holla
home solutions

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January 24, 2005

Lakshman One
School of Engineering Science
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RE: ENSC 440 – Proposal for a Remotely Accessible Temperature Control System

Dear Mr. One,

Please find attached the document *Proposal for a Remotely Accessible Temperature Control System*, which is our project proposal for ENSC 440: Capstone Engineering Project. We intend to design and construct a thermometer and temperature control system that interfaces wirelessly with a home personal computer, allowing the user remote access from any internet enabled PC.

Our project proposal contains an overview of our proposed project, a short description of design considerations, our prospective budget and sources of funding, an outline of our project schedule, and a team description. We also look into existing solutions to the problems our project intends to solve.

Holla Home Solutions is comprised of four determined, talented, and attractive senior engineering students: Jen Fong, Steve Judd, Wojtek Piaseczny, and Chris Richardson. Our company profile within the attached document outlines the skills and experience of each team member. If you have any more questions or concerns about our proposal, contact me by e-mail at holla440@gmail.com or by phone at 604-761-3739.

Sincerely,

Jen Fong

Jen Fong
President & CEO
Holla Home Solutions

Enclosure: Proposal for a Remotely Accessible Temperature Control System

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Proposal for a
Remotely Accessible Temperature Control System

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Executive Summary

You would be hard pressed to find a residence or place of business that does not come equipped with a climate control system. Whether that system includes a gas furnace, electric heating, or air conditioning it will doubtless consume energy to operate, energy that is increasingly expensive these days. Every day people leave their homes to go to work or to go on vacation and leave the heat on, wasting needless dollars heating an occupied residence. Conversely, many dread returning to cold and uncomfortable homes that were unheated during the day to save money.

To combat the problem of wasted energy and uncomfortable temperatures caused by unattended thermostats, many companies have built controls with programmable timers. These timers allow climate controls to be turned on and off according to a preset, user defined schedule. However, programmable thermostats lack the flexibility required to completely solve the aforementioned problems. While timing does allow climate control to cycle on and off, it does not offer the flexibility required to accommodate changes in individual schedules. In addition, manual override of programmable thermostats is almost always available on the device, allowing others to override programmed settings.

This document proposes developing a device that will allow users to change their temperature settings, including timing options, at home or in a vacation home remotely in order to accommodate changes in schedule, absent mindedness, and manual override. The device will interface with existing HVAC systems and would have wireless capability. The device will communicate with a home computer on a home wireless network, allowing temperature settings to be controlled from any desktop PC with Internet capability running our software. In addition, we hope to prove with the successful implementation of our device that remote control of home appliances over the Internet is secure and reliable paving the way for extended control of other appliances in future versions of our product.

Holla Home Solutions consists of four senior Engineering Science students with experience in microcontroller programming, digital signal processing, and Internet protocols such as TCP/IP. In addition, our team contains multiple talented programmers with training in a variety of languages.

We intend to perform the task of engineering our proposed device in thirteen weeks, strictly following a schedule of research, design, and implementation. We intend to complete an operational prototype by early March with our budget of $794.00, obtained via the ESSEF and other sources.

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Introduction

When sitting on an airplane flying over an ocean the last thing that one wants to think about is whether or not they left the heat on in their departed home. Someone at work might have the opposite but equally irritating feeling of dread when pondering the prospect of returning to a bitterly cold residence. The bottom line is that homeowners are not provided with the flexibility and control they require over their home temperature controls in order to reduce heating costs and maximize comfort.

Homeowners can purchase thermostats with timers that allow users to program a schedule for temperature control. This is an improvement, but does not accommodate changes in schedule, long absences, and manual override.

Through our project, we intend to develop a thermostat that sits on a wireless network and interfaces with a desktop PC in order to provide temperature control over the Internet. Our thermostat will operate using an existing home furnace heating system and will be based on a microcontroller with wireless capability. In addition to the thermostat, we will create a desktop application that will run on a Windows-based PC. The software only needs to be run a single home computer that is wirelessly connected to the thermostat.

