Design a Smart Transit System

Progress Report I

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Chapter 1 Design a Smart Transit System

1.1 Project Description

Project title: Design a Smart Transit System

Supervisors: Dr. Fayez Gebali, Dr. Kin F. Li and Dr. Michael McGuire

Victoria Regional Transit System coordinates the delivery of public transportation throughout Victoria. Since the system was created, buses have been improved to increase user satisfaction. For example, there is space for two wheelchairs on each bus, and this area could also be used by walkers and baby strollers. Despite such improvements on individual buses, the current transit system in Victoria, however, has not kept pace with more modernized systems where real-time transit scheduling and traffic data are accessible to the general public. It is not rare to encounter frustrations when buses are not arriving on pre-made schedules due to real-time uncertainties. On the other hand, emerging personal communication and computing technologies, such as smart phones, are fast growing popularity worldwide with hundreds of millions users. To resolve the imbalance between the current system and the ever-evolving technology, it is innovative to create a system which enables effective communication between transit bus, bus stop, and smart phone.

This revolutionary idea was ignited by the Integrated Microsystems Lab (IMS) (http://www.ims.ece.uvic.ca/). They have developed an App for a smart phone to guide a visually-impaired person along a predefined route to a specified bus stop. However, once the person is there, it is hard to know which bus is coming and to inform the bus driver to stop. Therefore, this project was inspired by their idea to develop an App for a smart phone to assist people with disabilities. The team would like to expand this idea by creating a "smart transit system" that communicates with buses, passengers, and possibly transit centre. For example, people could use their cell phones regardless where they are to know the estimated arrival time of a specific bus they are boarding.

Overall, the project idea is summarized as the following:

Objective: to investigate various appropriate approaches and development to meet the following requirements:

1. Communication between a smart phone and the bus stop
2. Communication between the bus stop and the transit bus
3. Features that could be available at the bus stop to support the desired functionality such as system power, displays, communication protocols, security and authentication, etc.
4. Integration of the above modules into a complete prototype

Innovative research and design of this project will explore the potentials of applying "smart" technology in transportation, possibly applicable to other systems as well. Eventually, the successful implementation of the system will revolutionize the way

individuals receive and disseminate temporal and spatial information. The convenience and reliability added to the transit system will encourage more people to use public transportation, and thus will benefit the environment.

1.2 Project Plan

For the design of a "Smart Transit System" project, there will be a total of ten weeks for research and development. In the first 2-3 weeks, background and market research will be conducted to build a foundation for the project. Specifically, background research will look at the best methods for this type of communication system, current technologies and what similar products have been created. Before contacting the relevant organizations, a proposal must be developed. After its completion, the market research can start and examine the client side of the proposed product. This includes gaining feedback from the transit organization, client base and any other involved parties.

Once the market research is completed, the focus can shift to the actual product – a "Smart Transit System." The group must define what will make the system 'smart' and how this will affect the users. A product definition will need to be developed from all the research. It will describe the potential functions and specifications. With this outline, the team will switch to researching alternatives. Each alternative will include its various functions that can be performed and the technical requirements.

Through a series of reviews and comparisons, one alternative will be chosen as the primary model. Based on the requirements and functions, research will need to be done on the design of the product. Several options should be listed for the possible microprocessors, displays, programming languages, etc. Once the variables have been selected, a series of analyses will be performed. They will cover cost/implementation, benefits and drawbacks. After a full review, the best design will be selected.

Based on the design, a work scope for the implementation process can be decided. This will outline the procedures and timelines for stages such as ordering and assembly of hardware components. At the end of the term, a report will be written to summarize the past ten weeks and a presentation will be developed to introduce the project.

1.3 Project Milestones

A detailed project plan with dates is summarized in Table 1 and Figure 1.

