

Lighting Control White Paper  
A Brief Technology Overview of the Lighting Control Marketplace  
X-10, Insteon, Z-Wave, ZigBee, RadioRA2, Universal Powerline Bus (UPB)  
Fuchsia Research Corporation  
August 2014

## Introduction

When considering lighting control and home automation, there are many options in the marketplace, to include selection of a supplier, technology, company's breadth of product line, ease of use, ease of installation, and service and support. Doing a Google search for 'home automation' or 'lighting control' can many times lead to confusion, resulting in head scratching 'chaos', given the information provided blogs, trade publications, hobbyists, and DIYers, many times provides incomplete and sometimes incorrect information.

If you have a multi-million dollar primary or vacation home, working with a high-end/cost architect, have a \$50,000-\$100,000+ budget for home automation and/or lighting control, this White Paper is probably not for you. This White Paper is for the rest of us, objective, to provide a general overview of the market, technologies, and assist in your selection of a home automation lighting control solution to best meet your needs – and budget.

## X-10

X-10 was developed in 1975 by Pico Electronics of Glenrothes, Scotland. It uses primarily power line wiring for signaling and control, the signals involve radio frequency bursts representing digital information. X-10 has led the way using powerline communication over the past 40 years and could easily be considered the father of home automation.

Some thoughts considering X-10. Select X-10 if you have a very limited budget, no more than \$10-\$15 per device. A Google search will provide dozens of potential suppliers. Key challenges for X-10 over the years has been a history of poor performance, distance limitations, power phase limitations, and sporadic reliability, rendering the technology as the (very) low end alternative for the DIYer needing a (very) low cost solution. Today there are hybrid systems using X-10 with wireless technologies, including Insteon, Z-Wave, or ZigBee.

## Insteon

Insteon is a home automation technology developed in 2004 by SmartLabs, marketed and sold by SmartHome.com. Insteon was designed to be backwards compatible with legacy X10 automation systems while expanding home automation capabilities to incorporate new features like wireless communication.

Insteon devices communicate over power lines and via wireless using the Insteon powerline protocol, the Insteon radio frequency (RF) protocol, or both -- called dual mesh networking. Insteon powerline devices are compatible with the X10 protocol, allowing them to talk and listen to X10 devices.

Some thoughts considering Insteon. Insteon is targeted at the low end DIY market looking for a low cost solution readily available from an on-line supplier (SmartHome). Insteon is a definite step up from X-10, however, cutting through all the marketing used by SmartHome, and I note the marketing is done quite well, you're dealing with X-10 technology with RF capabilities, meaning reliability (X-10) and range (RF) issues.

## **Z-Wave**

Z-Wave was developed by Zensys, Inc. a start-up company based in Denmark in 2004. Z-Wave utilizes a protocol for communication among devices used for home automation, using RF for signaling and control. Based on the concept of Zigbee, Z-Wave's objective was to build simpler and less expensive technology versus ZigBee.

Z-Wave operates at 908.42 MHz in the USA (868.42 MHz in Europe) using a mesh networking. Theoretically a Z-Wave network can contain up to 232 nodes, however, there are reports of trouble with networks containing more than 30-40 nodes. One must use care when selecting products as some products from certain manufacturers are not compatible with other manufacturers' products.

Some thoughts considering Z-Wave. Z-Wave is used by Leviton, technology is a definite step-up from Insteon. Z-Wave uses a routed network, making its products more complex (installation) and expensive. Z-Wave products communicate via RF, resulting in potential reliability and range issues. Leviton has had disappointing results in the home automation marketplace, key challenge ease of use, many saying installation is more painful than pulling teeth...

## **ZigBee**

The ZigBee specification was accepted and ratified by the ZigBee Alliance in December 2004. ZigBee signals operate like network signals and most closely resemble Bluetooth and WiFi. ZigBee devices are designed to communicate via radio frequencies, using 2.4 GHz for its worldwide standard frequency. ZigBee uses 915 MHz in the United States and 866 MHz in Europe.

Mesh networking, used by both Z-Wave and ZigBee, utilize switches as repeaters. Thus the reliability of the network is directly proportional to the number of units installed; the fewer the number of units the less reliable the mesh network. Adding base stations and repeaters increases reliability, distance, as well as cost. Single points of failure (one bad switch) can have dramatic effects, in some cases making portions of a network or home inoperable.

