

## Summary

### **BACKGROUND**

With the high costs and disjointed efforts of traffic and GPS data collection efforts, methods to improve the integration, consolidation, aggregation and use of multiple primary data sources beyond their current applications has potential benefits to many researchers and practitioners alike. Additionally, the accessibility of data already being collected by various sources also has vast potential beyond the scope realized at the primary source collection site. Global Positioning Systems (GPS) data can have multiple uses beyond its intended purpose of providing estimates of speed and travel times. GPS data collected from Automatic Vehicle Location Systems such as On-Star as well as other related data collection efforts that have collected data from highway sensors, traditional traffic surveys and passive data collection techniques (e.g., RFIT, Bluetooth, and Smart-Phones) show promise for potential usages beyond the original intended purpose in areas of traffic system planning, assessment, monitoring, simulation and control, emergency evacuation routing, and homeland security. Challenges to increase use of such data include, but are not limited to addressing confidentiality-privacy issues, statistical bias, precision and confidence, as well as resolution of issues pertaining to data ownership and the technological complexities of integration/aggregation of various eclectic data sources. While traffic/GPS data has a plethora of potential applications for a variety of uses, research products herein describe a straightforward methodology for data usage in the realm of traffic system planning and control through use of a prototype traffic simulation system designed and developed as part of this proposal

### **OBJECTIVE**

The objective of this research and software development effort is twofold: (1) to prepare guidelines on the use of multiple sources of GPS/traffic data to understand travel behavior as related planning and control of traffic systems, and (2) the development of a prototype traffic simulation and control application to demonstrate the capabilities of multiple data source integrations.

Accomplishment of the project as describe by the objective will require the following tasks.

### **DELIVERABLES**

The task descriptions provide a framework for conducting research, establishing guidelines, and developing the prototype simulation model. Each task describes an overview of plans that can realistically be accomplished within the time constraints and

budget proposed herein. The research provided herein presents the project team's original and current thinking based on own work and the works of others.

*Deliverable Task 1* Conduct a broad literature review and write a technical memorandum. The Literature includes focused interviews that are primarily to provide insights on the use of GPS / traffic related data to discover the methodologies and technologies used to collect, aggregate, analyze, and resultant applications of such data as well as related products. The technical memorandum addresses: (a) technologies: data uses, collection techniques, integration, and application for all sources of travel modes (e.g. car, bike, truck, transit, air, train), (b) Data Mining: combining / repurposing the various individual or merged data sources, (c) statistical and confidentiality issues: accuracies, biases, ownership, privacy, confidentiality, coverage, (d) how data sources could be used for traffic behavior and traffic flow modeling, congestion management, system performance as well as traffic control,

*Deliverable Task 2* Prepare an interim report that includes (a) a summary of the results discovered in Task 1; (b) a list of prioritized methods to integrate GPS data with traditional and emerging data sources for understanding travel behavior; (c) the potential capabilities and limitations of each promising method for travel/traffic modeling applications at different scales; and (d) potential customers for each method (e.g., DOT, Highway Safety, etc.). The interim report is includes an updated project plan

*Deliverable Task 3* Using an industry standard software or simulation platform, design, develop, test, and demonstrate (prototype) selected methods approved for design in Task 2. Using standard testing techniques, document the simulation, analysis, and insights discovered. The simulation should apply to the selected methods using sample data sets; and the demonstrations should evaluate the viability of the datasets using selected methodologies. Prepare a technical memorandum that comprises: (a) methods and data as related to accuracy, sample size, coverage, ownership, bias, costs, and confidentiality issues (b) synergies, efficiencies and value gained by consolidation and methodologies as well as ease of use; (c) capabilities and limitations of the simulation package, each method, and potential application.

*Deliverable Task 4* Prepare documents stating current policy directions and recommended guidelines on the use of multiple sources of GPS data to understand travel behavior and activity.