Table 1: Summary of tasks and dates

Task	Planned Completion Date	Actual Completion Date
Complete background and market research	12-06-15	
Define product definition	12-06-19	
Set list of alternatives	12-06-23	
Review alternative options	12-06-24	
Select alternative	12-06-24	
Compose preliminary components list – includes company, delivery times, price, possible design	12-07-06	
Analysis 1 – Costs/Implementation	12-07-13	
Analysis 2 – Benefits/Comparisons	12-07-13	
Revise components list	12-07-15	
Final design process – step by step plan, prototype design	12-07-22	
Finish implementation scope	12-07-29	
Group presentation	12-07-31	
Final report	12-08-03	

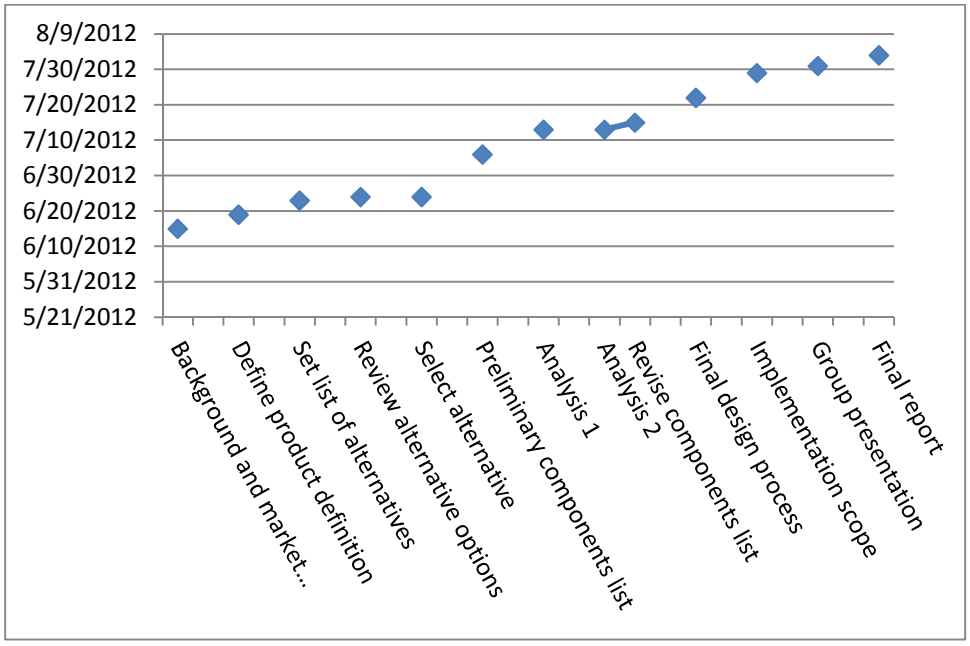

Figure 1: Project milestones

1.4 Project Deliverables

For the project, a list of deliverables was created (see below) to keep track of what will need to be produced over the term.

- Background/Market research – specs.
- Product definition
- Alternatives
- Alternative analysis
- Prototype design
- List of HW/SW components
- Cost/Implementation analysis
- Benefits/Comparisons analysis
- Implementation scope
- Report
- Presentation
- Website (optional)

1.5 Project Work Completed So Far

For the project, a meeting was conducted with Dr. Gebali on Friday, May 25th to discuss the objectives, milestones, deliverables, meeting schedules and interested parties. Dr. Gebali shared his insight on the project management process and the current technologies in the market. He helped us to explore the alternatives of implementing 'smart' technologies. Also, he provided useful contact information of experts who would be interested in this type of technology. Later, the team learned which deliverables separated the 399 and 499 project courses and the different levels of guidance associated with each. Finally, a weekly meeting schedule was set up to report the project progress and gain feedback.

1.5 Biography

Xiaoya Guo (Jessie)

Jessie is a 4th year Electrical Engineering student interested in power system and sustainable energy solutions. She is sure that the idea of a smart transit system in Victoria will encourage more people to use the public transit and lead to a greener future. Her past Co-op work experiences include digital medical image processing at the BC Cancer Agency, technical support at AbeBooks.com, transmission system modeling management at Alberta Electrical System Operator, and electrical substation design at BC Hydro. In her spare time, she enjoys working out and outdoor activities.

