manufacturer. Although rarely calibrated, most of these flow meters probably have reasonable accuracy if the meters are in serviceable condition.

Numerous types of venturi, annubar and orifice plate meters that use differential pressure transmitters are normally available in the field to collect useful data.

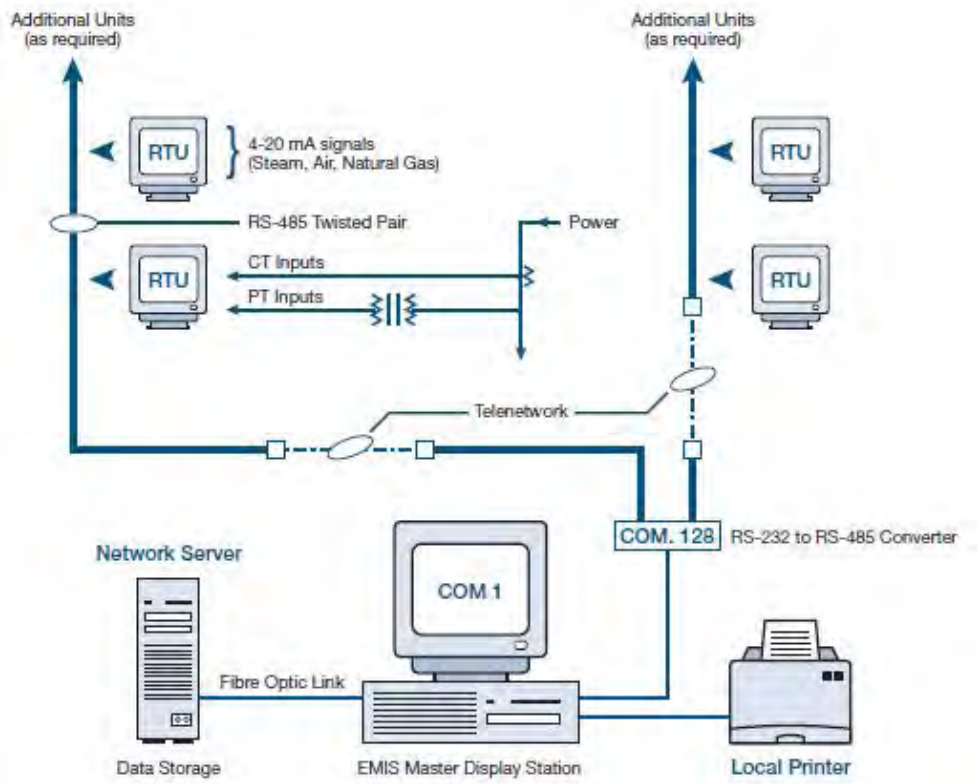
4.5 Linking Meters to Monitoring System

Energy management system needs to be configured to collect energy data in real time format from various remote electronic meters (natural gas, power, compressed air, steam and water).

Most meters normally have analogue output options (4-20 mA), serial digital interface options (direct RS 232) and network bus communication interface capability, for example, Ethernet, Modbus remote terminal unit (RTU), etc.

Although most meters can be initially used on a stand-alone basis, these can be integrated within a complete plant or facility-wide system for monitoring and control through a common communication link, offered through open architecture.

The following figure illustrates a commonly used system that utilizes RTUs mounted in the field to monitor energy use in various areas of a plant or facility. The RTUs are interconnected via a local area network (LAN) to a main EMS computer.



4.6 Meter Suppliers

Smart Meters, available from different suppliers, can be used to collect energy data over a wireless network.

