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Wireless Light Switching – Kaiser Permanente San Leandro

The purpose of this report is to investigate the advantages/disadvantages of using Wireless Light Switching technologies in the Kaiser Permanente, San Leandro HSB building. The report will evaluate the cost benefits, if any, of implementing this technology by comparing the cost of installing a hardwired, dual –level, push-button light switch to the cost of two of the available wireless light switches. In particular, wireless light switching by *Leviton* and ILLUMRA will be evaluated as possible solutions to be implemented in the HSB facility.

Wireless light switches are not connected to internal wiring. Instead, they operate by sending a radio signal to the light fixture that turns it on or off. Wireless light switches do everything that traditional switches do, including dimming and operating with automated lighting controls or sensor systems.

The *Leviton* line of Wireless Wall Switch Receivers (WSS10-0Dx and WSS10-GDx) work in conjunction with the Wireless Occupancy Sensors (WSCxx-I0W) and the Wireless Remote Switch (WSS0S-P0x). For new construction applications, this system does not provide any upfront cost savings when compared to traditional lighting control methods in the state of California. On the contrary, this system could introduce additional upfront costs. However, cost savings could be realized for future retrofit applications using this product. The manufacturer has stated that this product could cost up to 50% less than conventional hardwire system for retrofit applications. This is yet to be confirmed. Further cost analysis is required to determine the payback period for new construction.

ILLUMRA Self-powered Wireless Light Switches are powered by *EnOcean* technology that converts the press of the switch into a small amount of electricity. The system uses less hardware than that of the *Leviton*. The receiver is hardwired in line with the fixture. The light switch is wireless and battery-free. This product appears to be more advantageous over the *Leviton*'s product and is believed to be more suitable for the Kaiser Permanente, San Leandro HSB project.

Given that this is a new technology that has not been implemented in many healthcare applications, it is recommended that the use of this technology be limited on the San Leandro HSB project. In particular, the use of this technology in parts of the HSB building that will be subjected to frequent retrofit applications in the future could be advantageous and could result in future cost savings for the facility. These locations include but are not limited to conference rooms, lounges, private offices, executive offices, and restrooms.

PRINCIPLES OF RADIO SIGNALS IN BUILDINGS

1.1 RANGE OF RADIO SIGNALS

Radio signals are electromagnetic waves, hence the signal becomes weaker the further it travels, the range is limited. The radio coverage is further decreased by specific materials found in the

direction of the propagation. While radio waves can penetrate a wall, they are dampened more than on a direct line-of-sight path (LoS).

Radio transmission shapes an ellipsoid, with Transmitter (Tx) and Receiver (Rx) in its both focal points. Because of that the geometric shape of a room determines the radio range. At 30m range the theoretical diameter of the ellipsoid is around 10m (868 MHz). So narrow floors with thick walls are unfavorable:

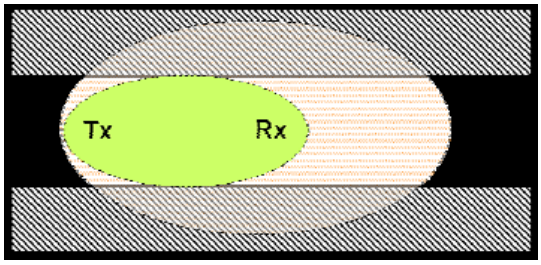

Figure: Radio transmission shapes an ellipsoid

The kind of antenna mounting and antenna distance from ceiling, floor and walls are a major influence for coverage. External antennas typically do have a better radio performance than internal antennas from in-wall receivers. People and other objects within a room also can reduce the radio range. Because of the big amount of different impacts, in practice the common specification of "30m in-door range" should be considered more precisely. Reserve in the range planning is needed to achieve reliability of the radio system, even in case of several unfavorable conditions combined.

1.2 SCREENING

Massive objects made of metal, such as metallic separation walls and metal inserted ceilings, massive wall reinforcements and the metal foil of heat insulations, reflect electromagnetic waves and thus create what is known as radio shadow. However singularized small metal studs, e.g. the metal studs of a gypsum dry wall, don't show a recognizable screening. Important objects and factors that decreases or constraints coverage:

- Metal separation walls or hollow lightweight walls filled with insulating wool on metal foil
- Inserted ceilings with panels made of metal or carbon fibre
- Steel furniture, glass with metal coating (typically not used indoor)
- Switch mounted on metal surfaces (typically 30% loss of range)
- Use of metallic switch frames (typically 30% loss of range))

Fire-safety walls, elevator shafts, staircases and supply areas should be considered as screening. Screening can be avoided by repositioning the transmitting and/or receiving antenna away from the radio shadow, or by using a repeater.