The Holla Home Solution desktop application will display the current home temperature to provide the user with a basis for making a temperature change decision. The user will have the option of turning the temperature up or down as well as setting up a temperature schedule based on timing.

With Holla Home Solution's remotely accessible temperature control system users will have complete control over their home HVAC system from any desktop computer with an Internet connection in the world. Through our product we will enhance the flexibility of the user, decreasing home heating costs and maximizing temperature related comfort.

This document is a proposal for the Remotely Accessible Temperature Control System, describing the system overview and presenting our proposed and intended design solutions. We have also included information on sources of funding, our perceived budget, and our project schedule including a Gantt chart.

System Overview

An appliance is a tool for the home; a smart appliance is a tool with access to a computer and to the Internet. Smart appliances have two popular benefits: energy savings and convenience. The operating cost of most appliances can be significantly reduced by, simply, optimizing its use. For example, an empty home probably does not need to be heated. Smart appliances also offer ease of mind. Forgetting to turn the iron off can be resolved by simply visiting a web site that monitors and controls a home's smart appliances. Figure 1 illustrates a typical smart appliance configuration.

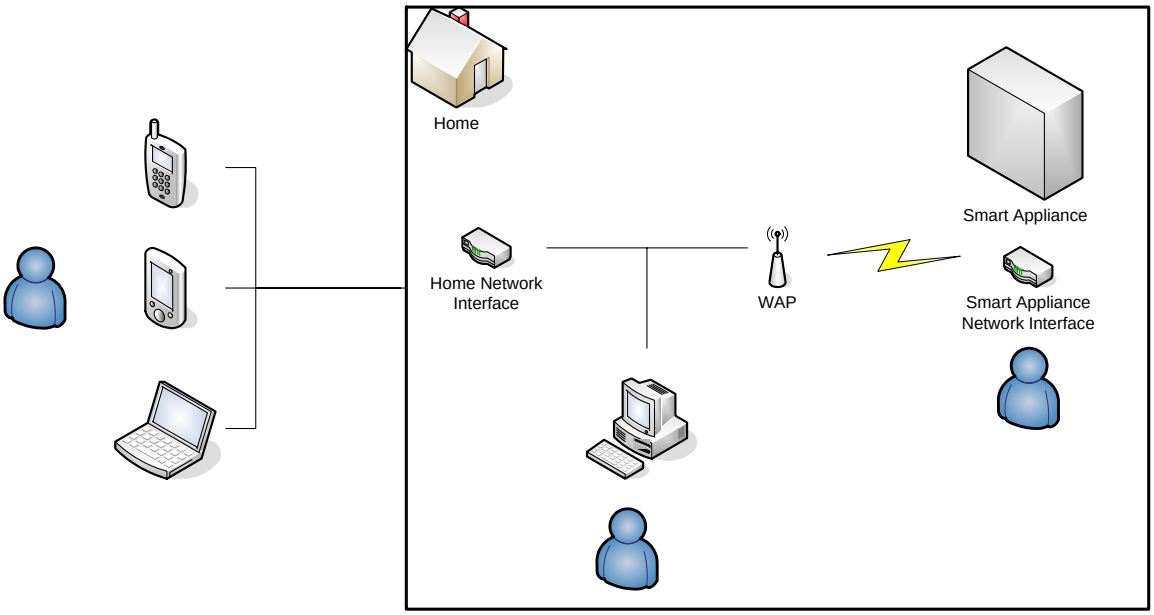


Figure 1: Proposed Home Network Structure

We will develop a standard for the remote control of appliances. We have chosen to build a thermostat as our proof of concept, accessible through a wireless home network. Once the thermostat is exposed to a home network, it can be further exposed to the world through a variety of established communication systems and accessed using, among others, cellular phones, PDA's, and laptops.

Possible Designs

We are proposing a remotely accessible wireless thermostat. From the user's point of view, the functionality, not implementation, is important. The following designs can all be used to create said thermostat, but our evaluation of them will be based on their extensibility to other appliances.

