Z-Wave FLiRS:

Enabling Wireless Smart Door Locks and Thermostat

Abstract:

A key feature of the popular Z-Wave wireless communications protocol that's particularly relevant to designers of smart door locks, as well as smart thermostats, and other home automation and security devices is the power-saving FLiRS operating mode. Without FLiRS, battery-powered smart door locks would be impractical. FLiRS, which stands for Frequently Listening Receiver Slave allows the product designer to set the desired wakeup performance while optimizing battery life. FLiRs also employees unique beaming technology that provides for transition from sleep to fully awake modes on the order of one second, a critical performance requirement for battery powered devices that must be communicated with at any time with short latency. With reliable, robust performance field-tested in thousands of homes, the Z-Wave protocol is the best choice for battery-powered door locks and many other home automation applications.

As the smart home and home automation markets keep expanding, along with traditional home and business security, there's an ever-growing need for wireless devices that run on batteries. Many battery-powered sensor types for security, such as door/window sensors, and motion sensors, achieve very long battery life because they're in sleep mode until they're triggered or "tripped". But other battery powered devices – such as door locks, thermostats, and control panels do not have the luxury of remaining in sleep mode for long periods of time, because they must always be listening to receive signals. Merely waking up every few seconds as other technologies do cannot provide the desired battery life. Sleeping for long intervals and then waking up to check a mailbox for pending messages can't provide for a timely response. For example, a home automation controller might need to lock a door, it can't wait for 30 seconds or more for the lock to wakeup and check in nor can the lock afford to fully wakeup every two seconds to check for commands. FLiRs solves this problem by providing a mechanism to wake up the lock within one second with battery drain very close to that of a fully asleep device.

How FLiRS Works

If a Z-Wave controller or other node in the network needs to communicate with a battery-powered device such as a door lock, the controller sends a special beam signal. The purpose of this beam is to wake up the FLiRS device.

The FLiRS device alternates between sleep mode and a partially awake mode in which it is listening for this beam signal at the rate ranging from once per second to four times per second (this is the designer's choice). When the FLiRS device receives this beam, it immediately fully wakes up and then communicates with the controller or other Z-Wave device utilizing standard Z-Wave protocol commands. If the device does not hear a Beam it goes back to full sleep for another period until it partially awakes again and listens for a Beam. It is this partially awake mode combined with the special Beam that provides for battery lives on par with fully sleeping devices while providing communications latencies of around one second.

Figure 1. Packet travels to last repeater in path to door lock

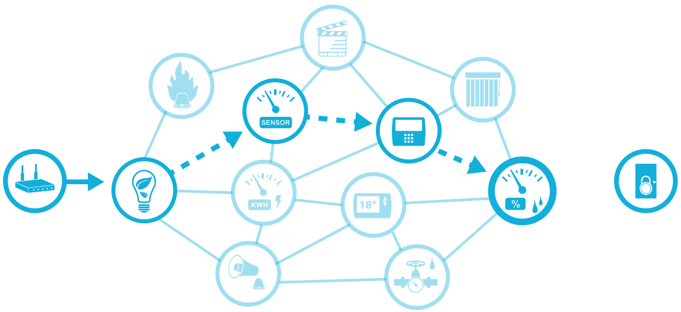
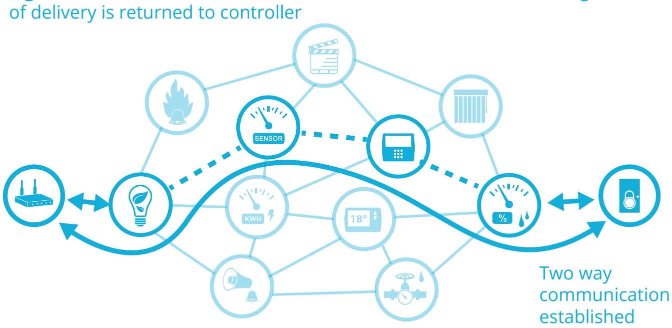


Figure 2. Last repeater in path sends wake up signal to door lock

Figure 3. DOOR LOCK IS AWAKE - Packet is delivered and acknowledgement of delivery is returned to controller



FLiRS is a standard feature of the Z-Wave protocol and has been available to the smart device designer since July 2013.