1.3 DISTANCE BETWEEN RECEIVER AND SOURCES OF INTERFERENCE

The recommended distance between receivers and other transmitters (e.g. GSM / DECT / wireless LAN) or high-frequency sources of interference (computers, audio and video equipment) should be at least 50cm. However, the transmitter can be installed next to any other high-frequency transmitters without any problem.

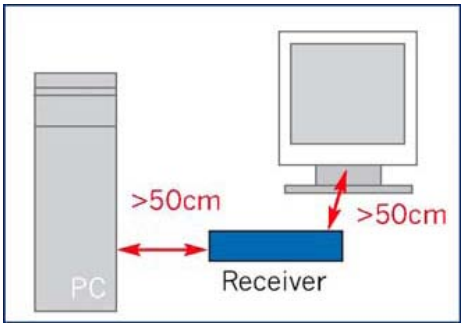

Figure: Separation from sources of interference

Enocean uses 315 MHz for its systems. On the other hand, *Lutron* technology uses 434 MHz, which is a bandwidth defined by Federal Communications Commission for very brief, low-power transmissions. While there are some low-power consumer devices (such as garage door openers) that use this bandwidth, *Lutron* has used this frequency successfully over the past 10 years, with over 1 million installations of wireless light switches.

1.4 Wireless Switches

The application of the above technology has been extended to cover lighting allowing for wireless light switching. Wireless light switches turn light fixtures on or off through radio frequency commands, rather than interrupting the flow of power to the fixture through electrical wiring. Wireless light switches eliminate the need to run wiring through walls and ceilings from switches to fixtures. Preliminary cost studies has shown that in the state of California, the use of wireless light switches is roughly cost neutral for initial construction while it has the potential for saving money on retrofit projects. This is primarily due to the high labor costs in the state of California. The technology is patent by *Enocean*. Many manufacturers have adopted this technology for light switching producing many products. These include but are not limited to ILLUMRA, *Leviton,* and *Lutron*.

1.4.1 *Leviton* Wireless Switches

The *Leviton* line of Wireless Wall Switch Receivers (WSS10-0Dx and WSS10-GDx) work in conjunction with the Wireless Occupancy Sensors (WSCxx-I0W) and the Wireless Remote Switch (WSS0S-P0x) to provide an optimal solution for retrofit lighting needs. The Wall Switch Receiver can be installed in place of traditional single-pole wall switches and fits in a standard single-gang wall box. No additional wiring is required.

These components are compatible with incandescent, fluorescent and low-voltage lighting. The Receiver responds to signals from the Wireless Occupancy Sensor, automatically shutting off

lights when the room is vacant. Lights are automatically activated upon entry in Auto-ON mode with the Wireless Occupancy Sensor. The Receiver also features a single manual-override switch that can be used to toggle the ON/OFF status of the light load while an area is occupied. The Wireless Remote Switch is self-powered (no batteries required), drawing on kinetic energy to charge itself each time the button is pushed. The Remote Switch can be used to control lights from multiple locations. It can also be used for a convenient three-way switch solution, eliminating the need to pull additional wiring.

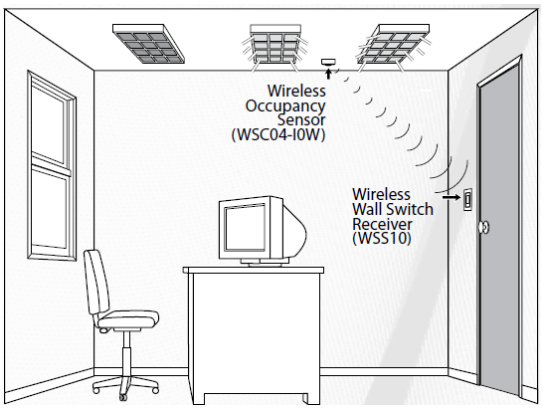

Figure: *Leviton* Wireless Switching Solution

Leviton's line of Wireless products is the ideal solution for retrofits and new construction, installation is quick and easy with no additional wiring required. Simply replace the existing wall switch with *Leviton*'s Wireless Wall Switch Receiver, attach the occupancy sensor and the installation is complete. However, this product requires the additional hardware, Wireless Occupancy Sensors (WSCxx-I0W) and the Wireless Remote Switch (WSS0S-P0x), to provide an optimal solution for retrofit lighting needs.

