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Low-Cost Multi-Service Home Gateway Creates New Business Opportunities

White Paper

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Abstract

A combination of technology advances, regulatory changes, and new service models have brought new cross-industry opportunities to a variety of companies who are striving to gain a competitive edge in providing bundled services to the home. These companies see the establishment of a reliable, flexible, low-cost home telemetry communications channel as a way to provide or enable new services which include:

- automatic meter reading (AMR)
- demand side management (DSM) and demand limiting
- home security
- appliance monitoring and maintenance
- home automation

By taking a network infrastructure approach to home communications, a single flexible, standards-based telemetry channel can provide the central capability needed to implement these new services as well as future enhancements and expansions. LonWorks(, now adopted as EIA-709, is a strong open international solution for the home networking infrastructure, supporting both powerline media for existing homes and twisted pair for new homes; many energy and security systems are already based upon LonWorks, the de facto standard for commercial building automation. Internet protocol (IP) likewise offers the advantage of open multiple media in addressing the wide area connection to the home, supporting phone lines, cable, and wireless media. Increasing demand for permanent Internet access from the home is also driving IP connectivity independently, whether by cable modem, ISDN, or xDSL.

Low-cost gateways between home control networks and IP-based wide-area connections are now available, specifically designed to meet the cost constraints and scalability requirements of these new services. By providing a flexible, expandable network infrastructure to support multiple services, these new devices enable companies to address compelling market opportunities by offering bundled services to the home.

This paper will explore the background and recent events which have created new opportunities for home telemetry services. Technical requirements for a multi-service home gateway are reviewed, along with solutions currently available in the market

Keywords

WAN, networking, home gateway, AMR, Security, network infrastructure, scalable.

Convergence of Factors Creates New Business Opportunities

A convergence of several technical and market factors has created a new set of business opportunities centered around a multi-service telemetry connection to the home. Forward-thinking utilities have realized that they can no longer limit themselves to considering how to implement their existing businesses more efficiently. They have broadened their focus to encompass not only current business needs but also new opportunities that leverage their existing position with the residential customer base.

Understanding these new opportunities is vitally important even to those organizations that choose not to pursue them, since they radically change the business landscape for many existing operational and customer service functions in the utility business.

Technology Advances

There are several technology advances which underlie the new business opportunities for utilities and other potential providers of telemetry services to the home. These are not futuristic predictions, but established technologies that are now being applied to the home/utility market.

Intelligent In-Home Devices -- Embedded networked controllers are appearing in a variety of in-home devices including: appliances, light switches, security systems, and electric meters. Embedded controllers imbue these devices with added local intelligence that supports a variety of applications such as AMR, DSM, preventative maintenance, and home automation. But this local intelligence is not application-specific. The same device, for example a freezer, can be part of an automated electricity demand limiting application as well as being controlled by the home automation system.

Ubiquitous and Low Cost IP Connections -- The demand for Internet services has driven IP connections to be present wherever people live and work, whether by cable modem, ISDN, or xDSL The cost of creating devices with IP connectivity has also dropped dramatically. Embedded software and embedded processor technologies have enabled full-featured IP appliances to be created for well under $200. These devices can support a variety of physical media including PSTN, Ethernet, Fiber Optic, and Wireless. Embedded web-servers provide flexible user interfaces that can support thin-client access devices such as screen-phones and set-top boxes.

Embedded Distributed Object Technology -- Linking 1 million or more homes to a service-provider head-end requires a powerful software and networking architecture that delivers scalable, robust communications. Distributed object technology provides this infrastructure and is a proven technology that is now appearing in embedded connectivity devices. A distributed object architecture also provides for simplified integration with multiple service providers and head-end applications.

Technical Standards

The power of open standards cannot be underestimated. For the home/utility space, Internet Protocol (IP) and the other standards that comprise the Internet are having a profound impact on system architectures and product designs. Over the last few years we have moved to a situation where IP technology for WAN and LAN implementation is fully accepted as the international standard for data networking. Gone are the days of proprietary architectures and vertically oriented networks. It is now clear that an IP-based architecture is the way to provide a future-proof system with flexibility to accommodate multiple services to the home.

The standardization of control networks has also undergone rapid change in the last few years. While there is not a single ubiquitous standard across all industries, three de-facto standards have emerged for home networking:

- EIA-709 (LonWorks()
- CEBus (EIA/ANSI-600)
- X-10

All three of these technologies support powerline carrier (PLC) communications, key in providing services to existing homes, with EIA-709 also supporting additional media including unshielded twisted-pair. All three of these standards have been widely adopted by multiple vendors and effectively set the stage for explosive growth in home products ready for networked access. EIA-709 in particular has found wide acceptance world-wide in both commercial and home environmental control, security, and lighting applications.

Regulatory Changes

The deregulation of electric utilities worldwide is causing companies to expand their scope and accelerate their strategies for retaining customers and attracting new ones. Customer choice and competitive forces require at a minimum increased metering capabilities. A higher frequency of meter data collection is needed to support billing regulations and to enable services to help control energy demand. Additional energy usage data such as load profiles are needed to better manage production and distribution systems. This additional data can also be used to offer customers value added services such as energy management and preventative maintenance.