*Deliverable Task 5* Prepare a final report documenting the research and simulation program. The final report should include (a) guidelines and policy developed in Task 4, (b) technical documentations of data manipulation procedures, including any algorithms, code, and "pseudo code" that could be used by practitioners in deploying the results from the research, (c) create a PowerPoint presentation summarizing the results of the research, and (d) using industry standards and COTS, consolidate and package the simulation demonstration software with technical / end-user documentation as a delivery of artifacts.



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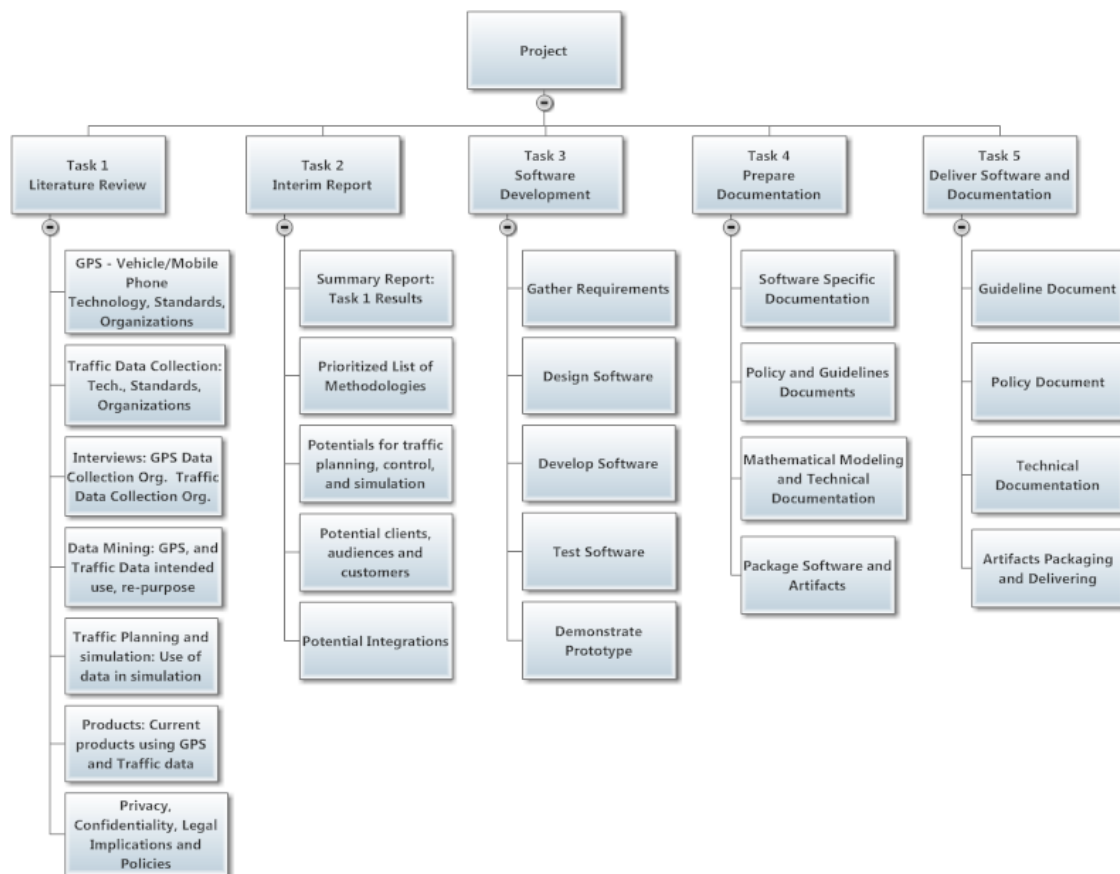
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## Draft Plan (Condensed)

The draft plan provides a summary of deliverables, work breakdown structure (WBS), schedule requirements and cost/budget requirements necessary to accomplish tasks 1 through 5 with limited risk and quality assurance. Other pertinent project plan information concerning quality assurance plan, risk management plan, communications plan as well as managerial tasks are provided as an attachment in appendix A (Detailed Draft Plan).

