Project Charter

Holistic Vehicle Tracking System

Adam Elliott
Taylor Kinsella
Matthew Lillywhite
Christopher McNeil
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Section 1

Executive Summary

This document will outline our project plan for the Holistic Vehicle Tracking System.

The purpose of this project is to create a whole vehicle tracking system capable of scaling up to the tracking of 650 vehicles simultaneously. The system will include the device placed on the vehicle and the necessary back end systems to provide a web interface for customers and administrators.

The Calgary transit website has a schedule query application which gives the expected time based on scheduled route plans. Smart phone apps also provide access to this same route schedule information through a different interface. A phone service provides stop by stop information of upcoming buses. However, there is no way to find out exactly where a specific bus is at a point in time. Currently arriving 5-10 minutes early in case the bus is ahead of schedule and waiting until 5 minutes after because the bus is late can be standard practice. 15 minutes of standing in winter conditions can be tough even for well-prepared individuals.

The Holistic Vehicle Tracking System combined with the Transit Buddy web application will provide Calgary transit users with readily available information about where their bus/train is on its route as close to real-time as possible. We hope this will help Calgary transit gain more ridership through user confidence.

Our primary goals are outlined in the project objectives section, these key elements are crucial for the project to complete on time and on budget. Our project is defined as a prototype and “proof of concept.” We use commercial boards and parts which we will install, configure and write code/script so that it will perform its task reliably. Nothing we will be doing is ground breaking or game changing; we are only using commonly available parts in a unique application. This project will not cover implementing this project in a real world application or producing modules for use outside of the prototyping / lab environment.

The hardware aspect of the project is to build small Arduino based module that can be attached to transit vehicles and will accurately and reliably provide next-to-real-time location data. The module will then transmit data across a GSM network to a database server that can be accessed from a web application by users via an interactive map.

The charter contains many terms that may need further definition. All acronyms and technical terms will be defined within the terminology section if you are unsure their meaning or usage. Team, key stakeholders and other stakeholders are defined within this document along with requirements of each person/group defined within. This document also lays out expected risks and mitigation strategies for each risk, all though this may not cover all possible risks it represents important areas which we will keep an eye on throughout the project.

A Gantt chart of all major project activities and associated deliverables is attached; it is fully interactive and lays out our project from beginning to end. Our facilities, all of which will be on the SAIT campus, are not considered in project costs. With that said SAIT’s facilities provide us with all the required resources including tools, power & furniture. An itemized budget is included, containing all major project costs including a contingency fund. A summary of the vendors as well as operating costs are listed in the budget.

In summary without GPS tracking, Calgarians have little confidence in the transit system especially during the winter months. This extra stress can be alleviated by providing accurate, near-real-time tracking as well as easy access to the information for all transit users.
Section 2

Project Vision

Our primary goal is to provide a proof of concept that near-real-time GPS tracking of Calgary Transit busses is possible. The final deliverable will be a GPS system based on an Arduino board which can provide location data to a server via the existing cell-phone network (Using an internet service provider). The data will be accessible through a web interface to both customers/clients and administrators.

The purpose of this project is to create a whole vehicle tracking system capable of scaling up to the tracking of 650 vehicles simultaneously. The system will include the device placed on the vehicle and the necessary back end systems to provide a web interface for customers and administrators.

Calgary Transit has a fleet of over 900 busses with approximately 650 busses running during peak periods. Calgary Transit provides over 100 million trips each year\(^1\). The current scheduling system is evaluated on a regular basis, but cannot take into account various weather, traffic, and other unique situations which affect bus times. It is not uncommon for the actual time of a busses arrival to be more than 10 min off from its scheduled arrival time. Currently passengers waiting at a bus stop cannot know if their bus arrived early or will be delayed, they can only be told what time the bus is scheduled to arrive. By having access to “near-real-time” data passengers can make informed decisions about when to leave for their bus stop and how their travels may be affected.

Being able to accurately track the Calgary Transit busses will provide the riders with an improved and more transparent service. This system will also give Calgary Transit access to constantly updated and accurate schedule information and bus locations.

GPS systems are a quickly expanding field. Knowing the location of assets and people can be very important to any business. There are many companies that have made this field the core aspect of their business, such as Nextbus and Calgary based GPSPolice.

There are many systems out there capable of tracking vehicles; our project will cover prototyping a low cost GPS/GPRS device that will transmit data to a database as a proof of concept. The application of the device, integrated with a web application, can help solve Calgary’s transit problems.

