The Green Frontier

New ways to reduce communications networks' carbon footprints – and new energy-saving network applications.

A BBC Staff Report

New HomePlug Green PHY Standard Powers Energy-Management Applications

Smart-energy solutions shouldn't use a lot of energy themselves – that's the premise behind a new home networking standard, HomePlug Green PHY. In December, semiconductor vendor Qualcomm Atheros announced the first HomePlug Green PHY chip, which is designed for embedded smart-energy and automation devices that communicate over power line networks. HomePlug Green PHY, a low-power version of the widely used HomePlug AV standard, can reduce network device power consumption by as much as 80 percent compared with HomePlug AV.

The new standard offers other advantages, too. It is interoperable with HomePlug AV, it offers extensive home coverage by using ROBO modes (repeat coding used to support low-rate, high-reliability data transmission) and it operates in frequencies higher than AM radio to avoid the noise in lower-frequency bands in home electric wiring.

When implemented on a single chip embedded in a sensor or connected to a microcontroller, the solution is also very low-cost. In fact, Dan Rabinovitsj, senior vice president of Qualcomm Atheros, calls the company's new chip a step toward the "Internet of Everything." Versions for commercial and industrial use are expected to follow soon.

The trade-off (there's always a trade-off) is the relatively low data rate – about 10 Mbps, compared with 200+ Mbps for HomePlug AV and higher for the new HomePlug AV2. However, considering that today's smart-energy home applications don't require more than 10 Kbps, 10 Mbps offers plenty of headroom for future applications. The utility industry, which would like today's smart meters to last for 20 years, agreed that 10 Mbps connections to home networks would be future proof.

A NATURAL CHOICE

Though home networking over power lines was designed to transmit video, and though today's smart-energy devices use Z-Wave or ZigBee protocols (see the Consumer Electronics Show coverage in this issue), power line is a "natural" choice for smart-energy applications, according to Jim Zyren, director of smart-grid marketing at Qualcomm Atheros.

"It burst onto the public consciousness with stimulus money," he says, "and that set some smart people to work." Some of those smart people were at Qualcomm Atheros, which won a grant from the U.S. Department of Energy to develop the Green PHY chip. Devices incorporating the chip will become available late this year.

Because HomePlug is based on Ethernet, it supports IP natively and efficiently. "That makes an addressable network that you can easily reach into," Zyren says. "With Z-Wave, you need a bridge to translate from Ethernet into Z-Wave, and then you're tied to Z-Wave technology. With Ethernet, you can have any kind of physical medium. You can have whole-home coverage that isn't tied to any single technology or vendor. It's an open-standards approach backed by IEEE standards."

Another advantage of HomePlug is its security. "Everyone's afraid the energy grid can be compromised," Zyren says. To maintain the integrity of the electrical grid, HomePlug uses AES 128-bit encryption and has sophisticated means of changing network keys.

HVAC AND ELECTRIC CARS

At first, consumers will use HomePlug Green PHY devices to control heating, ventilation and air-conditioning – today, the largest single load for most homes – and other appliances. As utilities build intelligence into their distribution systems, they will be able to integrate with home networks. Consumers may choose to allow utilities to turn off selected appliances to avoid brownouts.

Beginning this year, electric vehicles will add new levels of complexity to smart-energy monitoring. Electric cars now appearing on the market seem likely to reduce fuel costs, but they will strain the electric grid.

Zyren explains, "Two or three electric vehicles charging at the same time from the same transformer [which may be shared by five or six homes and is thus outside the home network] can cause damage to the transformer. You'll need high-speed communications between an electric vehicle and the charging pedestal – it's important if you're going to coordinate the charging of vehicles so as not to overload the transformer."

High-speed communications will also be needed for e-commerce applications when drivers plug into charging pedestals in parking lots, in garages and at curbs. "The user plugs in, gets acknowledgment and walks away," Zyren says. "It's like a cellphone – it roams and still gets billed to you."

General Motors and Ford, along with the five major German auto makers, have already endorsed the Green PHY standard for communications between vehicles and charging pedestals. The Association of Home Appliance Manufacturers also endorsed Green PHY for home networking, along with Wi-Fi and ZigBee.

In a few years, HomePlug Green PHY could be as ubiquitous a technology as Wi-Fi is today.

SMART GRIDS MEAN BIG BUSINESS FOR SERVICE PROVIDERS

To integrate power from multiple renewable sources into "virtual power plants," the world's electric grids must become much smarter and better connected. Over the next two decades, this will require equipment investment of some $2 trillion, according to market research firm Memoori.

Memoori estimates that sales of smart-grid systems amounted to $16 billion in 2010, with smart meters accounting for more than 30 percent of this sum. "This clearly shows that the business is still in its embryonic stages," the company says.

The smart-grid equipment business is poised to grow, however. Mergers and acquisitions reached $10.6 billion in 2011, and venture capital companies have invested some $1 billion per year over the last two years. These trends indicate that the supply side is gearing up to deliver more smart-grid products and systems.

