

ECE 480 Design Team 3
Design Issues

Power-over-Ethernet for Wireless Home Automation
Sponsored by Texas Instruments

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Introduction

The task of our team was to design Power over Ethernet (PoE) for wireless home automation. Since PoE is a relatively new technology, major technical issues must be addressed in order to accomplish this task. We must also consider the environmental conditions that the system will be deployed into. We will discuss three specific design issue considerations and how our project currently addresses, or could address, each design issue. Our team identified three important design issues throughout development of the prototype; safety, product lifecycle management and intellectual property.

Safety

Product safety is the most important issue designers face and must consider in order to make the design reliable and protect users from harmful contact of the product. Our team has taken great measures to ensure our product is safe and reliable for end-users. It is always a good practice to think of product safety before designing a prototype. Our team considered and utilized a plan for developing a safe, sustainable system using Power over Ethernet technology. Since we are designing a system that will be commercially deployed with users that have little or no experience with electrical equipment, we took extra precautions to make sure that our system can safely be used by anyone. To do this, we broke down our project into smaller independent entities. The majority of security measures took place at this level to ensure a safe overall system. We first identified the safety of the power supply and the power cords including the CAT5 cable. For our prototype, some wires are exposed and can be harmful if mishandled. Therefore, we must protect the end user from the exposed wires with insulators to prevent electrocution.

The power supply and the power sourcing equipment electrical wires are the only harmful electronics that our team must worry about. Thus, to protect ourselves as well as consumers, our team physically isolated each component from the other. This ensures that each component will be safe and avoid the case of unintentional contact between devices. Furthermore, the power supply did not come with a AC adapter. In order for us to use it safely, we made our own power cable by cutting and tripping a standard computer power cable and soldered the three wires (ground, high, neutral) on the power supply. These measures could make

the power supply unsafe due to exposed wires at the end. So to safely use this method, we protected the wires with electrical tape as a temporary solution. For future applications and prototyping these wires must be insulated permanently to ensure safety of the user.

Another safety issue to be considered is the storage of the board. Our team has proposed using an enclosure for all active devices on our design. This should be done to avoid electrostatic discharge and environmental contamination to key electrical component such as the microcontroller or WSoC. This case will host all components except the power supply and the power sourcing equipment. This will ensure supplementary product safety, since some of the chips and boards pins we are using for our design can easily be broken or bent if they are exposed and an enclosure is not used. Most of the wires that will be outside of the enclosure will be Ethernet cables which are safe to be outside of the enclosure and will give us less worry of product safety.

Product Life Cycle Management

Product Life Cycle Management (PLM) is defined as the process of managing the entire lifecycle of a product. This includes original conception of the idea, production, distribution, consumption, and retirement. As our team has progressed, these stages of PLM have been considered.

As products continue becoming smaller, size is one of the largest areas that affects the life cycle of a product. With this in mind, our team has continually strove to achieve the smallest design prototype that meets all of our design criteria. The biggest area for improvement can be seen in the power supply and power sourcing equipment. By utilizing a switching mode power supply, both weight and size savings are realized compared to using a linear power supply. Also, the TPS2384 power sourcing equipment device given to us by Texas Instruments can be shrunk down by cutting out unnecessary features depending on the target environment. This could allow us to create a single board design and create a small, yet efficient product.

Although size is critical to keeping a product out in commercial distribution, expandability is also another chief concern. Our team has utilized 802.15.4 ZigBee communication between sensors to fulfill the low-power requirements. However, in certain situations, the limited range that ZigBee provides may not be sufficient and other communication protocols may be desired. Taking this under advisement, our team has aimed to making the shift from ZigBee to something

such as Bluetooth easier. Only the replacement of our transceiver radios would be required to modify the environment from ZigBee to Bluetooth technology. The rest of our integrated chips and boards would not need to be modified in order to accommodate this change. Consequently this also alleviates some of the design challenges an experienced end user may have with expanding on our product.

By producing a smaller sized and more expandable product, distribution and marketing aspects would become more streamlined. Consumers do not want to buy a product that is bulky or too hard to use, thus life cycle heavily depends on producing a product that will cater to the end users needs. If this aspect of PLM is ignored or not fully accounted for, the life cycle of that product could be considerably short and the financial repercussions could be devastating.

As every product reaches its inevitable end of life, companies that produce or sell these products must have ways to dispose of them. As countries strive to become more environmentally conscience, more products are including information in user manuals on proper ways to dispose of the old product. More often than not, companies are handling the burden of disposal for their own products due to the hazardous materials that some electronic devices are built with. This allows more ease for the consumer as there only responsibility is to ship or drop off their products to the manufacturer. Luckily, companies such as Texas Instruments have started utilizing newer technologies such as radio frequency identification (RFID) to help aid in the proper disposal of certain products. This along with the development of products using alternative non-hazardous materials will help ease the final step in PLM.

Intellectual Property

The technology that we are trying to improve in our project is currently a major one in the industry too. In our project, we are dealing with integration of Power Over Ethernet with Wireless Home Automation. As such, this is a great idea; a new step towards future technology. This puts an enormous challenge in front of us. As designers we ought to protect this technology from wrong use, and also to give the public a good product. At the beginning of the project, Texas Instruments had the team sign IP documents giving IP rights to the company. This said, as engineers, the team is equally responsible for evaluating the possible IP exploitations we might have to encounter in the future. The design idea implemented by the team to achieve both PoE as well as robust wireless communication can be copied and falsely produced and introduced to the

market. Hence, it is essential to copyright the design. After this, the code used to program the functionality also needs to be copyrighted.

Further, as this project is essentially an integration of existing technologies to “invent” a new way of doing Home Automation, it becomes very necessary to patent our product. Our product is the first of its kind to be introduced to the market. Texas Instruments and we as a team are taking full fledged measures to ensure smooth transition from prototype to final product. Currently, the project is in the final stages of prototyping. What lies ahead is rapid production of multiple boards which integrate the technology onto a single board, and this final product will be presented to Texas Instruments, who will further ensure the functionality and quality of the product.

Conclusion

In creating a successful prototype, our team aided the process with safety and product lifecycle management techniques. Several concerns were addressed and handled as they were encountered, including developing an enclosure for our boards and insulating exposed wires. Focus on size, shape, weight, power consumption, and efficiency were chief concerns throughout the design phase. Using this method of planning, our team was able to effectively enhance longevity of life and safety of the product. Due to the nature of the project and the relatively new technology involved in the design, IP rights were signed to our sponsor Texas Instruments. By doing this, our team may have facilitated the design solution for a commercialized product, a very exciting privilege.

References

[1] Josh Wyatt, *Maximizing Waste Management Efficiency through the Use of RFID*, Texas Instruments, 2008. Available at:
<http://www.ti.com/rfid/docs/RFIDWasteManagementWhitePaper.pdf>