



Universal Powerline Bus Communication Technology Overview

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UPB Communications Technology

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Overview

Powerline Control Systems, (PCS), pcslighting.com, is a California corporation in the business of designing, developing and manufacturing advanced powerline carrier based lighting controls. PCS has developed a new proprietary powerline communication technology, the Universal Powerline Bus (UPB). The UPB provides an incredibly reliable and inexpensive solution for residential and commercial powerline communications applications. While other powerline technologies exist, none compare to the UPB in cost per node, reliability and functionality. Our solution for potential applications such as lighting controls, appliance communication, HVAC control, and Internet-to-Application Device communication will cost the manufacturer less than \$4 per node for two-way transceiver components. PCS has, to date, licensed the UPB powerline communication technology to three product manufacturers, including the largest electrical equipment manufacturer in the world. We are in the process of

negotiations for additional licenses with Integrated Circuit Manufacturers, Lighting Controls Manufacturers, Automated Meter Reading (AMR) and Internet Gateway companies. We anticipate significant joint development revenues to increase over the next few years and royalty income to commence in the fourth quarter of 2002.

Although we are actively licensing the right to use the UPB technology we are simultaneously moving towards incorporating that technology into our existing PCS lighting control products. Our initial product line will include UPB Dimmers, Wall and Desktop Controllers, Lamp and Appliance "Plug-In" Modules and PC Interface Module. We believe that manufacturing PCS lighting control devices incorporating the UPB technology will enhance the overall Licensing Program and lead to a more rapid deployment of our technology. We are on schedule for these products to be introduced in mid 2002.

"In the next three years, all new products that deal with information, control, and measurement are likely to be built incorporating Internet-enabled technologies."

"Our analysis indicates that despite some of the challenges of having a myriad of standards and information discontinuities among devices, there will be upwards of a 200% increase in device networking investments over the next three years....."
Excerpts taken from the Harbor Research white paper "Strategic Trends in Device Networking" by John C. Williams. jwilliams@harborresearch.com

We have also entered into application specific projects to develop the UPB technology into other existing products.

Currently we are developing a UPB based remote control system for a major manufacturer of three phase 277VAC commercial lighting fixtures. This effort promises to deliver both fine-tuned group lighting control and significant energy savings for large commercial installations such as stadiums and gymnasiums. The advantage of a UPB based system is that it can provide multi-state control to each fixture in a retrofit installation without running any new control wiring.

We are also designing a utility meter with Schlumberger Resource Management Systems, the electric utility meter division of Schlumberger, that incorporates the UPB technology in an inexpensive ANSI residential utility meter. This

product will allow gateways or other devices to remotely read the electric meter.

There are a large number of applications, both stand alone and integrated that can benefit from the cost and reliability characteristics of the UPB communication technology.

PCS desires to enter into Joint Development Agreements (JDA) with manufacturers that can realize a technical and marketing advantage by incorporating of the UPB technology into their existing or new products.

We also wish to enter into JDA's with other technology partners such as the major hardware and software manufacturers who have a vested interest in the development and deployment of PLC technologies. We will be announcing the availability of our UPB Technology in March 2002 at EH EXPO in Orlando.

Residential Topography

The following diagram illustrates a typical residence showing the different communications channels. There will be two channels of communication from the gateway to the devices in the home. There will be a high-speed channel that provides for basic Internet browsing, email, audio, video, telephone, etc. This channel must be fast enough to keep up with the gateway-to-internet speed. Because of the speed requirement the cost per node of this channel will be high.

There will also be a low speed, low cost communications channel that will provide for control functions for applications such as lighting, HVAC, sprinklers, automatic meter reading, security, and also provide simple data communications to all basic household appliances. This channel must be available at a cost of \$3 ~ \$5 to meet the cost-vs-utility trade-off requirements of these relatively inexpensive devices.