On the demand side, many traditional electric utilities have been slow to get involved in smart-grid projects or have been hindered by regulators, but competitors are now leapfrogging over them to enter the business. Some organizations that require constant and reliable power – hospitals and large manufacturing plants, for example – are creating their own smart microgrids and integrating them with building management systems.

Other companies are building virtual power plants on a large scale. For example, Flexitricity connects and manages a pool of emergency diesel generators across the U.K. It uses these generators – which belong to private businesses and would otherwise be sitting idle most of the time – to provide power on short notice to the national grid. It is also beginning to aggregate other types of power sources, such as small hydro generators and combined heat and power plants.

Any smart grid, whether it is created by a traditional utility, an independent competitor or an electricity user, needs a robust and reliable communications infrastructure. That will present a major opportunity for communications service providers over the coming years.

Designing Network Gear to Save Energy

Equipment manufacturers and network designers are always looking for ways to reduce energy costs. As providers upgrade their networks, they gain efficiencies by removing powered equipment from the field, pushing fiber closer to end users and minimizing the number of central offices. Last year, the Energy-Efficient Ethernet standard was introduced to allow Ethernet equipment to stop drawing power when it isn't in use.

A new opportunity for saving energy is emerging in the neglected interface between routers and the transport layer. As Jim Theodoras, director of technical marketing at ADVA Optical Networking, explains, several standard methods exist for connecting routers to transport gear, all of them inefficient.

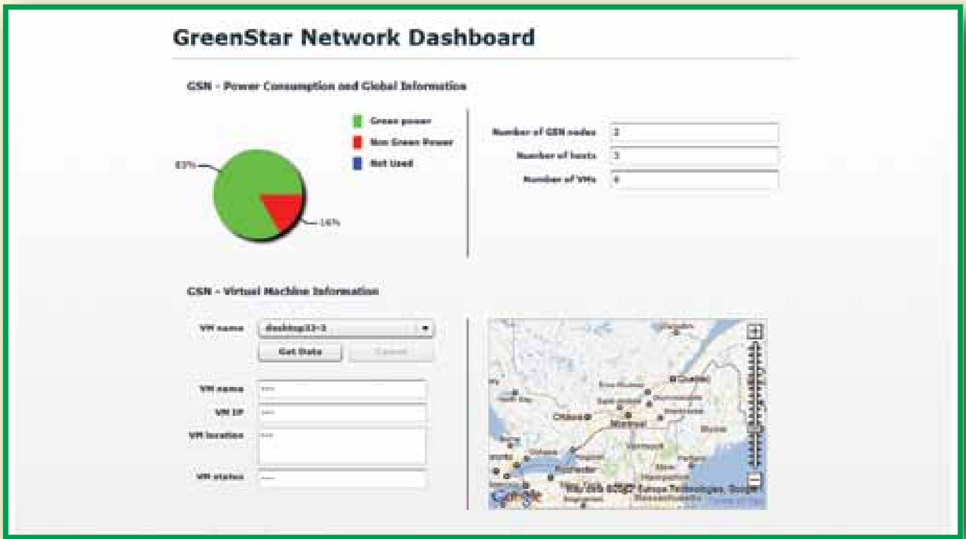
The basic problem is that light must change wavelengths as it travels from a router to a transport box such as a multiplexer. Older methods of connection use interface devices between the two boxes to change the wavelength. This is redundant and wasteful, Theodoras explains.

A newer method, IP over WDM, eliminates extra devices by placing a transponder inside each router to retransmit signals on the frequency expected by the transport gear. This helps matters, but, as Theodoras says, "A router isn't the most efficient place to put a transponder. It draws a lot more power per slot than the average transport box."

One service provider required its router vendor to use pluggable WDM optics in router ports, solving both the redundant-device problem and the port density problem. However, this approach created what Theodoras calls a "nightmare that still hasn't been solved." He says, "The problem was both operational and logistical – you had to stock certain colors [of optics] and know which one went into which port."

THE BEST OF BOTH WORLDS

A new solution uses ADVA's Optojack, a four-year-old device that was originally introduced for an entirely different purpose – demarcation and service monitoring at handoff points between carrier networks or between carrier and customer networks. The Optojack is a pluggable WDM optic device, but it is tunable – in fact, it tunes itself automatically. "It immediately knows what the color, rate and characteristics [of the output signal] are, and it tunes the laser to what it needs to be," Theodoras says. "It allows you to cable any port on a router to any port on a multiplexer, and everything is automatically configured." Interestingly, this new use for the Optojack was pioneered by ADVA's customers and is now being strongly promoted by the vendor because it saves not only energy but also space and capital expenditure. ❖



The GreenStar Network (GSN) aims to create technology and standards for reducing the carbon footprint of information and communications technology. Led by École de Technologie Supérieure, an engineering institute in Quebec, and funded by CANARIE, Canada's advanced research and innovation network, the GSN includes nodes powered by sun, wind, hydroelectricity and geothermal power, which tend to be highly variable. Whenever possible, the network sends computing tasks to nodes where renewable resources are available. This dashboard permits researchers to monitor the network's activity and energy consumption.