### Work Breakdown Structure (WBS)



*Work Breakdown Structure – Task Deliverables*

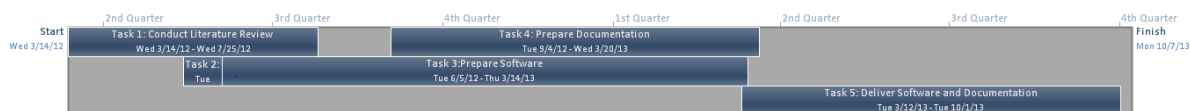
### Work Packages (Deliverables)

Work Packages based on Work Breakdown Structure

1.0 Conduct Literature Review	2.0 Prepare/Deliver Interim Report	3.0 Prepare Software	4.0 Prepare Documentation	5.0 Deliver Software and Documentation
1.1 Research GPS Technologies/ Systems	2.1 Prepare Summary of Literature Review	3.1 Gather Requirements	4.1 Prepare Software Documents	5.1 Deliver Guidelines and Policy
1.2 Research Traffic Data Technologies/ Systems	2.2 Prepare the Prioritized List of Methodologies for Planning	3.2 Design Software	4.2 Prepare Guidelines and Policy	5.2 Deliver Software Technical Document
1.3 Interview GPS and Traffic Data Providers and Users	2.3 Prepare Prioritized List of Potential Clients / Re-purpose	3.3 Develop Software	4.3 Prepare Technical Documentation	5.3 Deliver Process Technical Documents
1.4 Research Travel/Traffic Planning utilizing GPS/Traffic Data	2.4 Prepare Prioritized List of Potential Integrations	3.4 Test Software	4.4 Package Software	5.4 Deliver Packaged Software
1.5 Research Products utilizing GPS/Traffic Data		3.5 Demonstrate Software		5.5 Deliver Software Installation Instructions
1.6 Research Policy, Confidentiality and Privacy Issues w/GPS data		3.5 Demonstrate Prioritized List of Planning Methodologies in Software		5.6 Deliver Software End-User

## Schedule

The schedule encompasses roughly 200 days (4 and ½ quarters) starting second quarter 2012 and ending in the middle of second quarter 2013. Associated with the schedule are five primary tasks: (1) Literature Review, (2) Interim Report, (3) Prepare Software, (4) Prepare Documentation, and (5) Deliver Documentation and software. Depicted below are the highlights of the tasks broken down into time requirements by quarter. The interim report is accomplished at the end of the literature review and into the task prepare software.



Task Name	Start	Finish
<b>Task 1: Conduct Literature Review</b>	<b>Wed 3/14/12</b>	<b>Wed 7/25/12</b>
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>Tue 5/15/12</b>	<b>Mon 6/4/12</b>
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Close Project	Tue 10/1/13	Mon 10/7/13