Dedicated Network Appliance

A system that was engineered with a single purpose in mind is said to be *dedicated.* It provides a complete solution, including the user interface and connection to the appliance. A dedicated system can take advantage of the intricacies of a particular appliance and optimize for them. The drawback is that these optimizations will probably render the system unusable in other appliances. A dedicated thermostat would connect to a PC or control center through software with prior knowledge of the thermostat's functionality.

Hub-Oriented Network Appliance

This approach is similar to dedicated appliances, but additionally allows appliances to communicate directly with each other through a hub rather than relying on a PC for this channel. The hub represents a middle-man between the PC and the appliance. A hub-oriented system is useful when multiple appliances reside on the same network, and these appliances have the ability to synchronize or share data with each other. For example, a clock appliance would be able to set the time on all other appliances on the network.

Self-Describing Network Appliance

A self-describing appliance is able to communicate with software that does not have prior knowledge of the appliance's functionality. Using a communication channel, a network in this case, software on a PC would discover appliances, as well as their functionality. Each appliance must be able to describe itself exhaustively in terms that the PC software can understand.

Proposed Design

Our thermostat will be a self-describing network appliance. This implementation promotes factoring out appliance-specific functionality, and focusing on the creation of a generic smart appliance infrastructure.

Communication will flow bi-directionally between the PC and the thermostat. The PC will be equipped with software able to discover self-describing appliances wirelessly. Upon being discovered, the thermostat, implemented using a microcontroller, will identify itself to the PC, and provide the list of function calls it supports. At this point, a connection has been established and the PC is ready to handle user requests for the thermostat. There will also be a control on the thermostat itself that overrides any remote requests. Figure 2 shows the separation of functionality on the microcontroller that will allow this project to be easily extended to other appliance applications.

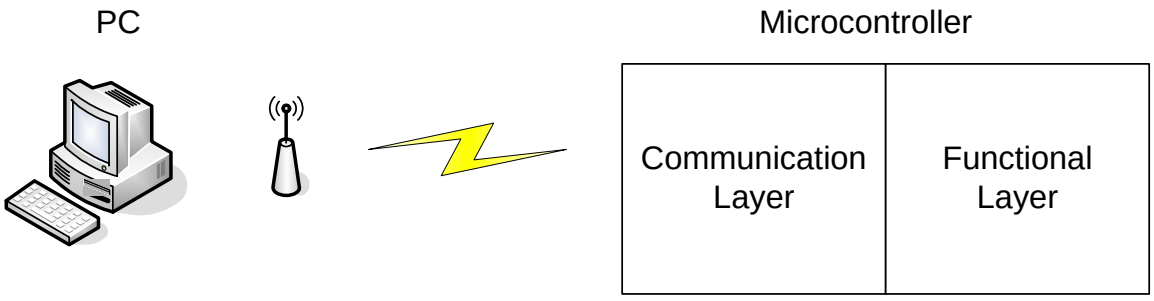


Figure 2: Microcontroller Layer Separation

This device will promote responsible energy expenditure by building on the functionality of existing programmable thermostats. By connecting our thermostat to a computer network, we are in effect connecting it to any number of devices that are also capable of communicating via a computer network. A web interface will be provided as a part of our project.

Sources of Information

When researching our problem and our intended design we will use whatever information is available from the company that built the current furnace and temperature control system of the house we intend to run with our prototype. This information will likely be invaluable in interfacing our design with an actual home heating system.

We will definitely be using the product specifications and information that comes with the microcontroller we will eventually use in our design. We will have to consult an API to determine how we are to program our device.

The Internet will be a key source of information in finding the microcontroller we are going to use as well as other hardware. We intend to build our own thermostat by integrating a third party thermometer into our design and interfacing it with our microcontroller. We anticipate that most of our research for this component will be done online.

Finally, there are many professors and TA's that will be guiding us in this venture. We intend to consult with them frequently and consider them a valuable source of information.