Some thoughts considering ZigBee. ZigBee faces the same challenges as Z-Wave, and a few more... Given ZigBee's specification is more complex than Z-Wave, it is the most expensive technology vs. X-10, Insteon, Z-Wave and UPB, however, a lower cost vs. higher priced LutronRA2.

## **RadioRA, HomeWorks and Radio RA2**

RadioRA was developed by Lutron in 1991, an RF technology that transmits on 418 MHz, not 900 MHz or 2.4 GHz like the rest of the market. Lutron claim is repeating commands multiple times from different sources. HomeWorks was launched in 2002, Lutron's second RF product line. Utilized fixed vs. meshed network. RadioRA2 was introduced in 2009.

RadioRA2 utilizes a viable RF fixed (not mesh) network. Given the frequencies used are the same as those for many other wireless devices (cordless phones, speakers, intercoms and baby monitors), there can sometimes be overlap where an installer/technician may be need to make everything interoperable (e.g. turning on lights interrupting a phone call or sound system).

Some thoughts considering RadioRA2. Lutron is the industry leader. Lutron targets the 3% top end of the home market, 5X-10X+ more costly than other technologies reviewed. A \$10,000 cost for a very basic installation, can easily top \$50,000, sometimes more than \$100,000. Lutron is for the multi-million dollar home market. If cost is not a consideration, select Lutron.

### **Universal Powerline Bus (UPB)**

Universal Powerline Bus (or UPB) is a protocol for communication among devices used for home automation utilizing power line wiring for signaling and control. The technology was developed in 1999. Both X-10 and Universal Powerline Bus (UPB) use standard power lines for communication, however, the technologies are significantly different. UPB utilizes Pulse Position Modulation based on timed pulses rather than carrier frequency used by X-10. It makes recognizing UPB and differentiating the pulse from noise very reliable, unlike X-10.

An X-10 signal is 4 volts at its strongest level, while UPB is 40 volts, a factor of 10X, the end result is faster and more reliable communication, especially when transmitting over longer distances. UPB allows more data to be communicated over a much wider address space enabling a higher level of control and far less potential of interference between adjacent homes. UPB is a two way communication protocol, whereas X-10 is primarily unidirectional, allowing the UPB system to verify a given message was successfully received.

Some thoughts considering UPB. UPB can travel well over a mile on a single 14 gauge circuit. UPB is so strong, a pulse on phase A of a residential split phase power service, will travel outside of the home to the street side power transformer and return back into the house on phase B. And since UPB operates at such a low frequency, these large pulses have no negative effects on common household appliances, computers, TVs, stereos, etc...

### **Conclusion**

I tried my very best to include the key technologies and major suppliers in the home automation and lighting control marketplace. Yes, there are many other low end – and high end – options in the marketplace. I purposely did not include the many ‘quasi-mesh’ technologies used by low cost toy-like suppliers, and some of the very high end, ridiculously expensive alternatives, like Vantage and Crestron that utilize mesh technologies. Lutron is targeted at the multi-million dollar home market. If cost is not a consideration, you have money to burn, Lutron is the obvious choice.

A common conclusion by trade publications, hobbyists, DIYers, and blogs, over the past 5+ years, is that UPB is exponentially more powerful and reliable versus X-10 – and also much more powerful and reliable versus mesh technologies used by Insteon, Z-Wave and ZigBee. Because UPB utilizes Pulse Position Modulation (as opposed to mesh networking), the resultant signal is so very powerful, a system consisting of as few as 2 devices can operate reliably across a home or property, a distance up to one mile!

At the end of the many tests conducted, and hundreds of testimonials, UPB is constantly selected the ‘optimum’ choice when considering a technology for home automation. A technology that provides reliability, ease of installation (especially retrofit construction), flexibility – and value (cost). And UPB technology is synonymous with Simply Automated, the home automation lighting control industry leader, located in Carlsbad, CA. Check out [www.simply-automated.com](http://www.simply-automated.com)

Feel free to contact me @ [saustin1@san.rr.com](mailto:saustin1@san.rr.com)