RFID key entry system for Hicks labs

E90 Proposal

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Abstract

A key card access system to two labs in Hicks is proposed. The system will be based on Radio Frequency ID (RFID) tags embedded in or attached to student ID cards. Design activities will consist primarily of programming and debugging, with installation to be performed in large part by Facilities. Total expenditures are estimated at about $1000.

Introduction

The current system for controlling after-hours access to Hicks is time-consuming and puts an unnecessary burden on the student. At present, engineering students who need to use labs in Hicks outside of normal business hours must use keys. Key distribution is controlled by Key Central, which receives key requests from the department administrative assistant. The requests can take up to two weeks to process. Each room has its own key and as a result many students carry many keys. Since there is a significant fine for losing each key, some students would face fines of over $200 if they lost their sets. A digital access system based on RFID tags would solve this problem, but professionally installed digital access systems like the ones used in the Science Center and by Information Technology Services cost tens of thousands of dollars. To add such a system to Hicks would cost between five and twenty thousand dollars.

The purpose of this project is to build a low-cost RFID system that could be administered by Engineering Department personnel. The system will initially control access to the two doors to which students most often request keys (213 and 310), but it will be easy to expand to control all doors in the building. It will allow an administrator to set room access permissions by connecting to a web server built for this purpose. Students will be able to use the RFID transponders embedded in student IDs to open the doors they are allowed to open. The system will work in parallel with already existing locks to ensure that other groups that need access to Hicks will not need to change their administrative procedures. Whereas professional systems tend to include components adaptable to a wide variety of environments, this system will cut costs by being specially designed for the needs of the department. It will also cut costs by using wiring already in the building.

This proposal presents a brief introduction to the technical issues that will be addressed, our plan for completing the project, and total project costs.

Technical Discussion

Figure 1 shows a block diagram of the proposed system. The system has six key components: the reader, the door controller, the Ethernet controller, the door strike, the power supply, and the server.

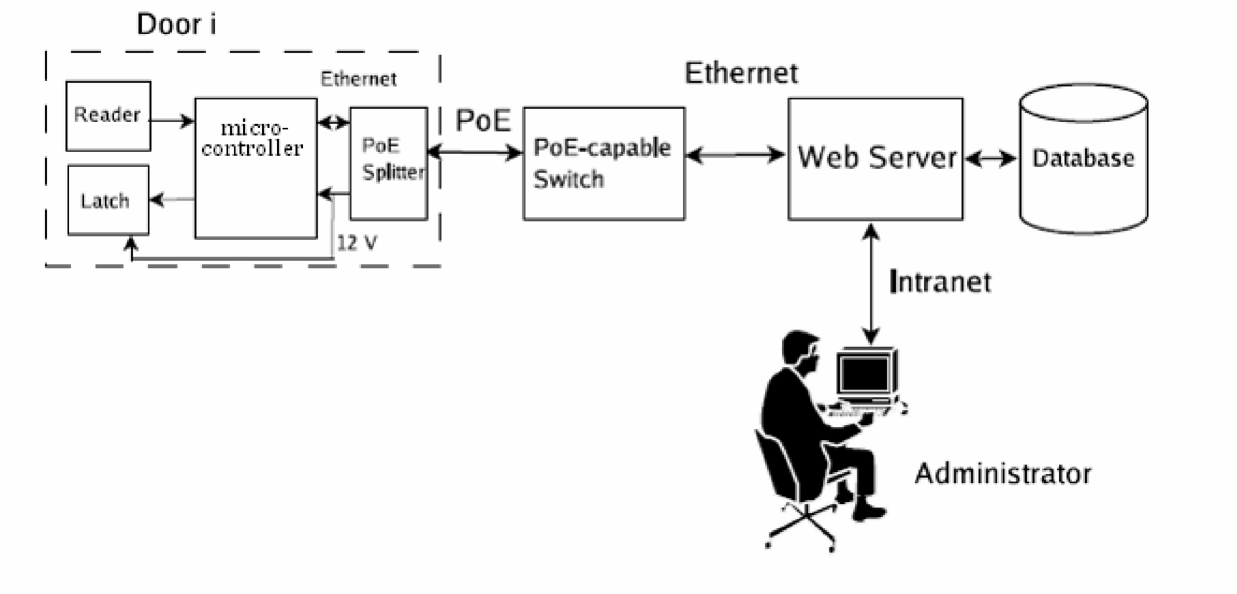

Figure 1. Block diagram of proposed entry system.