Budget

Table 1 outlines the costs that will be incurred in creating our remote temperature control system. Notice that in addition to the materials that will be purchased, we have included additional assets that will be vital to completing this project but will not increase our current expenses. The idea of doing the latter is to provide a thorough overview of all the components that will be utilized in the development of our wireless control system.

Table 1: Materials and Their Associated Costs

Required Components to be Purchased	Cost $CND
Micro-Controller with On-Board Transceiver	$300
Development Tools	$99
Digital Temperature Sensor	$100
Power Supply	$150
Batteries	$10
Miscellaneous Equipment (i.e. cords, solder etc)	$35
Contingency Fund	$100
Materials Needed Without Creating Addition Costs	
Personal or Notebook Computer	$0
Wireless hub	$0
Internet Connection	$0
Total	**$794**

The main component in the Development Tools allotment above is the software that we will be using to write to the microcontroller. All of the smaller valued items, including shop tools, small wires etc, we have an anticipated need for are contained in the Miscellaneous Equipment budget. In addition, we expect to incur some costs that we have not anticipated thus far and so have created a Contingency Fund in accordance with our conservative accounting practice.

Schedule

The Gantt chart in Figure 3 depicts our expected schedule of tasks and the estimated period necessary to complete each module. Table 2 further breaks down the dates in the Gantt chart. Table 3 shows the technical milestones and the deliverable due dates for the Remotely Accessible Temperature Control System.

