



The Status of Broadband Over Powerline (BPL)

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What is Broadband Over Powerline?

- High-speed, long-distance data transfer on powerline (medium & low voltage)
- Enabled by advances in signal processing and chipset speeds

Connect to Internet via "backhaul" such as fiber, often at substation

Data transfer typically at frequencies between 3 MHz to 30 MHz

Known as BPL or "access BPL"



Power Line Carrier (PLC)

Building Automation	Low Data Rate (<64 kbps) Meter reading, SCADA & Load Management
Short Range (<1000 ft.)	Long Range (<40 miles)
In-Building Networks, Audio	Video Telephony Internet High Data Rate (>286 kbps to 3,000+ kbps)

PLC Attenuation



BPL Wide Band Noise



BPL Radiated Emissions

E in dB (μ V/m)

Signal **NB30 Limit Line** Frequency (kHz)

Regulations and BPL Deployment

Federal Communications Commission regulates communications spectrum



BPL Functions: Broadband Services

- Internet access
- Voice over Internet Protocol
- Real-time, interconnected games
- Video on demand
- Streaming video
- Remote monitoring and security
- In-home network
- And more...?



BPL Technology Has Matured

It works

As demonstrated in field trials and recent commercial deployments

lt's fast

- Speed competitive with cable and DSL. Main.Net at 286 – 800 kbps in Manassas, VA. Some vendors > 2 Mbps. Second generation equipment, new (faster.
- Speed is symmetrical
- Increased standardization (e.g., HomePlug*, IEEE P1675)
- Proving business case the next step.



*Registered trademark of the HomePlug Alliance

BPL Example: Amperion Network Topology



Amperion BPL Deployment



Lynx Injector

Antenna mounted on top of a street light



Property of Amperion, used with permission



Falcon and PowerPod

Mast Antenna



Numerous BPL Trials/Deployments

Commercial deployments

- Cinergy (Cincinnati area 260,000 homes passed)
- City of Manassas (citywide build-out; 35,000 pop.)
- PPL Telcom (~16,000 homes passed)

Selected tests/trials

- AEP
- Ameren
- Central Virginia Electric Coop
- Chelan County PUD, WA
- Con Ed
- Cullman Electric Coop, AL
- IDAComm
- Fayetteville Public Utilities, TN

- Florida Power & Light
- Hawaii Electric
- PEPCO
- Pacific Gas & Electric
- PUC Telecom Sault St. Marie, Ontario
- Progress Energy
- Southern Telecom



Consolidated Edison BPL Initiative

- Utility applications by Con Ed. Broadband service handled by Earthlink. Ambient equipment.
- Westchester County trial about 15 test users in 2004, including police station. Expanding.
- Tests at multiunit buildings also planned in NYC
- Funding for application testing from NYSERDA



Applications of focus:

- 1. Predicting failures
- 2. Load management
- 3. Conduit replacement (video security cams)
- 4. Detecting stray voltage

Commercial BPL Deployment in Cincinnati

- Current Broadband is a joint venture of Cinergy Corporation and Current Communications
- Pass 55,000 homes by end of 2004
- Pass total of 260,000 homes in 2005
- Participants: Aug. 2004: ~400 Projected — 20% of homes passed
 - \$29.95/mo for 1 Mbps
 - \$34.95/mo for 2 Mbps
 - \$39.95/mo 3 Mbps



Commercial BPL Deployment in Manassas, Virginia

- Main.net is equipment provider
- Citywide build-out of network (35,000 pop.) tied to 60-mile fiber network
- Estimated cost per subscriber \$630 at 20% penetration rate
- ~\$27/mo for 286 800 kbps
- Franchisee provides equipment, Internet access service, backoffice consumer services



City utility responsible for equipment/network external to building

BPL Prospects

What Works?

What Doesn't (Yet)

- Attenuation Solved
- Wideband Noise Solved
- Potential to Enhance the Power Delivery System

- Radiated Emissions
- The Business Case

Vision of the Power System of the Future



OBJECTIVES:

Self-Healing and Adaptive

Interactive with consumers and markets

Optimized to make best use of resources and equipment

Predictive rather than just reacting to emergencies

Distributed across geographical and organizational boundaries

Integrated, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT

More Secure from attack

Annual revenue or savings/avoided costs per customer



EPRI Activities

- Technical Assessment of BPL
- Data Standards for Communications
- Interoperability
- Architecture for the IntelliGrid
- The Energy Portal

Data Exchange



Common Information Model



Utility Communications Architecture (UCA)



Interoperability



Why Is an Architecture Needed for the IntelliGridSM?



See www.epri-intelligrid.com

The Energy Portal



The Portal Empowers Consumers



Connectivity to electricity markets
Information on consumption
Access to other services

The Portal Empowers Consumers



- Choose suppliers
- Select tariff
- Monitoring usage
- Respond to price signals
- Monitor appliances and devices
- Remotely program operations
- Consolidate bills
- Outage detection
- PQ monitoring
- Security
- Data
- Entertainment

EdF Consumer Portal Functions



Roadblocks to the Portal



Standardization
Connectivity
Regulation
Technology

The Energy Portal



- Bundled "essential" services
- Brand identity in the home
- Transform customer relationships
- Reduce customer churn
- Provide energy services

Energy Portal Object Models for Demand Response Functions

- Object models for specific demand response applications
- Detailed definition of information requirements using the documentation procedures and methods developed for Intelligrid Architecture, IEC 61850, DER/ADA project,



•Services required of each object based on the functional requirements (monitoring, control, logging, file transfer, user interface, etc.

- •Communication bandwidth and latency requirements
- •Security requirements and policies



BPL References

- The Possible Use of the Electric Power Transmission/ Distribution System as a Waveguide for a Wideband Communication System, EPRI, Palo Alto, CA: 2001. 1001891
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 kgeorge@primen.com
- The Race for Broadband Communications on Power Lines: Communications on Power Lines — Update 2003, EPRI, Palo Alto, CA: 2003. 1009200
- Communications on Power Lines, Changing Business and Technology Ramifications, EPRI, Palo Alto, CA: 2002. 1006967
- Technical Update Wideband power Line Communications: Overview and Status, EPRI, Palo Alto, CA: 2003. 1008155

Selected List of BPL Equipment Suppliers

Ambient Corp., Newton, MA (ConEd an investor) www.ambient.com

Amperion, Inc., Andover, MA (AEP an investor) www.amperion.com

Current Technologies,

Germantown, MD (Cinergy an investor) Main.net Powerline Communications, Inc., Reston, VA

www.powerline-plc.com

GridStream (formerly PowerComm Systems, Fayetteville, TN www.gridstreamtech.com

PowerWan, Inc., Palo Alto, CA www.powerwan.com

www.currenttechnologies.com www.powerwan.com