Between the weather and traffic delays it makes it difficult to accurately predict a transit schedule. This leaves many Calgarians standing out in the elements to make sure that they catch their bus and arrive at their destination on time.

Currently arriving at a bus stop 5-10 minutes early in case the bus is ahead of schedule and waiting until 5 min after because the bus is late can be standard practice. Th 15 minutes of standing in winter conditions can be tough even for well-prepared individuals.

This uncertainty causes many Calgarians to use alternative methods of transportation, such as driving across the city or walking. As Calgarians attempt to become more environmentally responsible this seems to be a large stepping stone for all Canadian cities but specifically Calgary with our sprawling city.

**Problem / Opportunity**

The opportunity would be to provide Calgary transit users with readily available information about where their bus/train is on its route as close to real time as possible and to gain more ridership for transit through user confidence.

Currently the Calgary transit website has a schedule query application that gives the expected time based on scheduled route plans. Smart phone apps also provide access to this same route schedule information through a different interface. A phone service provides stop by stop information of upcoming buses. None of the available methods can give updated or live data about when the next bus will actually arrive. This data is accurate only under ideal conditions and does not allow for real world data to be shared with users.

Transit uses twitter to notify Calgarians of any major delays or issues but has no way to tell individual users of specific bus routes of unique delays happening on their route.

This leaves Calgarians waiting or missing their buses do to real world events that cause the bus to be ahead of or delayed in its normal schedule.

**Project Description**

Our project is to build a small Arduino based module that can be attached to transit vehicles which will accurately and reliably provide near-to-real time location data. The module will then transmit that data across a GSM network to a database server that can be accessed from a web app by users via an interactive map.
**Current Situation**

GPS technology is already being used to help in our day to day lives; it only requires knowledgeable and motivated individuals to apply its benefits to real world scenarios.

Around the world, including in North America, this idea is already in common practice. Many inter-city buses and trains have GPS tracking systems installed on them to give actual location data.

Calgary transit is currently implementing a test system on the trains to track arrival times and is planning for a system to be installed on buses.

Without GPS tracking Calgarians have little confidence in the accuracy of the transit schedule especially during the winter months. This extra stress can be alleviated by providing accurate, near-to-real time tracking as well as easy access to the information for all transit users.

**Key Stakeholders**

The following table outlines key stakeholders associated with this project.

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Managers</td>
<td>Adam Elliott, Taylor Kinsella, Matthew Lillywhite, Christopher McNeil</td>
</tr>
<tr>
<td>Client</td>
<td>Colin Chamberlain, Jason Fischer</td>
</tr>
<tr>
<td>Performing Organization</td>
<td>Future Transit Now</td>
</tr>
<tr>
<td>Sponsor</td>
<td>Colin Chamberlain, Jason Fischer</td>
</tr>
</tbody>
</table>
This section of the project charter specifically outlines major activities to be undertaken and their associated deliverables. It also describes the projects' out of scope activities, which will be specifically excluded from the project's final deliverable.

The overall target of this project is public Calgary transit clients/customers, and resolving the inaccuracy/reliability of transit scheduling services to provide a greater quality of service to Calgarians. This will be done by simulating an environment with prototype devices which could potentially be used to solve transit tracking inefficiency.

Although the main target may be public transit, there is no reason this project could not be implemented elsewhere (i.e. taxi services, delivery services, etc.). Anything can be tracked at a certain point in time using this GPS system, from small to enterprise level environments.

**Scope**

We intend to provide transit customers with a web application capable of delivering near real-time transit tracking results with integrated map. Prototype models of GPS hardware devices capable of communicating over the network through a GSM module to a database which can be accessed by customers/clients through a web application. Database access through the web application will be handled by server login authentication services.

Major activities and corresponding deliverables of the ‘Holistic Vehicle Tracking System’ to be undertaken are as follows:

- **Design/construct prototype hardware device**
  - Arduino Uno R3
    - Chassis/casing
  - Power consumption
    - USB Battery backup for graceful start/stop
    - Main power via vehicle battery
  - GPS module connected to Raspberry Pi board
    - Provides tracking of vehicle
  - GSM module connected to Raspberry Pi board
    - Provides communication between Raspberry Pi board and associated server

- **Configure HP Proliant G7 server**
  - Fully functional server running Windows server 2012 Operating System

- **Configure/manage HP Proliant G7 server services**
  - Microsoft Azure Platform
  - Microsoft IIS
  - AD & DS
  - DNS
  - DHCP

- **Create/Configure Database**
  - Microsoft SQL server database, capable of communicating with GSM modules over the network to log/track transit status’

- **Create a user interface**
  - Web application capable of querying database for transit tracking status’
  - Managed user authentication security
  - Graphical map positioning transit location
Out of Scope

The scope of the project is to simulate a Calgary transit tracking system environment. We will not actually be mass producing hardware components or physically implementing a real-world application. The importance of the project is that it could be successfully implemented on a large scale at a reasonable cost, with improved tracking results and quality of service to Calgarians.