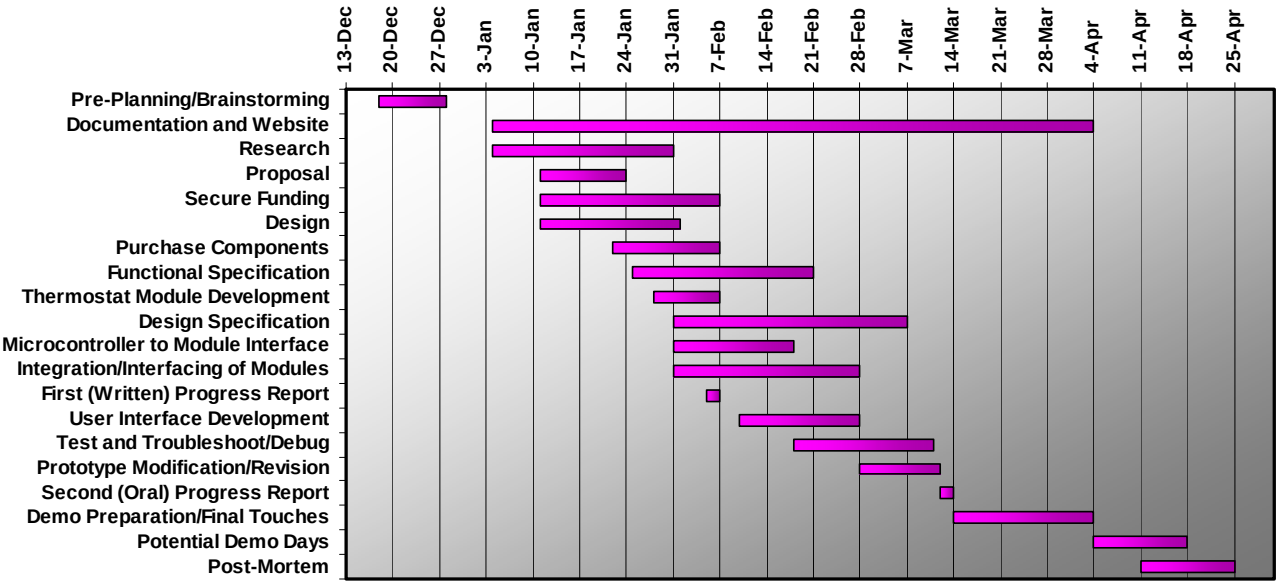


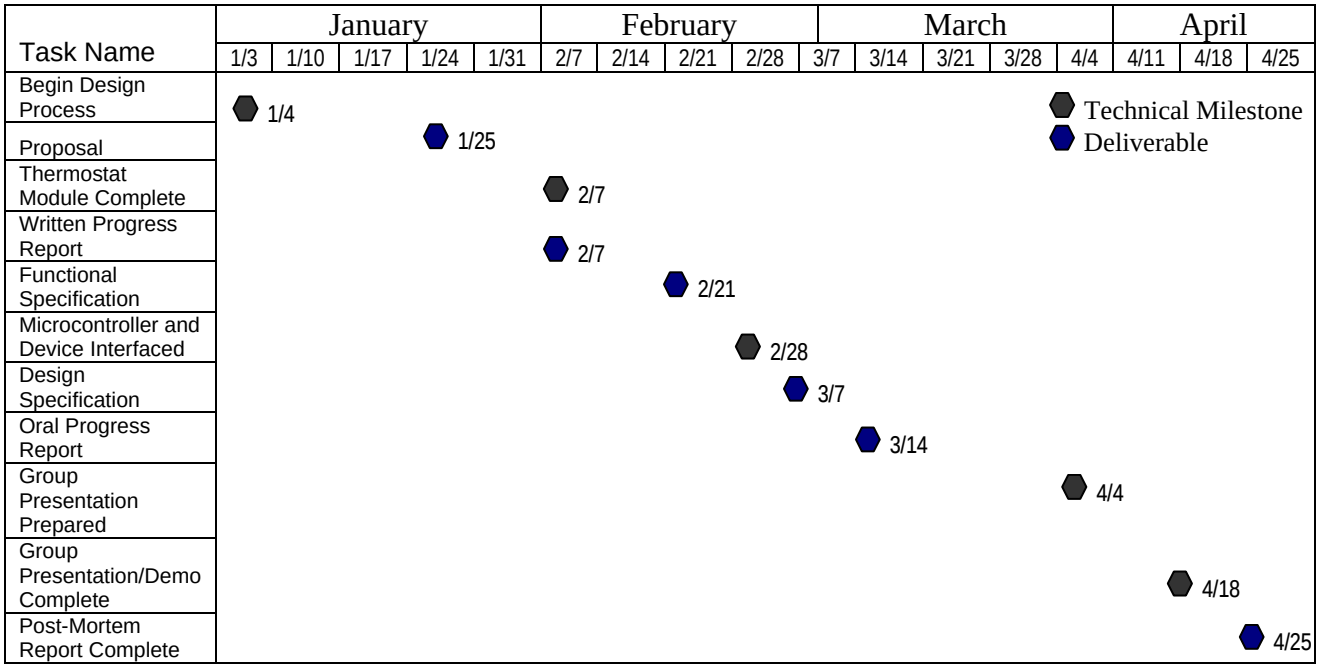
Figure 3: Gantt Chart for Remotely Accessible Temperature Control System

Table 2: Break down of dates illustrated in the Gantt chart

Task	Date Range
Pre-Planning/Brainstorming	December 18 - 28, 2004
Documentation and Website Development	January 4 - April 4, 2005
Research	January 4 - 31, 2005
Proposal	January 11 - 24, 2005
Secure Funding	January 11 – February 7, 2005
Design	January 11 – February 1, 2005
Purchase Components	January 22 - February 7, 2005
Functional Specification	January 25 - February 21, 2005
Thermostat Module Development	January 28 - February 7, 2005
Design Specification	January 31 - March 7, 2005
Microcontroller to Module Interface	January 31 - February 18, 2005
Integration/Interfacing of Modules	January 31 February 28, 2005
First (Written) Progress Report	February 5 - 7, 2005
User Interface Development	February 10 - 28, 2005
Test and Troubleshoot/Debug	February 18 - March 11, 2005

Prototype Modification/Revision	February 28 - March 12, 2005
Second (Oral) Progress Report	March 12 - 14, 2005
Demo Preparation/Final Touches	March 14 - April 4, 2005
Potential Demo Days	April 4 - 18, 2005
Post-Mortem	April 11 - 25, 2005

Table 3: Remotely Accessible Temperature Control System Milestones



Sources of Funding

Largely, there are three options available to us for obtaining the capital estimated in our budget; the first of which is with the SFU Endowment Funds. Through the Faculty of SFU Engineering Science Department, we are eligible for financing by the Engineering Science Student Endowment Fund (or ESSEF). With an approximate upper bound of $1000 awarded through the ESSEF, we may be able to partially, if not completely, fund our project through this vice.