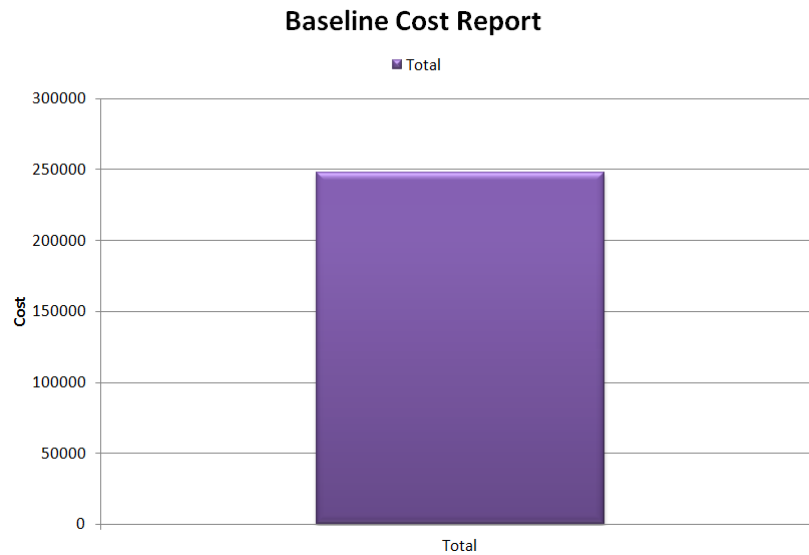




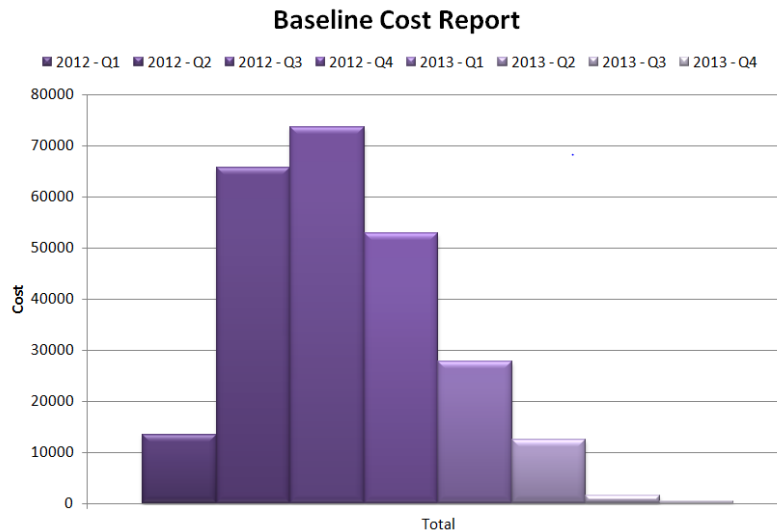
## Costs/Budget

The baseline costs are composed primarily of direct work resources to include researchers, software designers, software engineers as well as technical documentation writers. Current estimates of approximately \$250,000 are for the research, design, development, testing and packaging of simulation software for the repurposing of GPS data to traffic planning and simulation software.

### Overview of Total Cost: \$250,000.00



### Cost Breakdown by Quarter





## Qualifications of the Research Team

The following CVs are provided for the research team. Each researcher has several years of experience within the domains of statistics, data mining, software design/development, and other various related engineering disciplines.

### **Project Manager: Ronald Sones**

#### **Education**

Ph.D., Information Systems, Virginia Commonwealth University, Richmond VA, 2001

M.A. English, University of Richmond, Richmond VA, 1990

M.B.A., Management, Baylor University, Waco TX, 1984

B.S., Computer Science, Baylor University, Waco TX, 1980

#### **Selected Publications**

Sutherland, J.W., Sones, R.T., and Tarn, J.H.; "Technical inhibitions to Globalism: Factoring in Integrative Requirements," *Proceedings of Third International Decision Sciences Institute Conference*, Pueblo, Mexico, June 1995.

Sones, R.T. and Tarn, J.H. "Exploiting the Power of High-Technology Small Firms: Integrating the Core Corporation," paper accepted for discussion at the National DSI Annual Meeting, November 1996.

Sones, R.T. "Economic Co-evolution via Cellular High Technology Small Firms," *New Technology-Based Firms at the Turn of the Century*, During Win et al. eds., Pergamon, Oxford, 2000.

Sones, R.T. (Fall 2000) "The Integrative Facilities of Office Systems Applied to the Core Corporation." *Information Technology, Learning, and Performance Journal*, 18 (2), 25-39.

Sones, R.T. (2001) "Resolving the Complexity Dilemma in E-Commerce Firms through Objective Organization." *Logistics Information Management*, 14 (1/2), 107-118.

Sones, R.T. (2002) "Fueling Economic Recovery Through High-Technology Small Firms," *Proceedings of the Southeast DSI Annual Meeting*, Feb. 2003.