Everything not explicitly stated as being in scope will be considered to be out of scope.

Specific out of scope project activities are as follows:

- Mass production of Arduino modules
- City wide implementation
1. Adam Elliott will dry fit the Arduino modules and take measurements before January 7\textsuperscript{th}, 2014 so that we can have a weatherproof case ready before February 18\textsuperscript{th}, 2014 when we start field testing.

2. Taylor Kinsella will have the server hardware setup, software configured and hardened before January 9\textsuperscript{th}, 2014 when we will need to setup the database on the server.

3. Matthew Lillywhite will have the pseudo-code completed by January 13\textsuperscript{th}, 2014, so that when the other team members are done their initial hardware setups they will be able to start coding the web application as a team.

4. Christopher McNeil will organize a cell plan / getting a SIM card for GSM module before cell connectivity test on March 5\textsuperscript{th}, 2014.

5. Matthew Lillywhite will be responsible for getting 2 - 4 users/testers to perform the use-ability tests on February 3\textsuperscript{rd}, 2014.

6. Christopher McNeil will need to have the database setup before any of the web/database connectivity testing can be done the first of which is on February 18\textsuperscript{th}, 2014.

7. All team members must work together in order to fix bugs between each field test to efficiently use our time and assure our project finishes on April 11\textsuperscript{st}, 2014 with the best product possible.
The following terminology is used within this document and may require additional explanation:

**AD & DS** – Active Directory & Domain Services

**Arduino Board** – Hardware module to be placed on vehicle

**Database** – Used to capture, analyze and organize a collection of data which can be used to serve clients.

**DHCP** – Dynamic Host Configuration Protocol

**DNS** – Domain Name System

**GitHub** – Web-based hosting service for software development projects

**GPL** – General Public License

**GPS** – Global Positioning System

**GSM** – Global System for Mobile communication

**HP Proliant** – Hewlett-Packard Proliant Server

**Microsoft IIS** – Internet Information Services

**Raspberry Pi** – Hardware module to be placed on vehicle

**SIM Card** – Subscriber Identification Module; an integrated circuit, securely storing international mobile subscriber identity (IMSI) keys for an associated mobile device. Also capable of holding a minimal amount of data associated with the mobile device.

**SQL** – Structured Query Language

**Windows Azure** – A cloud computing platform and infrastructure developed by Microsoft to deploy and manage applications and services through a single, global network of Microsoft managed datacenters.
This project is comprised of four successful SAIT Polytechnic students, all undergoing the ‘IT Computer Systems’ course.

Project team members and corresponding roles are as follows:

<table>
<thead>
<tr>
<th>Member</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam Elliott</td>
<td>Manage Hardware</td>
</tr>
<tr>
<td>Taylor M Kinsella</td>
<td>Configure/Manage Server &amp; Services</td>
</tr>
<tr>
<td>Matthew Lillywhite</td>
<td>Design/Deploy Web Interface</td>
</tr>
<tr>
<td>Christopher McNeil</td>
<td>Configure Database, Documentation</td>
</tr>
</tbody>
</table>
Section 8

Project Stakeholders

The following table describes other project stakeholders which were not identified as key stakeholders in the Project Purpose section of this document:

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role or Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calgary Aldermen</td>
<td>Responsible for improving transit ridership</td>
</tr>
<tr>
<td>Calgary Transit</td>
<td>Potentially a target for implementing this project upon completion.</td>
</tr>
<tr>
<td>Calgary Transit Customers</td>
<td>Will be an end user of the product.</td>
</tr>
<tr>
<td>SAIT Polytechnic</td>
<td>Provides the project team with a facility to carry out work and funding needed for budgeting purposes.</td>
</tr>
<tr>
<td>Telecom/Internet Service Provider</td>
<td>Provides us with a network to transmit data from the hardware module to the server.</td>
</tr>
</tbody>
</table>
As with any project, there are numerous risks involved which must be identified and given a strategy for mitigating their possibility of occurrence.