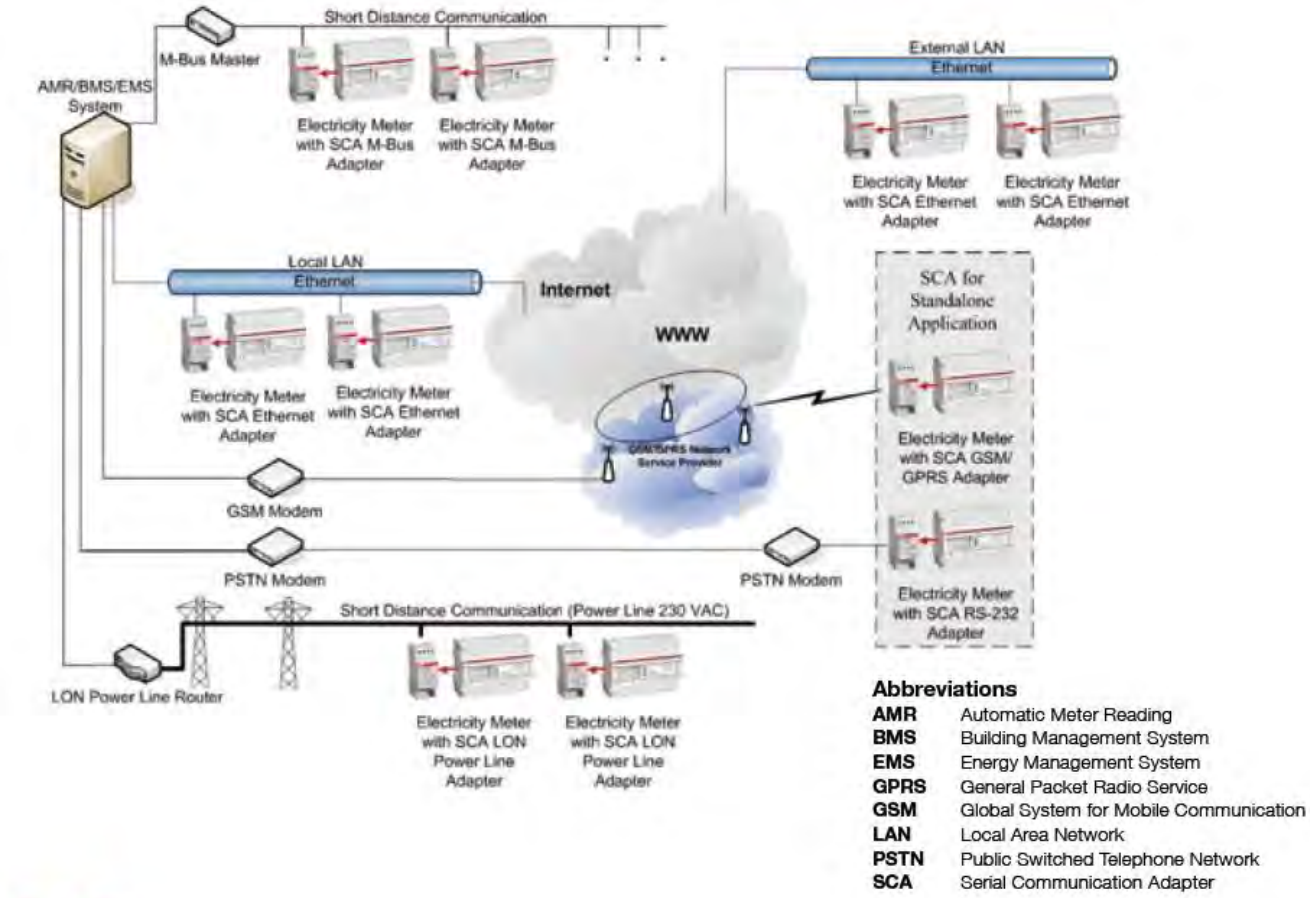
ABB have a complete range of DIN-mounted electricity meters for different applications, together with a wide range of communication options. The meters are quick and easy to install due to their DIN-rail mounting.

There are four different product lines:

- ODINsingle,
- DELTAsingle,
- ODIN and
- DELTAplus

Together they offer several types of configurations for different applications due to their intelligent programming possibilities.