Emily (Chu Feng) Huang

Emily is a third year Electrical Engineering student interested in digital signal processing. She believes that the design of smart bus stop could help out passengers with disabilities and give the public ample guidance when travelling. She had experienced different transit systems while she resided in Singapore and Taipei; therefore she could use her personal experiences as research reference. She also has fundamental knowledge of programming languages such as C and JAVA so she could help implementing the communication system of smart bus stop. With the previous experience working in EcoCAR team, she has basic knowledge of car structures. In her spare time, she enjoys participating in charity organizations' fund raising events and doing community service. Therefore, she could constantly speak to people with disabilities to understand their needs.

Ludi Ling

Ludi is a 3rd year Electriacl Engineering student interested in the coding and digital signal processing. He likes to learn different software applications. In his first year engineering design course, he used a water sensor to control and modeling the electricity generation by water. His past Co-op work experience include web design at Cogen Media Ltd, and he learned the popular coding languages like PHP, CSS and MySQL. He is good at math and electrical circuit analysis. In his spare time, he likes play computer games, basketball, tennis, etc.

Ping-Hsiang Hung (Benson)

Benson is a 3rd year Electrical Engineering student interested in embedded system and network security. He worked with computer vision development in AUVic, submarine hazard research at the Geological Survey of Canada, forest fire analysis and management at the Canadian Forest Service, and university website maintenance support at the University of Victoria Communication Services. Currently he acts as the project coordinator for the AUVic team and manages team outreach, website, recruitment, as well as computer system development for the autonomous underwater vehicle. He enjoys

foil fencing and sabre fencing during his spare time and attend fencing tournaments sometimes. He has experienced the semi-smart transit system before; therefore he understands that the smart transit system project will give the public more conveniences by improving the current transit operation and providing timely bussing information.

Lara Juras

Lara is a 4th year electrical engineering student specializing in electromagnetics and interested in optimizations in technology that can improve everyday practices and allow her to be creative. This project captured her interest since it is innovative and involves design freedom. She also is excited about the communications aspect and applying course work. Lara brings her previous work experience to the group from assisting project managers at ASYS GmbH with a solar panel machine line project, acting as a project coordinator with the hardware development project managers at Research in Motion and working with databases in the electrical team at Lafarge Canada Inc. Not to mention, her travel experience across the world (e.g. Germany, Spain) provides invaluable insight to current technologies in public transportation systems. This also means she understands the insecurities people may feel in an unfamiliar area and recognizes the need for a "Smart Transit System." In her free time, she enjoys practicing yoga and pilates, viewing films and traveling to new countries to experience the culture.

Chapter 2 Seminar Review

This chapter includes two sections. Each section will review the seminar during the ELEC 399 class

2.1 Fortinet Seminar

A speaker from Fortinet was introduced at the first seminar. Forinet is a software company that specializes in network security. The speaker first introduced one of the main products that Fortinet developed, FortiGuard Distribution Network (FDN). FDN is a system global network for the FortiGuard Distribution Servers used to detect threats and potential dangers in marketed products. It also provides further updates and advisories. All the updates are sent from the primary server and broadcasted to every single FortiGate system through over 80 secondary servers. In order to detect threats in current products on the market, FortiGuard centre uses the idea “think like a hacker” to predict the potential security threats that may be attacked by hackers before any actual attack happens. Once the threats are discovered, Fortinet will notify and confirm with the vendor. Advisory of the threat will be published after the threats are confirmed by vendors.

The speaker from Fortinet then introduced three steps of design for all Fortinet products: input, critical thinking, and finally outcome product. Input usually comes from two major groups: external and internal.

Customers and markets are considered as external input. The direction for the development of new product or features for the products are based on the needs or feedbacks from the customers.

The internal input project managers, sales, and sales engineers can provide important idea for new implementations since they associate with customers and business a lot. They understand the current needs and the majority customer requirements for the product so that development team can develop new products or updates based on these inputs. Also, people of importance, such as founders, have influence on the company policy and direction; thus, they can provide inputs for the design as well. After the design input is set, the team moves to a critical thinking phase. The team discusses the question assumptions for the input idea to prevent any potential security threat and unnecessary features. At last, the final product comes out from the development team and is released into the market.

Overall, this seminar gave us a basic understanding of product development. The technique of development method could be used in ELEC/CENG 399 project and future projects.

2.2 Library Research Seminar

The University of Victoria library provides databases for all departments. Since this seminar was designed for students in computer and electrical engineering, the speaker focused on how to research computer and electrical engineering relative articles, conference papers, and reports.