The following table outlines possible risks involved with the undertaking of this project, along with their associated impact/severity levels (Low/Medium/High):

<table>
<thead>
<tr>
<th>Project Risk Assessment</th>
<th>Probability</th>
<th>Impact</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk 1 – Scope Creep</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Mitigation Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk 2 – Team Absences</td>
<td>4</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Mitigation Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk 3 – Faulty Hardware</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Mitigation Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk 4 – Conflicting Project Goals</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Mitigation Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk 5 – Lack of Resources</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Mitigation Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mitigation Strategy:
- **Risk 1 – Scope Creep**: As a group, we planned an outline specifying objectives and their associated deliverables involved in the project scope to be followed carefully. In addition, we have provided a list of out of scope activities which will specifically not be touched upon during the course of this project.

- **Risk 2 – Team Absences**: All project documents are accessible by all members via a shared network drive. By communication through e-mail, phone, video conferencing, even if a team member is absent they will be able to stay in contact. It is near impossible to make it to every meeting and we understand this.

- **Risk 3 – Faulty Hardware**: There is always the possibility that our hardware will be received in poor condition/not working. The simplest solution is to order more than one similar model at a time. If all fail, we will order again from a different provider.

- **Risk 4 – Conflicting Project Goals**: Project goals are laid out in this charter which will be agreed to and signed by each member of the team before the undertaking of the project. Group members held meetings prior to the final design of the project to discuss individual goals and find common ground at the beginning of the project.

- **Risk 5 – Lack of Resources**: We plan to order and maintain two copies of the hardware module for redundancy in case one fails. Any resources needed for the servers will be provided by SAIT Polytechnic and available as needed.
Please consult associated Gantt chart attached to this document for project scheduling information.
The majority of this project is to be completed within the confines of SAIT Polytechnic campus, specifically in room MD213. The cost of using SAIT facilities is covered within our school tuition fees. Field tests will be done in off-hours on non-congested roads using project team member’s personal vehicles.

The following resources are required to complete the project successfully:

- 16-gauge wire
- 18-gauge wire
- 20 Channel EM-406A SiRF III Receiver with Antenna
- Arduino Stackable Header Kits
- Arduino Uno chassis
- Arduino Uno R3
- Belkin Wireless Router – IEEE 802.11n (F9K1001)
- Cat5e/Cat6 patch cable (2 x 10ft, 2 x 20ft, 2x 6ft)
- Cellular Shield with SM5100B
- GPS Shield
- HP Proliant DL385 G7 Server
- Prosafe 5-port 10/100/100 switch
- Quad-Band Cellular Duck Antenna SMA
- Telus SIM card/data plan
- Wireless mouse/keyboard

If any of the above resources are unavailable, an applicable replacement, capable of completing the same tasks, will be required to complete the project.
This section outlines hardware, software and operational costs associated with the Holistic Vehicle Tracking System project budget. Project budget costs are separated based on materials needed (such as hardware and software), and man hours it will physically take our project team to complete all major activities and produce a final deliverable.

A final, cumulative budget of $95656.06 and 816.5 man hours will be required to ensure the success of this project.

### Equipment and Facilities

Facility costs are not applicable since we will be working in the project lab (MD213) of the SAIT ICT department. This facility is physically secured by security cameras, surveillance and provides us with the power we will need to carry out the project.