The FLiRS implementation in Z-Wave is extremely reliable, robust, and capable of extraordinary power savings to extend battery life. Using the 1-second rate for frequently listening, a typical (Sigma 500-Series) Z-Wave radio listening device will consume, on average, just 50-µA of power. For smart door locks, battery replacement at 1-year intervals, or even longer, becomes possible thanks to FLiRS.

The beaming strategy is not unique to the Z-Wave protocol, but for home automation applications, door locks in particular, Z-Wave's implementation is the best in the industry. With ZigBee, for example, a very different beacon system is used that needs precise, synchronized timing between devices. This solution does not provide the very short 1 second latency performance of the Z-Wave solution and requires expensive timing crystal's and other components that drive up the cost of the device. Additionally, the Z-Wave FLiRS beaming works perfectly and reliably with repeaters, thus extending the potential range between a door lock or thermostat and a controller. With ZigBee the use of repeaters can be unreliable, especially since there are so many different implementations of the protocol that compatibility can be hit or miss. Additionally, with Z-Wave FLiRS beaming, only the final node in the network actually sends the beam signal to the FLiRS device, thus further reducing latency when repeaters are utilized.

Wi-Fi is even more problematic, because it has no FLiRS mode. Which is why most Wi-Fi thermostats require AC power. Some smart thermostats utilizing Wi-Fi or other protocols try to get around this problem by implementing a relatively crude timer-based wakeup system in which the thermostat only wakes up every 10-minutes, or at even longer intervals. Such latency might be acceptable for a thermostat, although frustrating for the consumer who wants conformation of the command action. Waiting 10 minutes to lock or unlock a door is completely unacceptable.

For example, a homeowner might use a tablet app to adjust the temperature via the system controller. The app says the temperature has been set to the new number, but when the user looks at the thermostat, the temperature is still set to the old number. Frustrated, the consumer may next touch controls on the thermostat to set the desired temperature manually. This will have the effect of waking up the thermostat, so it accepts and display's the new setting. Consumers may get the impression that their home automation systems are not working properly. And even if they see that eventually their adjustments take hold, they may still be puzzled by the delays.

Applications for Z-Wave FLiRS

The smart door lock is the “killer app” for Z-Wave FLiRS because of the design constraints previously explained. It's the one device in today's home automation and home security market that has such a stringent latency requirement that most other solutions are simply impractical. This is why Z-Wave is the communication solution of choice for more than 80% of the battery powered communicating door lock currently selling in the market.

Smart thermostats do not absolutely require the ultra-low latency of Z-Wave FLiRS, but they generally work better and better meet consumer expectations with their lower latency and higher reliability.

In addition to smart door locks and thermostats, other beneficiaries of Z-Wave FLiRS technology include smart lawn sprinklers and battery-powered automated window treatments. Any battery-powered device that requires listening for a control signal is a candidate.

Conclusion

Among modern technologies, batteries have progressed at a much slower rate than processors or displays, a situation that's unlikely to change anytime soon. With the popularity of home automation being driven partly by the convenience and aesthetics of wireless devices, battery power is an essential requirement.

FLiRS is one of several features of the Z-Wave protocol that make it ideally suited to battery-powered applications. With over 1200 devices from hundreds of manufacturers already available, and all interoperable via Z-Wave, it is the world's most widely deployed home automation wireless protocol. The Z-Wave implementation of FLiRS enables smart door lock manufacturers and thermostat manufacturers to offer consumers reliable, robust products that can operate for a full year or more before requiring battery replacement. For more information visit z-wave.sigmadesigns.com.