Sones, R.T. (2003) "Distance Learning: A Brave New Approach to Education," *Proceedings of the Southeast DSI Annual Meeting*, Feb. 2004.

Sones, R.T. (2003) "Instructor's Manual" for "Object-Orientated Systems Analysis and Design" written by George, Batra, Valacich and Hoffer, Prentice Hall, 2004.

#### **Related Experience**

##### **James Madison University**

Dr. Sones taught advanced programming using C++, System Analysis and Design, intermediate and advanced Java, and graduate courses in MIS and information security. His committee service included chairing the programming faculty committee revising the programming curriculum for information systems majors and participating in a cross-disciplinary evaluation board for the analysis and award of university grants for the infusion of technology in education. He also coached teams of student programmers over the five years representing the JMU Business School at the regional ACM Programming Contest. He developed courses in object orientated analysis and design using UML,

systematic algorithm developments, and online graduate courses in policy and ethics. Dr. Sones also participated in the development of a multi-disciplinary e-commerce program involving three of the university's schools.

#### **University of Mary Hardin-Baylor**

Dr. Sones served as director of the information systems track in the Computer and Information Systems Department. An assistant professor, he taught courses in structured programming (using C++), visual programming (using Visual Studio), computer architecture, web application development, and computational algorithms. He had responsibility for curriculum development and coordination with other computer –based majors in the university.

#### **Computer Sciences Corporation**

Dr. Sones began with CSC as a programmer and held positions with increasing levels of responsibility reaching the junior executive level of Director. Assignments included full life-cycle systems development, system migration, modernization of legacy systems, and business process reengineering. He directed the efforts of up to 150 people with responsibility for an annual budget in excess of \$14M.

One of his latest assignments included the design and prototyping of a decision support system to provide total asset visibility for the DUSD Logistics. With a client-server architecture, the system collects source data from multiple service systems and NATO partners to populate a data warehouse. It then provides commanders in the field robust decision support tools on laptop systems via cellular modem queries. The multi-level secure database provides up to ½ terabyte of information. Dr. Sones worked as senior computer scientist, project manager, department manager and program manager in a variety of assignments for the Department of Defense, the U.S. Postal Services, various civil agencies, and commercial clients.

#### **Baylor University**

As a programmer/Analyst in the academic computing center, he directed the efforts of student programmers and help desk employees. He directed the transition of academic software from the 36-bit Honeywell 636 to the 32-bit VAX 11/780, supported faculty and graduate students in research, and developed academic applications. He also assisted the Business School in the development and teaching of a Computers in Accounting course.

## **Researcher 1: Mark Shanek**

### **EDUCATION**

PhD and MS in Computer Science from the University of Minnesota in 2007  
BS Computer Sciences and BA Mathematics, Rutgers University in 2001  
Certified Ethical Hacker certification

### **SELECTED PUBLICATIONS**

“Proposing a Multi-touch Interface for Intrusion Detection Environments”, In the Proceedings of the Symposium on Visualization for Cyber Security”, September 2010 (with Jeffrey Guenther and Fred Volk)

“Efficient Cryptographic Primitives for Private Data Mining”, In the Proceedings of the Hawaii International Conference on System Sciences, January 2010 (with Yongdae Kim)

“Privacy Preserving Nearest Neighbor Search.” Book chapter in “Machine Learning in Cyber Trust: Reliability, Security, Privacy” Eds: Jeffery Tsai and Philip Yu: Publisher: Springer-Verlag, 2009 (with Yongdae Kim and Vipin Kumar)

“Remote Software-based Attestation for Wireless Sensors”, In the Proceedings of the 2nd European Workshop on Security and Privacy in Ad Hoc and Sensor Networks, July 2005 (with Karthikeyan Mahadevan, Vishal Kher, and Yongdae Kim)

“Privacy Preserving Nearest Neighbor Search “, Mark Shanek, In the Proceedings of the 2006 IEEE International Workshop on Privacy Aspects of Data Mining, December 2006 (with Yongdae Kim and Vipin Kumar)