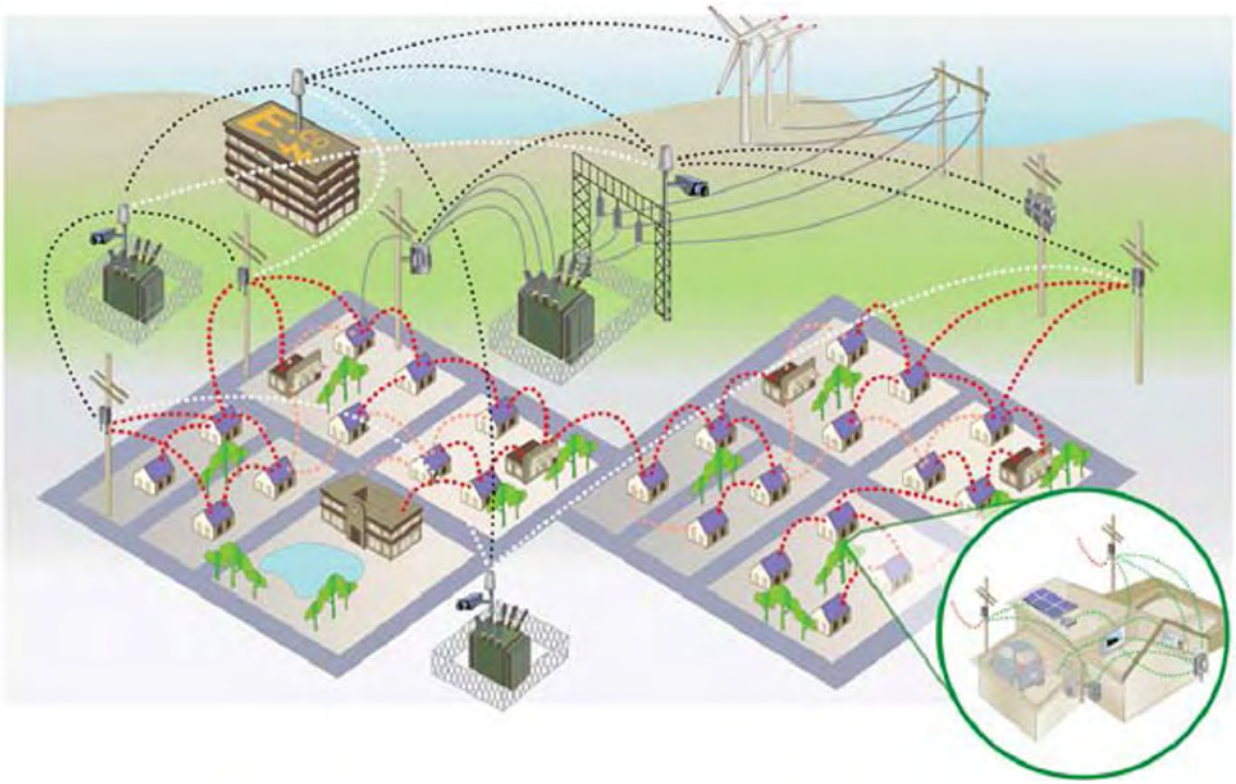
Test Standards of these products are EN 50470-1, -3 in EU and EEA countries.



Third Party Supplier

Trilliant offers a variety of advanced and C&I meters as well as basic residential electric meters from major manufacturers such as GE, Itron, and Landis+Gyr. Each meter is available in a wide range of ANSI forms, voltages, and meter class ratings and is equipped with a factory-installed, under-glass wireless communications module. The module adds intelligence to the meter so that even a basic residential meter can provide many of the functions of an advanced meter and support interval metering and TOU billing. Each electric meter can report a power outage or restoration event to the head-end in real time, and each meter can detect tampering by reporting changes in energy flow direction or a reverse flow after an outage. Additionally, Trilliant supports meters with integrated service disconnect switches to allow remote disconnect/connect.

Trilliant also offers wireless gas meter modules that can easily retrofit the most commonly deployed small- and large-diaphragm gas meters from manufacturers such as American, Rockwell, and Sprague. A battery-powered gas meter module provides operational life greater than 20 years.



5. Conclusion

Energy management system with wireless energy data gathering system provides a cost effective solution to industrial customers who want to retrofit their existing meters to collect necessary energy data for their energy management system. A wireless option is easily expandable, and MANET wireless network offers reliable, and secure data communication facilities.