<u>1.) Reader</u>

The proximity tag reader reads 26 bits of data from a chip embedded in student IDs and outputs the ID number to the microcontroller using a Wiegand protocol (the standard data transmission format for RFID readers). The Wiegand protocol requires three wires: common ground, data high, and data low. When there is no data to transmit, both data high and data low remain at high voltage (usually 5 V). When the device transmits a ‘0’, data low is low and data high stays high. When the device transmits a ‘1’, data high goes low and data low stays high. The number of parity bits and form of stop and start bits vary device-to-device. The AWID SR2400 is an appropriate reader; it can be supplied by 5-12 VDC and has a maximum power consumption under 1.0 W.

<u>2.) Controller</u>

The controller will read the data from the reader and send it to a server over Ethernet. The controller will receive “open” or “don’t open” commands from the server and connect power to the door strike or turn on an error/permission denied indicator accordingly. A serial EEPROM with a local hard copy of user codes and permissions will be used if the controller is unable to communicate with the server. The microcontroller will interface with Ethernet via a small Ethernet controller chip.   The Ethernet chip requires 16 inputs from the controller. The PIC16F873A has enough I/O pins to communicate with the Ethernet controller, the reader, and the EEPROM.

<u>3.) Ethernet Controller</u>

The Ethernet controller will send the request to open the door from the microcontroller to the server.   The RealTek Full-Duplex Ethernet Controller with Plug and Play Function (US RTL8019) is appropriate for this function.

4.) Strike

The strike will be a HES 4500 series, which takes 24 or 12 VDC and has a peak power demand of 2.88 W. It is installed in the door frame, and thus does not interfere with the lock already in place.

5.) Power Supply

The door controller will communicate with the server via Ethernet. The same Ethernet cable can be used to power the system using Power over Ethernet (PoE). The system will use a power splitter (the D-Link DWL-P50) to extract power from an Ethernet cable and supply it to the strike, controller, and reader. PoE can supply up to approximately 15 watts to a device at 48 V, and the above device steps down to 12V delivering 12 W; our combined approximate power consumption envelope is around 5 W peak. The switches installed in Hicks are already capable of injecting PoE power to an Ethernet port, so no additional hardware will be needed at the far end.

6.) Server

The server will manage the database of names and allowed IDs. When a user swipes his or her card, the door's microcontroller sends a request to the server, which then either confirms or rejects the request in a return message. If the request is confirmed, the microcontroller opens the door. The server also manages a web-based management interface, accessible by Engineering department staff. The web interface consists of a set of PHP server scripts, which interface with a local SQL database such as MySQL. The idea behind the web interface is to ease system management. All code will be well-documented and editable, so a future administrator could fix bugs or add features as desired.

Project Plan

The project is divided into three main parts: controller programming, server programming, and testing. The controller and server can be programmed, designed, and debugged simultaneously, but final testing must occur after both components are completed. Molly will be primarily responsible for the controller, Alex for the server, and both for testing. Detailed tasks, estimated completion times, and dependencies are listed in Table 1. A Gantt chart showing projected start and completion dates is shown in Figure 2. Since the major design constraint is that the system be robust, ample time is given to testing and debugging.

Table 1. Tasks, estimated completion times, and dependencies.

Section	***Task***	***Time***	***Needs***	***Feeds***
1. Controller	1.1 select controller	1 h	-	1.2
	1.2 order controller	1 w	1.1	1.5
	1.3 design PCB	10-15 h	-	1.4
	1.4 order PCB	2 w	1.3	1.5
	1.5 program controller	40 h	1.2, 1.4	1.6
	1.6 bugfixing	30 h	1.5	-
2. Server	2.1 research server setup requirements	2 h	-	2.2, 2.3
		4 h	2.1	2.3, 2.4, 2.5
	2.2 configure server			
	2.3 configure database	2-4 h	2.1, 2.2	2.4
	2.4 write data manipulation scripts	20 h	2.1, 2.2, 2.3	2.5, 2.6
	2.5 write web-based user interface scripts	20 h	2.2, 2.4	2.6
	2.6 server bugfixing	40 h	2.4, 2.5	-
3. Installation	3.1 door latch	4 h	1	5
	3.2 wiring	8 h	1	5
	3.3 box	2 h	1	5
4. Documentation	4.1 manual writing	10 h	2	-
5. Testing	5.1 testing	20 d	1-3	-