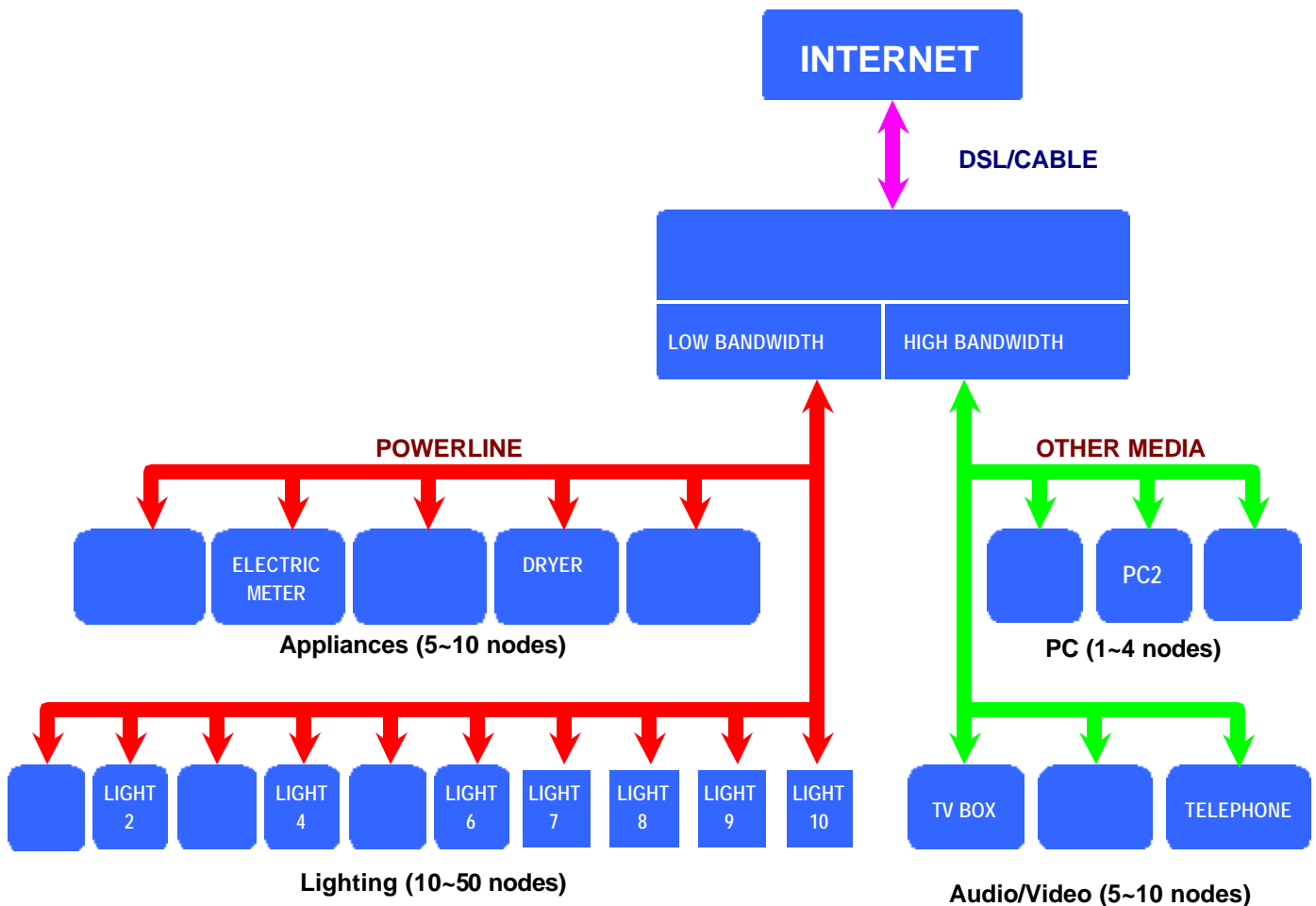


Figure 2: Topology of Residential Communications Channels

UPB Communications Summary

Highly Reliable - The UPB method of communication is 100 ~ 1000 times more reliable than current X-10 technology and 10 ~100 times more reliable than CEBUS or LONWORKS powerline technologies. Reliability is defined as the percentage of transmitter/receiver pairs that correctly operate upon initial installation. The UPB test units are randomly installed in the environment typical of the target market. This market is defined as the single-family residential market in the US. This environment is defined to be the existing base of homes, without any modifications. This means that there should be no "fixing" the electrical system of the residence by adding couplers, repeaters or filtering. The first version of UPB will be over 99.9% reliable (>100 times X-10). Current X-10 is around 70%-80%.