Deregulation is also causing the traditional functions of the electric utility, such as metering, to become unbundled. A flexible system architecture is required to provide multiple parties with collected data and communications access to the home.

Regulations on telecom providers are also having an impact. Increasingly these companies are being allowed to offer additional services such as security monitoring, services which they have previously been barred from offering. This brings additional players into the picture and indeed changes the rules of the game.

Beyond Meter Reading

The convergence of all the factors described above has created the potential for a new approach to utility functions such as meter reading. If one considers a general purpose connection to the home, and an in-home capability to communicate with many types of devices, then what emerges is an opportunity to provide multiple services over the same shared network infrastructure. This naturally spreads the costs of this infrastructure across multiple applications and creates a compelling business case for deployment.

Some of the applications or services that can be combined using this approach are:

- Automatic Meter Reading (AMR)
- Demand Limiting - via tiered pricing and other mechanisms
- Home Security
- Appliance Monitoring and Preventative Maintenance
- Home Automation with Remote Access

The business case for a multi-service model is made compelling beyond the sharing of infrastructure costs across multiple services by the opportunity for offering customers bundled services.

System Architecture to Implement a Multi-Service Network Infrastructure

Figure 1 shows a high-level system architecture for implementing multi-service network infrastructure to the home. This architecture provides scalability, flexibility, and cost effectiveness to support wide-scale deployment - not just selected customer segments. Several notable aspects of this system architecture are discussed below.

IP-based WAN Solution

IP networking technology has evolved at a dizzying pace over the last several years and shows no signs of slowing down. Technologies for providing network connectivity to the home will continue to advance, being driven largely by the desire to have high-speed Internet access. An IP-based network connection to the home is the right choice for a multi-service telemetry system for several reasons:

First, it provides a base solution for covering the maximum number of homes immediately, that of implementing the IP connection over the shared residential phone line. There is no extra WAN infrastructure to deploy, greatly reducing the cost of the system, increasing its flexibility, and providing a clear path towards future technologies.

Second, it allows a full-time Internet connection to be re-used for telemetry data. Rather than create an expensive, single-purpose infrastructure such as a wireless LAN/WAN system, this approach leverages the continuing high levels of investment in IP connections to the home such as cable and xDSL.

Third, it creates a future-proof telemetry system, since the architecture can easily adapt to new physical media. Internet Protocol has shown a remarkable ability to adapt to additional physical network media as they are created. Some of the common media available to the home today that support IP are:

- PSTN - including sharing single residential line
- Coax/HFC - via cable modem
- xDSL
- ISDN

Finally, IP has been proven in its ability to scale to link systems comprising millions of network nodes. The Internet is a clear example of the resiliency and expandability of IP networking technology, and in fact can play a direct role in implementing a home telemetry system.

A Network Infrastructure Approach

Existing approaches to AMR take a device-connectivity approach. That is to say, they link a single device, the meter, into a wide-area network accessible by head-end applications. The architecture in Figure 1, in contrast, takes a network infrastructure approach. An in-home network is linked in a general way to the wide-area network, and finally to multiple head-end applications. Access is provided to any device on the in-home network from any head-end application. In-home devices can include the meter, load-control devices, home security devices, appliances, lighting devices, and home automation systems.

This approach creates an inherently expandable architecture that supports multiple applications and services over the same network infrastructure. It also supports multiple models of system installation. Some components, such as the meter, may be installed by the service provider as part of the infrastructure deployment. Other parts, such as home automation devices, may be purchased and installed by the residential consumer.