Equipment costs for the outlined project are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>QTY</th>
<th>Resource</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Channel EM-406A</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$59.95</td>
</tr>
<tr>
<td>Arduin Uno – R3</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$29.95</td>
</tr>
<tr>
<td>Arduino Sackable Header Kit</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$1.50</td>
</tr>
<tr>
<td>Belkin Wireless Router – IEEE 802.11n F9K1001</td>
<td>1</td>
<td>BESTBUY</td>
<td>$29.99</td>
</tr>
<tr>
<td>Case / Chassis</td>
<td>1</td>
<td>SAIT (3D print)</td>
<td>N/A</td>
</tr>
<tr>
<td>Cellular Shield with SM5100b</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$99.95</td>
</tr>
<tr>
<td>Contingency</td>
<td>1</td>
<td></td>
<td>$500.00</td>
</tr>
<tr>
<td>DC Barrel Jack Adapter – Male</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$2.95</td>
</tr>
<tr>
<td>GPS Antenna – External Active Antenna</td>
<td>1</td>
<td>ADAFRUIT</td>
<td>$12.95</td>
</tr>
<tr>
<td>GPS Sheild</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$14.95</td>
</tr>
<tr>
<td>HP Proliant DL385 G7 Server</td>
<td>1</td>
<td>SAIT</td>
<td>$3398.99</td>
</tr>
<tr>
<td>LM7805 CT-ND Voltage Regulator</td>
<td>4</td>
<td>DIGIKEY</td>
<td>$3.04</td>
</tr>
<tr>
<td>Microsoft Azure</td>
<td>1 x 6 months</td>
<td>MSDNAA</td>
<td>$600.00</td>
</tr>
<tr>
<td>Patch Cables (Cat5e/Cat6)</td>
<td>(2 x 10ft; 2 x 20ft; 2 x 6ft)</td>
<td>MEMORY EXPRESS</td>
<td>$50.00</td>
</tr>
<tr>
<td>Power Supply</td>
<td>1</td>
<td>ADAFRUIT</td>
<td>$5.95</td>
</tr>
<tr>
<td>Prosafe 5-port 10/100/100 switch</td>
<td>1</td>
<td>BESTBUY</td>
<td>$55.95</td>
</tr>
<tr>
<td>Quad-Band Cellular Duck Antenna SMA</td>
<td>1</td>
<td>SPARKFUN</td>
<td>$7.95</td>
</tr>
<tr>
<td>Telus Data Plan</td>
<td>1 x 4 months</td>
<td>TELUS</td>
<td>$40.00</td>
</tr>
<tr>
<td>Telus SIM Card</td>
<td>1</td>
<td>TELUS</td>
<td>$10.00</td>
</tr>
<tr>
<td>Windows Server 2012 R2 – Standard</td>
<td>1</td>
<td>MSDNAA</td>
<td>$882.00</td>
</tr>
<tr>
<td>Wireless Keyboard/Mouse</td>
<td>1</td>
<td>MEMORY EXPRESS</td>
<td>$34.99</td>
</tr>
</tbody>
</table>

**Total**                                              |      |          | **$5841.06**|
Operating Costs

The following operational costs were calculated using the attached Gantt chart:

<table>
<thead>
<tr>
<th>Item</th>
<th>Hours</th>
<th>Rate</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam Elliott</td>
<td>206.5</td>
<td>$110.00</td>
<td>$22715.00</td>
</tr>
<tr>
<td>Taylor M Kinsella</td>
<td>214.5</td>
<td>$110.00</td>
<td>$23595.00</td>
</tr>
<tr>
<td>Matthew Lillywhite</td>
<td>182</td>
<td>$110.00</td>
<td>$20020.00</td>
</tr>
<tr>
<td>Christopher McNeil</td>
<td>213.5</td>
<td>$110.00</td>
<td>$23485.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>816.5 hrs.</td>
<td></td>
<td><strong>$89815.00</strong></td>
</tr>
</tbody>
</table>
Section 13 Promotion and Communication

Our project is defined as a prototype and proof of concept. We use commercially available boards and parts which we will assemble, configure and write code/script so that it will perform its task reliably. Nothing we will do is ground breaking or game changing; we are only using commonly available parts in a unique application.

As stated in section 14 most of our resources will be documented and put on GitHub.
Section 14

Intellectual Property

Since the concept of this project is not new and is currently being implemented around the world the possibility of unique proprietary intellectual property produced by this project is low. All project team members have agreed to divide all project deliverables equally. Since there are four team members, each member will be entitled to one quarter of intellectual and physical property rights produced upon successful completion of this project. Team members who purchase parts or hardware will be entitled to ownership of those parts and hardware once the project is complete.

In the interest of interacting with the open source community, we plan on releasing all code related to the Arduino via a GitHub project. We will release the relevant code with a GPL.

By releasing our code with a GPL, we will:

- Assert copyright on the software, and
- Offer others license, giving them legal permission to copy, distribute and/or modify it under certain conditions.

We hope that by doing this, others will be able to use and expand upon the work we have done in this project.
Offer

Our project will include, Prototyping an Arduino based board capable of communicating via a GSM network with a database server and receiving and relaying GPS data. We will also provide a proof of concept by implementing a web application that uses the GPS data to provide near-to-real time tracking of a transit vehicle.

Approvals

From our project sponsor we will need:
- Lab space to setup in and use for project work.
- Support when purchasing some parts / giving access to MD213 supply closet.
- Using instructors as technical / troubleshooting support (Rudy Aman, Jason Fischer, Colin Chamberlain etc.)

And finally we need instructor approval for the initiation of our project.

Project Charter Signoff

<table>
<thead>
<tr>
<th>Offering</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam Elliott</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taylor M Kinsella</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matthew Lillywhite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christopher McNeil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Approval            |           |      |
| Colin Chamberlain   |           |      |
| Jason Fischer       |           |      |
Bibliography