No New Wires - 100% powerline communication, no new wires.

Affordable - The incremental cost to add two way communications transmitting and receiving components to a microprocessor-based application circuit is approximately the same as the cost to add X-10 type transmitting / receiving components. This cost is less than \$4.00 in US parts and anticipated royalty costs.

Higher Speed - 20 to 40 times the speed of X-10 in terms of data transmitted. This is equivalent to over ten full commands per second. The average latency of command to action is less than .1 second.

Two Way Communications - Hardware, software and protocol design allow for two-way communication in all products.

House Separation - Multiple houses on one transformer will be separated by means of an addressing scheme allowing for at least 256 systems (houses) on each transformer. UPB system incorporates over 64,000 total address space vs 256 for conventional X-10. There will also be applicable encryption incorporated into the DLL layer and if necessary at the higher network layers.

Interaction - UPB communication can be used in the presence of all X-10, CEBus, or LonWorks compatible equipment with no interference between either UPB equipment or X-10, CEBus, or LonWorks equipment. The UPB technology uses a completely different frequency range than any of the wide-band, narrow-band, or spread spectrum technologies. The physical method of UPB communication is entirely different than the modulation-demodulation techniques of all X-10, CEBus, or LonWorks.

Peer to Peer - No central controller necessary for single point-to-point control or group (scene) control.

Simplicity - the UPB solution uses "off the shelf" components for transmission, receiving and control circuits, including standard microprocessors. No ASIC's (application specific integrated circuits) are necessary.

The Market

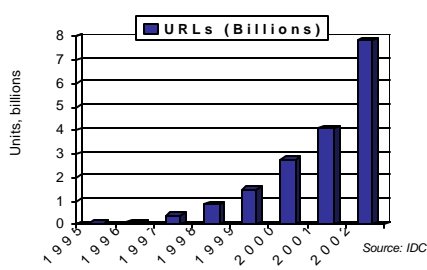
The potential applications market for a highly reliable, cost effective powerline technology such as the UPB is upwards of 3 Billion annually. Alternative powerline communication technologies, either existing or in development are not cost effective or reliable enough to meet the requirements of the midrange US residential market. The UPB technology opens previously untapped overlapping markets in the areas of Home Networking, Lighting Control, HVAC, Home Automation, RF Control, Security, Home Theater, Internet Enabled Control, etc.

In the home automation industry alone there is an existing market in the range of \$100M in sales per year. The company with the overwhelming largest share of that market is X-10 Ltd., which uses the X-10 physical media and protocol. With the expiration of the X-10 patents in 1998, combined with the superiority of PCS's UPB technology, this market is immediately available. Additionally the hardwired lighting market is an additional \$500M in sales per year. Both of these existing lighting markets will welcome the UPB technology considering its high reliability and low cost.

- In 2003, upwards of 50% of online user interactions will involve multiple coordinated information appliances and intelligent devices (e.g. cars, electrical meters, etc.)
- Over the next 3-5 years, device networking & integration will grow at greater than 45% compounded annually
- By 2003-2005, 20% of all mass market products (cars, phones, buildings, appliances, etc.) will be built on Internet connectivity.¹

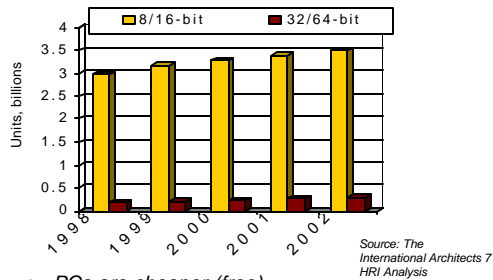
"The Internet has created a universal platform for networking intelligence between people, their machines, and each other. As we move forward, the billions of intelligent chips, sensors, and controllers that have been deployed in cars, homes, office buildings and the community will begin to leverage the low cost of Internet-based communications. Figure 3 represents the rapid growth of leading infrastructure deployments, which will enhance the potential for wide-spread device networking."¹