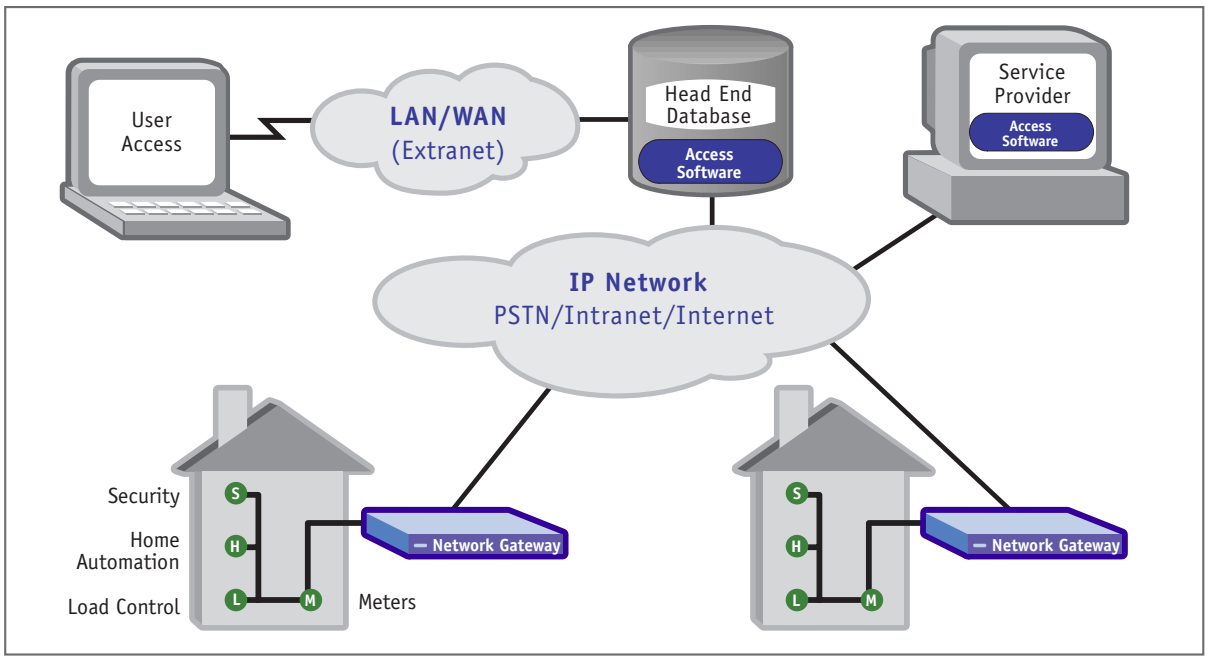

Figure 1: System Architecture for Multi-Service Home Gateway Solution

Multiple Media for In-Home Network

Home networking technologies such as EIA-709 (LonWorks) support multiple physical media including power-line carrier (PLC) and twisted-pair, applicable for use in any country. This allows both a structured wiring approach for new homes, as well as a retrofit solution for existing customers. It is important that the architecture for a multi-service system support multiple physical media to address the full range of application needs and to be able to adapt to future developments.

Distributed Objects To the Home

A system that can support a wide variety of services beyond simple metering must be based on a software architecture that can accommodate a wide range of requirements and grow with the system. Distributed object technology has emerged in the enterprise as a powerful way to create large networked systems and to tie together disparate subsystems into a unified whole.

Now, distributed objects have been embedded into low-cost networked devices, enabling a flatter, simpler system architecture that delivers flexibility and scalability without requiring any central server bottlenecks.

Distributed object technologies such as CORBA provide the perfect link between control devices and enterprise software, since they allow the control data to be delivered in a way that easily integrates with those service applications.

Multi-Service Home Gateway is Key

A key component in the architecture described in Figure 1 is the home network gateway. There has been much discussion in the industry about the requirements for a home gateway, but much of it has been without the benefit of a clear business model context. Also, the issues surrounding standards such as IP and in-home networks have not benefited from the clarity which they exhibit now.

In the context of a multi-service business model, and the technology and standards developments described above, the requirements for a home gateway become clear.

Plug & Play Installation

Installation of the in-home aspects of the system must be simple and automated. For professionally installed components, the costs of installation, and therefore the install time, must be minimized to enable a feasible business model. The level of technician required for the installation can have a substantial impact on the install costs and must be considered carefully by vendors of system products, particularly the home gateway.

It is also important that the system support consumer installed components in the system. Consumers demand that installation be simple and fool-proof. As the central manager of system elements, the home gateway must ensure that these devices are installed onto the network properly and do not erode system integrity for communications with other devices such as the meter.

Downloadable Functionality and Remote Maintenance

The multi-service model is based on the idea of a flexible and growing set of services implemented by the gateway. This requires that it be possible to upgrade and add to the system functionality by downloading new software to the gateway over the wide-area network connection.

The cost points and large numbers of devices in a system, require that as much maintenance of the system as possible be available remotely over the wide-area network. Assessing faults and diagnosing system problems remotely keeps maintenance costs to a minimum.

Low Cost

As a key component in the system, it is critical that the home gateway be available at a cost the allows for an overall attractive business model. The technology advances discussed above have resulted in the availability now of low cost multi-service home gateways that can be used to implement a wide variety of business models.

Secure Communications

No matter what wide-area infrastructure is being used for telemetry communications to the home, security is an important concern. The home gateway must implement both access control such as password protection and authentication, as well as privacy features, to ensure that important telemetry data is not compromised.

Support for Multiple WAN Interfaces

IP provides the basis for an architecture which operates over multiple WAN media. The home gateway must be available with support for these different media to accommodate a broad deployment. Communications to different customer segments is often best achieved with different physical media to the home. Shared PSTN provides a broad reach for most consumers. However, as deployment of cable and xDSL modems continues, interfaces to these devices via 10baseT (Ethernet) will be increasingly required.

Conclusion

The business landscape surrounding the connection to the home is changing rapidly. Technology changes, along with regulatory changes, have created a new set of business opportunities and a new way to think about traditional utility functions such as AMR.

The home gateway has been identified in the past as a key challenge in implementing these kinds of business models. Finally, low-cost, multi-service home gateways are here and being deployed today. The price/performance of these connectivity devices meets the needs of a variety of new business opportunities today, and is expected to continue to evolve to meet the needs of future services.

Forward-thinking companies are now implementing a network infrastructure model for telemetry to the home which encompasses AMR, security, and a host of other consumer services. The opportunity is here today; winners and losers will be quickly determined as the pace of change continues to accelerate.