There are three ways to access the databases. The first way in accessing the databases is to open up the UVic library website (http://library.uvic.ca) and click the "Databases" tab under the "Search" icon. After that, click "Databases by Subject" and choose either electrical engineering or computer engineering will list out all the available databases.

Another way to search for relevant information is by choosing the "Research Help" icon beside the "Search" icon which redirects the user to another page. On the left side of the website, choose "Subject Guide" in the left bar, select "Electrical and Computer Engineering" in the databases list, and click "Find Articles" to find engineering articles. The UVic library provides a variety of different databases for students to access: ACM Digital Library, IEEE Xplore, Inspec and Compendex, Business Source Compete, and SpringerLink/ScienceDirect/Computer Science Index.

The third way to search in databases is by using the patents and standards feature in the Research Helps site. The way to access this feature is similar to the second way of accessing subject guide for electrical and computer engineering. Instead of choosing "Electrical and Computer Engineering" in this list, choose "Patents and Standards" to search for information. There are three kinds of Patents able to choose from in this feature: World Patents, Google Patents and IEEE Standards.

One of the most important notices that students need to remember during the search is to access the databases via the UVic library website in order to have access to full ebooks and online items. To search more effectively, use subject headings, author or publisher name, publication type or date as keyword to narrow down the searching field and to increase the chance of finding matches. Furthermore, to increase the searching efficiency, use the library website to find call numbers and locations for the printed version or order items through Online Interlibrary Loan Forms.

One of the useful resources that the library provides is RefWorks, which can be used in technical writing for referencing items. This resource allows importing articles, papers, and reports through library system to the RefWorks and exporting the saving as references directly.

Chapter 3 Textbook Review

Part one of "System Analysis and Design" by Alan Dennis includes two chapters. The first chapter is an introduction of the book. It explains system analysts' role played in Information Systems (IS) development, introduces the fundamental systems development life cycle and its four phases, and ways to identify and initiate potential IS development projects.

The systems analyst plays a key role in IS development projects. A systems analyst analyzes the business situation, identifies potential improvements, designs an information system to implement the improvements, and encourages others to use the system. The goal of a systems analyst is to help the organization to perform work better so that it can create greater profits or provide service more effectively. Hence, a systems analyst focuses on how the system would support the organization's goals, existing systems, and business processes. Systems analyst skills can be divided into six categories: technical, business, analytical, interpersonal, management, and ethical. Technical skills are required to understand the existing technical environment in the organization, the new system's foundation, and the way to integrate both into a technical solution. Business skills are required to understand business situations and to ensure IT helps achieve business goals. Communications skills are essential to analysts who act as a bridge between users and managers, managers and programmers. Ethical skills are required when dealing with team members, managers and users to ensure fairness and honesty. Four specializations of systems analysts are business analyst, infrastructure analyst, change management analyst, and project manager.

The System Development Life Cycle is consisted with four fundamental phases: planning, analysis, design, and implementation. Each phase utilizes techniques that produce deliverables. The planning phase identifies the system's business value to the organization and develops a project plan that explains how the project team will go about building the system. The analysis phase identifies the system users, system functions, and under what situation it will be used. The design phase determines how the system will operate in terms of the hardware, software, the user interface, reports, and specific databases and programs. Finally, the implementation phase constructs and installs the system, and establishes a support plan.

Project identification and initiation process is where a project comes from. A project is identified when there are business needs. Once the needs are identified and escalated, project initiation begins. System request is a common technique at the project initiation stage. It is a document usually completed by the project sponsor that addresses the business needs for building a new system and the potential improvements.

After the business requirements and system needs are defined, feasibility analysis is conducted to guide the organization in determining the feasibility of proceeding with a project. Feasibility analysis can be broken down into three common areas: technical feasibility, economic feasibility, and organizational feasibility. Technical feasibility is essentially a technical risk analysis that determines if the system can be successfully

designed and developed by the IT group. Economic feasibility is a financial risk analysis that identifies costs and benefits of the system, and determines the cash flow and investment return. Organizational feasibility addresses how well the system will be accepted by end-users and how well the system will align with the business strategy of the organization. The deliverable is a feasibility study document to the approval committee upon the end of project initiation.