Another option for financing is through external sources. These include companies that are in the business of developing electrical thermostats and/or control systems for house hold appliances. Some of these companies include Honeywell and Braeburn Thermostat, both or which are involved in controlling heating and cooling indoors and both of which do not currently sell the technology we are developing. If we cannot initially obtain financing from any external companies, we hope that once we have developed our system and can demonstrate its marketability to the public, companies operating in the same industry will purchase our technology. Other external financing sources may include bursaries other then the ESSEF, scholarships or even entrepreneurs that see potential growth in our organization.

Our third and least desirable option is for each group member to contribute equally for any additional capital that may be needed. In fact, if we are unable to obtain any funding through the ESSEF or other external sources, a $200 donation to the project by each group member is quite acceptable.

Team Description

Jennifer Fong *– President and Chief Executive Officer*

Jen is a 5th year Electronics Engineering student at Simon Fraser University. She possesses a wide range of experience, with past roles in both hardware and software capacities, working with the SFU Arial Robotics Group and at Howe Sound Pulp and Paper. Jen's passion, however, is ice hockey. Her patience, leadership and motivational skills gained as the captain of Team BC in the Senior Women's AAA division and assistant coach for the U-18 program will be invaluable assets in keeping the peace between Holla Home Solutions team members, enroute to the forefront of home solutions technology.

Stephen Judd *– Chief Financial Officer*

Stephen is a 6th year student at Simon Fraser University. In addition to his time spent studying to be an Electrical Engineer he has taken courses towards a Business Minor. His engineering expertise lays in electrical-mechanical control systems, which will prove fundamental to the successful completion of this project. With his broad field experience working in both large and small teams, often as project manager, Stephen will be relied upon to instill effective group dynamics and offer insight into issues concerning the business aspects of the design. Due to all of these qualifications, Stephen has been granted the position of CFO.

Wojtek Piaseczny *– Chief Software Engineer*

Wojtek Piaseczny is a 5th year Computer Engineering student currently completing his Honours Bachelor degree at Simon Fraser University. He has a plethora of industry experience, most notably at Advanced Telecommunications Research Institute International in Japan. His skill set includes hardware, but his passion is software. He has an owning interest in a small software development firm, and for the most part, people like him. Wojtek spends his free time skiing, windsurfing, playing hockey, and traveling. The breadth of his experience will be an asset to the Holla Home Solutions team.

Chris Richardson *– Chief Hardware Engineer*

Chris is in his 4th academic year of the Engineering Science program at SFU, but he actually started in 2000. His practical experience encompasses mostly software. Chris held the position of software developer on two previous work terms with Parity Computer Solutions programming primarily in Visual C++, with a little PHP and SQL on the side. Beyond the technical aspect Chris brings the ability to communicate clearly and his organizational skills to the table. Outside of engineering Chris enjoys sports such as soccer, golf, and snowboarding and is an avid reader.

Conclusion

Holla Home Solutions is excited to push the edge of current smart appliance technology. Currently, many smart appliances are built as dedicated systems that are difficult to integrate. The wireless thermostat will serve as a functional prototype for self-describing home devices. Its module-oriented design will allow for easy integration of many appliances that can be controlled through a single computer. In addition to offering the same energy efficiencies as many of today's digital appliances, Holla Home Solutions also provides ease of mind, allowing users to monitor their homes in real-time. The final product will heavily emphasize ease of both deployment and use, in the hope of attracting interest from the common North American household.

The education, experience, and determination of the Holla Home Solutions team make us confident in our ability to successfully complete this project according to the proposal presented here. The long-term plan for this project is to bring the wireless thermostat to market while developing functional modules for other common household appliances.

References

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http://www.zilog.com/