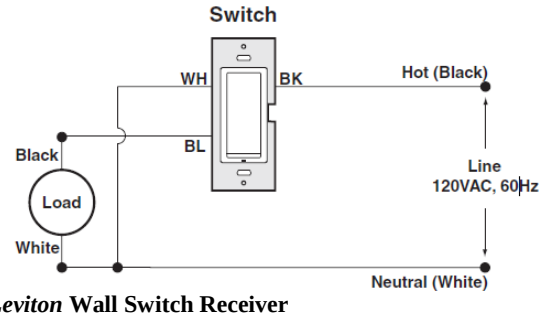

Figure: Wiring Diagram for *Leviton* Wall Switch Receiver

Leviton's Wireless Occupancy Sensors (WSCxx-I0W) features Manual-ON/Auto-Off and Auto-ON/Auto-OFF modes. It is self-powered, a built-in solar cell draws on available ambient light to power itself and can operate for up to 48 hours without the need for batteries or external power in standard Manual-ON/Auto-Off mode; three (3)AAA batteries are required for Auto-ON operation.

For new construction applications, the cost of this system in the state of California doesn't provide any upfront cost savings when compared to traditional lighting control methods. On the contrary, this system could introduce additional upfront costs. Further cost analysis is required to determine the payback period for new construction. The advantage and the cost savings could be, however, realized for future retrofit applications. The manufacturer has stated that this product could cost up to 50% less than conventional hardwire system for retrofit applications. This is yet to be confirmed.

1.4.2 **ILLUMRA Wireless Switches**

ILLUMRA Self-powered Wireless Light Switches are powered by *EnOcean* technology that converts the press of the switch into a small amount of electricity. This electricity is used to transmit a wireless signal that communicates with a wide variety of ILLUMRA Receivers. Battery-free wireless light switches are primarily used to control lights in homes or businesses but they can be used to control virtually any on/off device. Each Self-powered Wireless Light Switch can be placed anywhere within range of a receiver. Traditionally the wireless light switch is surface mounted on a wall with screws or industrial tape but can also be used in a standard switch box or as a wireless hand held remote.

	E3T-S1Axx	E3T-S2Axx
Range	50-150 feet (typical)	
Frequency	315 MHz	
Power Supply	Self-generated when switch is pressed	
Buttons	2 Buttons (1 rocker)	4 Buttons (2 rockers)
Output Channels	Only limited by number of receivers in range	
Dimensions	2.75 (W) x 4.5 (H) x 0.62 (D) inches	
Radio Certification	FCC (United States):SZV-PTM200C IC (Canada): 5713A-PTM200C	
Addressing	Factory set unique ID (1 of 4 billion)	

Figure: ILLUMRA self-powered wireless light switch specifications

ILLUMRA Receivers are engineered to receive radio transmissions from ILLUMRA Self-powered Wireless Light Switches and Sensors. Control virtually anything that turns on and off by simply wiring a receiver between the power source and the device. ILLUMRA Receivers are commonly used to control lights, lamps, fans, blinds, HVAC systems and security systems.

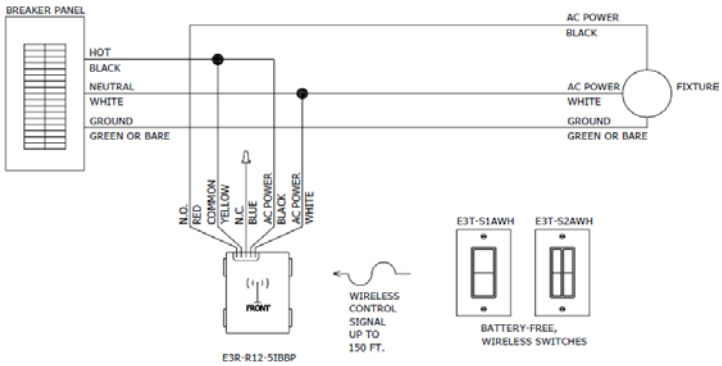

Figure: ILLUMRA Wireless Solution Wiring Diagram

For new construction applications, the cost of this system in the state of California appears to be neutral. Further cost analysis is required to determine the payback period for new construction. This system could introduce further cost savings in a retrofit application.

Installing traditional light fixtures and switches can be time-consuming and expensive. In new construction, wiring and conduit can be installed in walls that have not yet been closed up. But during future renovations, getting new wiring, fixtures and switches installed is much more difficult and can be costly in terms of labor. With today's technology innovations, wireless light switches are a viable and sustainable alternative for lighting in a multitude of different facilities subject to frequent renovations.

1.5 Sources

- http://www.enocean.com/en/application-notes/
- http://www.illumra.com/Downloads/Install_Guide/E3T-SxAxx_ig.pdf
- http://www.illumra.com/Downloads/Wiring_Diagrams/120V_5-WIRE_BASIC.pdf
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