Worldwide Web Presence Is Booming



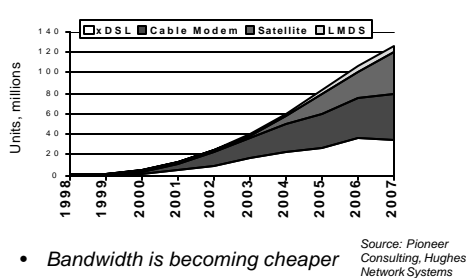
- Internet connections are becoming cheaper (free)

WW Embedded MCU Growth Represents Opportunity



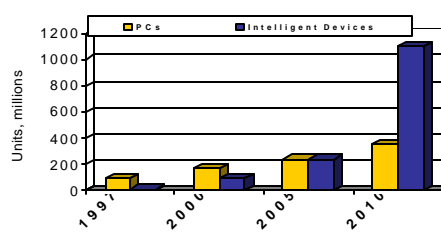
- PCs are cheaper (free)
- Chips are cheaper

Global Broadband Access Subscribers



- Bandwidth is becoming cheaper

Intelligent Devices Will Outpace PCs



- Phones, PDAs, game consoles, set-tops / web TVs are becoming Internet connected

Figure 3: Growing Infrastructure For The Extended Internet¹

Although there is an immediate application in the lighting controls market, the overwhelming target market for the UPB technology is in providing a powerline communication solution for home networking especially Internet enabled communications.

All major manufacturers in the area of appliances, appliance controls, lighting controls, electrical controls, communications IC's and Internet gateways are our potential licensees. This includes Invensys, Whirlpool, Maytag, GE, Sunbeam, Leviton, Lightolier/Genlyte, Honeywell, Johnson Controls, Zilog, Microchip, Cypress, Cirrus, Motorola, and Toshiba to name only a few. Many of these companies are already allocating significant resources to pursuing just such a powerline communications solution.

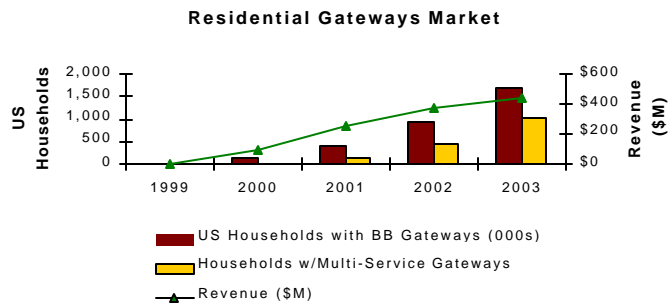
There are also a vast number of other companies such as Microsoft, Sun Microsystems, Cisco, emWare, and XtraWeb, that are developing all manner of Internet enabling technologies that have significant interest in this technology.

The future of the Internet lies not with PC's alone but with the billions of everyday devices that work behind the scenes.

In a world where everything will be connected, including the smallest everyday devices such as home appliances, meters, thermostats, pumps, valves, and light switches, the ability to create new applications and new business is incredible.

Without a low cost, reliable "gateway-to-application-device communication" solution the low bandwidth half of the Internet home networking control business will never exist. UPB is that solution.

- Over 25% of U.S. broadband households will have a residential gateway by 2003



- Aggregate U.S. households with home networks
- Revenue for products shipped annually

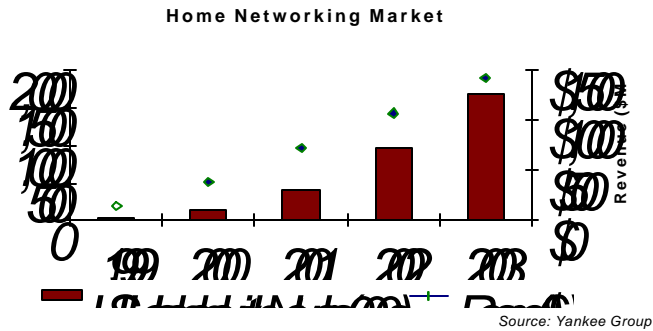


Figure 4: The Networked Home – Growth In Residential Gateways And Home Networking¹

The above excerpts and figures 2 and 3 are taken from the Harbor Research white paper "Strategic Trends in Device Networking" written by John C. Williams, jwilliams@harborresearch.com.