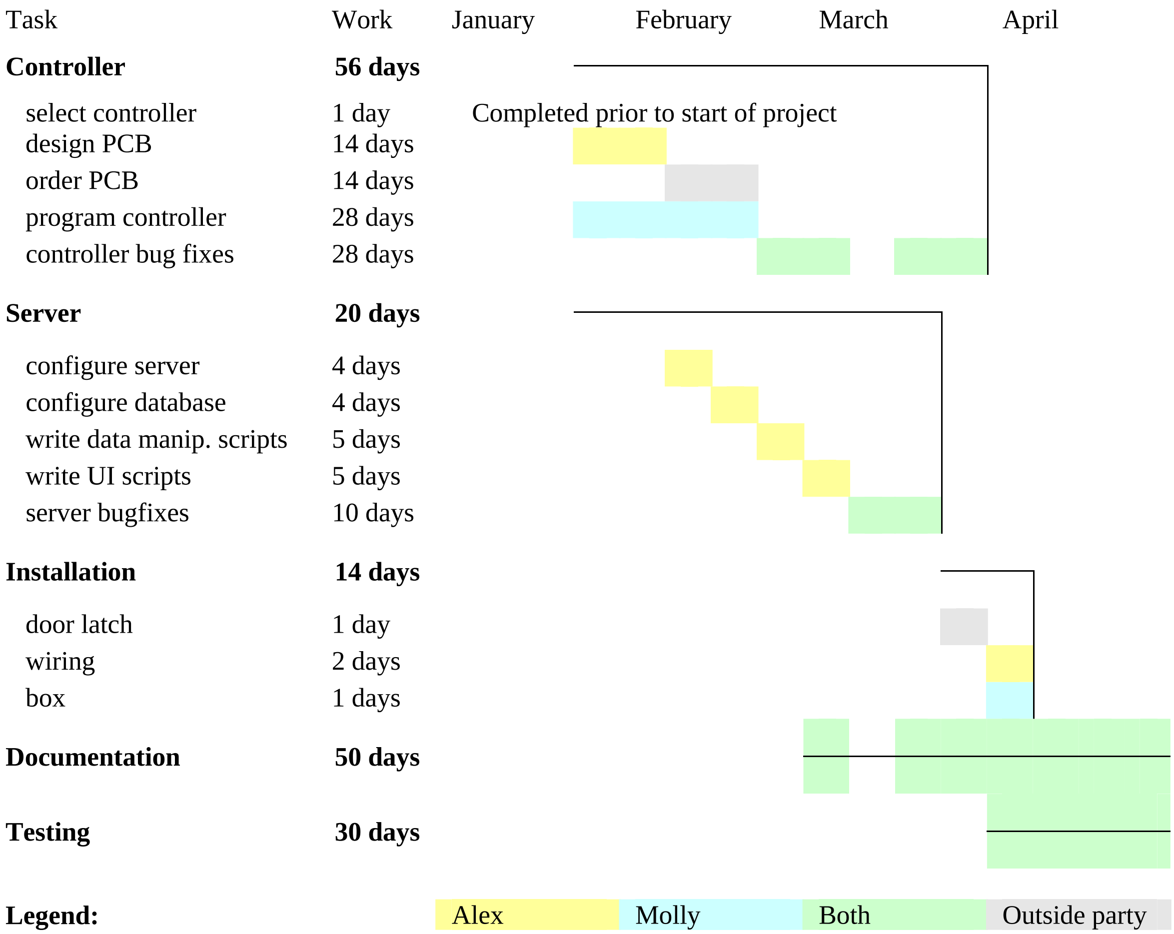

Figure 2. Gantt chart showing tasks, estimated completion times, and personnel assignments. .

Project Costs

Table 3 shows a list of components, the required quantity, and the cost per unit. Certain components (the EEPROM, for example) are omitted because their costs are negligibly small.

Table 3. Estimated costs of components, cost per door, and total cost.

Component	Quantity	Cost per unit
Proximity Reader	2	$86
Controller	2	To be supplied by department
Ethernet Controller	2	$16
Door Strike	2	$300
Power Splitter	2	$40
Server	1	To be supplied by department
PCB	2	$50
Cost per door		$492
Total estimated cost		$1000