The text book applies all the above concepts to a fictitious company called Tune Source. In the first chapter particularly, system request, steering committee approval, and feasibility analysis are demonstrated using examples of Tune Source.

The second chapter of the textbook is called "Project Selection and Management". Three parts are included and they are "Project Selection", "Creating the Project Plan", and "Managing and Controlling the Project". This chapter discusses how to evaluate and select project, create a project plan and prepare to manage and control the project.

Project selection is the most important step of the whole project. Project manager needs to consider the project cost, the project's anticipated risks and returns; also, the business strategy of the companies is a good reference for selecting project. The approval committee has the responsibility to evaluate not only the project's costs and expected benefits, but also the technical and organizational risks associated with the project. Chapter 2 lists different ways of classifying projects-- size, cost, purpose, length, risk, scope and economic value. Portfolio management takes into consideration different kinds of projects that exist in an organization. A good project portfolio will have the most appropriate mix of projects for the organization's needs. The approval committee acts as a portfolio manager, with the goal of maximizing benefits versus costs and balancing other important factors of the portfolio.

Once the project is selected by the approval committee, it is time to plan the project. The first challenge faced by project managers is to determine the best project methodology. Chapter 2 shows some predominant mmethodology options - Waterfall Development, Rapid Application Development (RAD) and Agile Development. It teaches how to choose from these options in different situations. After choosing the methodology, the project manager develops a preliminary estimate of the amount of time the project will take. There are several estimation software packages that could help the project manager to finish this task. Then, project manager creates a work plan which is a dynamic schedule. To create a work plan, the project manager identifies the tasks that need to be accomplished and determines how long each one will take. Then the tasks are organized within a work breakdown structure. Using the project work plan, the project manager can tell whether the project is ahead of or behind schedule, how well the project was estimated, and what changes need to be made to meet the project deadline.

Staffing the project is another part of the project plan. Project manager should calculate the average number of staff needed for the project. It is not wise to add more staff to shorten the project length, because a large number of staff members are difficult to coordinate. The project manager should keep team sizes under 8 to 10 people. After that,

a staff plan that lists the roles required by the project is needed. Team members should have both technical skills and interpersonal skills. Assigning project team members is a combination of finding people with the appropriate skill sets and finding people who are available. Project manager should keep conflict between the team members to a minimum, and give some rewards to motivate team members to make the project a success.

Once the project begins, the project manager manages and controls the project. The estimates that are produced during the planning phase need to be refined as the project progresses. A well-done project plan prepared at the end of the planning phase could have a 100% margin of error for project cost and a 25% margin of error for schedule time. Project manager must try to avoid introducing scope creep or feature creep into the schedule during the project. Time boxing can be used to deal with shortened time frames. The project manager also keeps a close watch on the project risk. A risk assessment is created and updated to evaluate the likelihood of various risks and their potential impact on the project.

As for our project, Part 1 of the textbook helps us understand the fundamental phases of project development, select the right project, understand the project risk, and create a high-level project work plan.

Conclusion

A “Smart Transit System” will provide the foundation for advancing the current bus transit in Victoria. This project will provide a connection between the growing communication market and a well-used transportation system.

By creating the outlined project plan, milestones and deliverables, the “Smart Transit System” project will be able to take shape over the course of the term. The work plan provides guidelines for how the team will ensure every area of the project is explored. This allows the group to know the time restrictions and where emphasis will need to be placed. The milestones and deliverables act as a basic schedule that reminds the team what needs to be done over the course of this project.

From the team’s biographies, it can be seen that those involved have the necessary skills and interests to complete this project. The broad range of specializations and interests allows the project to be explored in a variety of sources. Each person will be able to contribute from past experiences and learn about new technologies in a growing field.

The two lectures have provided insight into the planning structure of network safety technologies and how the library databases can provide multiple research sources for a project. Fortinet provided an example of how the industry develops products from the project managers to the hardware and software teams to the final product. The library databases provide many search options and high level sources that could be used in the project research.

Overall, the report summarizes the interests, plans and external sources that will provide guidance for the project.

References

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