Communications Requirements

For the past several years various companies have been involved in PLC research and development, spending several tens of millions of dollars searching for a powerline based communication technology that will satisfy the requirements of the retrofit residential controls market. We have developed a specification of the physical and MAC layer requirements that a

communications technology must meet in order for that technology to address the large retrofit mid-price-range residential communications market.

Much of this specification is stated in terms of the existing X-10 technology because this is the only current technology with any significant penetration into this market.

Reliability - The technology should be 99.98% reliable (1000 times better than X-10). Current X-10 is 70-80% reliable. Reliability is defined as the fraction of transmitter/receiver pairs that communicate properly upon initial installation. This reliability must be achieved with no filtering, coupling, repeating or other "fixing" of the residence electrical system.

Retrofit – communication must be "no new wires", either power line or RF

Cost – The cost must be close to the cost of X-10 products (in terms of the incremental cost due to transmitting/receiving component cost). Costing up to 50% more than X-10 is acceptable. Costing five or ten times as much as current X-10 products is not acceptable.

Speed - UPB transmissions must be at least as fast as X-10 although faster would be a big plus.

Two way - The media and protocol must be designed to be fully two way for a variety of set up, configuration, and computer control reasons. UPB will be 100% two-way capable.

Compliance - The communications media must be FCC compliant.

Simplicity – the solution should be able to be implemented with off the shelf components, including using only standard microprocessors (no ASIC's required). The use of custom ASIC's will be required as large volumes justify the cost reduction possible only with the use of these devices. It is important that low volume and early-stage development be possible without the use of ASIC's.

Interaction – Should be able to be used in the same environment as other PLC technologies, such as X-10, CEBus, or LonWorks, without causing unacceptable interactions.

As a result of extensive research and investigation we have concluded that no other PLC communications technology either existing or in development will meet the cost / reliability requirements.

UPB Features

Communications

- Wireless- retrofittable
- Phase independent - no couplers, repeaters, filters
- No central controller needed - distributed intelligence and memory
- 65536 possible network (house) addresses
- 65536 possible device addresses
- Two-way communications

Cost

- Inexpensive - \$4.00 for two way communication, including transmission-receiving components and royalty
- UPB anticipated high volume per/unit royalty ~ \$1.00

Speed

- Physical Baud rate of 480 bits/sec
- .2 sec command response time, 5 times faster than X-10
- Data transmission rate 30 times faster than X-10 (400 bits/sec)

Reliability

- Over 99.9% reliable

Compatibility

- Will not interfere with X-10, CEBUS, Echelon technologies

Simplicity

- Uses off-the-shelf components
- No ASIC necessary
- No load on power supply
- Minimal PCB space required

Proprietary

- Patents
- Trademarks
- Copyright

International Applications

- Technology is suitable for 240V 50HZ single phase operation.
- Commercial applications designed for up to 277V 3 phase

Agency Compliance

- Meets FCC requirements
- Meets UL requirements

UPB Lighting System Products

The following PCS UPB Lighting System products are scheduled for deployment as beta test systems in October 2001 and released products in 2002. Many of these products are UPB based versions of our current line of X-10 compatible lighting products.

Wall Switches

- 600 - 1000 Watt Incandescent
- White, Ivory, Black, Almond, Gray
- Relay switch for florescent light, non-dimming control
- Decora Style Rocker Switches
- All switches can be controlled be inexpensive slave switches
- Low voltage transformer/inductive control

Wall Controllers

- 6 button scene controller with bright/dim
- 8 button scene or individual circuit control
- Led night lighting on all buttons

Desktop Controllers

- 6 button scene controller with bright/dim
- 8 button scene or individual circuit control
- Led night lighting on all buttons
- Operation identical to Wall Controllers

Plug-in Lamp Control Modules

- 300 Watt Incandescent single channel
- 800 Watt Incandescent two channel
- On/Off lamp switch trigger circuit

High Power Dimming Module

- 2000 Watt Incandescent Control
- Single Circuit and Four Circuit Versions
- Mounting Panel for up to four dimming units

Controller Interface Plug-in Module

- RS232 communications
- Isolated Communications
- 9600 N,8,1 Std Protocol
- 5,9,14 VDC, 2.5VA regulated or non-regulated isolated power available

Computer Interface Plug-in Module

- RS232 communications
- Isolated Communications
- 9600 N,8,1 Std Protocol

Setup Installation Tool

- Portable plug-in contractor setup device for lighting system setup
- 16 keys
- 20x4 LCD Display
- EEPROM Memory to store whole house setup file
- RS232 Port for uploading downloading computer control

Agency Compliance – All Products

- Meet FCC requirements
- Meet UL requirements

Communication System Comparison

	X-10	CEBus	LonWorks	LeGrand CAD	Lutron Radio RA	Leviton Hard-wired	Lutron Hard-wired	PCS UPB ^ä
Type of System	PLC 120khz fixed freq	PLC 100-140khz spread spectrum	PLC 120,140khz dual freq	PLC 97.6khz	RF	Low Voltage	Low Voltage	UPB Technology
Retrofit	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Speed, bits/sec	60 bits/sec			600 bits/sec				480 bits/sec
Speed, commands/sec	1 per sec	5 ~ 10 per sec	1 ~ 100 per sec	?	?	N/A	?	5 per sec
Two Way	No	Yes	Yes	Yes	Yes	No	No	Yes
Reliability	Very Poor 70%-80%	Med 90%	High 95%	?	High	Very High 100%	Very High 100%	Very High > 99.9%
Cost Xmtr/Rcvr Components (US)	\$1 ~ \$2	\$15 ~ \$20	\$30 ~ \$40	?	\$30	\$0.75	\$2	\$3 ~ \$5
Distributor Cost Switch	\$20 ~ \$70	\$70	None Available		\$200	\$60	\$300	\$70
Central Controller Required	Yes	No	No	?	Yes (Repeaters)	No	Yes	No
Maximum Loads	256	Many	Many	?	32	20	Many	64,000

Technology Partners

To fully capitalize on the gigantic potential that this new technology affords we need to accelerate the development of the UPB technology and the manufacturing of PCS lighting controls incorporating this technology.

PCS desires to enter into Joint Development Agreements (JDA) with manufacturers that can realize a technical and marketing advantage by incorporating of the UPB technology into their existing or new products. These JDA relationships

will develop into a License Agreement for the UPB technology. We also wish to enter into JDA's with other technology partners such as the major hardware and software manufacturers who have a vested interest in the development and deployment of PLC technologies.

License Partners

PCS desires to enter into licensing agreements with manufacturers interested in incorporating UPB communications into either existing products or new products. License agreements may include time periods excluding competitors from developing UPB related products. Licensees may also desire to include Joint Development Agreements so

that PCS engineering staff may assist licensee in technical aspects of incorporating the UPB communications in product development.

Financial Partners

PCS is seeking investment partners in order to accelerate the development and proliferation of the UPB communications method. We believe there is a great investment opportunity for the right investor. Because of the relatively small size of the investment needed we believe that an Angel type investment

is the most appropriate for PCS. We are also actively seeking investment from our licensees and other potential customers.

IP Protection

As of June 2001 PCS has filed two patents covering the basic methods and implementation of the UPB technology. A significant effort in the UPB development will be a very aggressive and constant IP effort consisting of a continuous

stream of patents covering all UPB developments and variations. Our budget allows for considerable resources for IP development. The UPB name and Logo are trademarked.

References

- 1 Williams, J. C., 2000, "Strategic Trends in Device Networking," Harbor Research, jwilliams@harborresearch.com