### **RELATED RESEARCH AND EMPLOYMENT EXPERIENCE**

Experience includes Software Engineering (including design, development, and testing) of a network testing Operation Support System (OSS) and a network monitoring and analysis OSS, custom business application development, Web development, database administration, PC repair and maintenance, network installation and deployment, LAN administration, QA Testing, and documentation. Other areas include: (1) Designing novel user interface for Intrusion Detection Analysts, coupled with algorithmic support, providing a guided exploration of the data, (2) Developed privacy preserving algorithm for nearest neighbor search on horizontally partitioned data

University professor and instructor: “Data Structures and Algorithms”, “Programming Language Theory”, “Modern Cryptography”, “Computer Network Architecture and Programming”, “Technical Aspects of Information Security”

*Air Force Research Laboratory, Rome Research Site*

Designed and implemented a distributed storage system (built on Pastry) for the Cybercraft project including requirements gathering for secured storage systems.

*Telcordia Technologies, Inc.*

Participated in design, development, and testing of dynamic web interface to legacy network monitoring and analysis Telecommunications Operations Support System (OSS)

## **Researcher 2: Robert Rich**

### **Education**

Ph.D. candidate, Industrial and Systems Engineering, Virginia Polytechnic and State University,

M.S., Integrated Manufacturing Systems Engineering, North Carolina State University, 2000

B.A, Business Management, Liberty University, Lynchburg, VA, 1991

A.A., Civil Engineering, Marion Military Inst., Marion, AL, 1987

### **Related Experience**

#### *Computer Sciences Corporation*

Research and benchmark of industries standards within the supply chain planning domain. Using a combination of mathematical models and existing software modeled the USAF Maintenance, Repair and Overhaul planning system into a cohesive and practical application for use. Performed years of research and interviews with all ranks within the USAF personnel to discover, and define the nature of the supply chain problems to synthesize solutions.

#### *Enterprise System Solutions*

Process Engineering, Project Management, Specialized Software Designer, and Developer (Company founder and Owner)

#### *Industrial and Financial Systems (R&D)*

Software Designer, Software Developer, Software ERP-Product Manager for Aerospace Sustainment Software. (Primary contract for F-35 Sustainment Software, Lockheed Martin)

*US Army*, Field Artillery Officer

### **Research Skills**

Extensive knowledge of Genetic Algorithms, Decision Analysis, Linear and Non-Linear Optimization Techniques, Data Mining, and Use of Statistical Modeling of Data

### **Presentations**

USAF Expeditionary Combat Support System Pathfinder Advanced Supply Chain

USAF Expeditionary Combat Support System Advanced Supply Chain Planning Models

USAF Expeditionary Combat Support System Enterprise Equipment Management Concept of Operations

### **Publications**

Rich, Robert (2008). USAF Concept of Operations for Equipment Management, White Paper for USAF ECSS Program future processes

### **Researcher 3: Ed Lewis**

#### **Education**

Phd Management Science, State University of New York at Buffalo, 1978

MS Industrial Engineering and Operations Research, State University of New York,  
Buffalo, 1969

BA, Mathematics, State University of New York at Buffalo, 1965

#### **Related Experience**

##### *Current Consulting Client List*

Nuclear Regulatory Commission

U.S. Air Force: Logistics Command; School of Aerospace Medicine

Houston Lighting and Power Co

Chicago Pneumatic, Coates Division

Beatrice Foods, Martha White Division

FFV Aerotech International

Vanity Fair Corp, Red Kap Division

Spandek Corp., PDQ Pizza

TRIDON, Inc.

Ingram Periodicals

First American National Bank

Mosely & Associates ( Environmental Engineers )

Centennial Medical Center ( OR Services )

Aetna Financial Services

Deloitte & Touche

##### *Consulting Activities and Primary Areas of Expertise:*

Operations Management, Distribution Analysis, Exploratory Data Analysis and Data Mining, Forecasting, Inferential Statistical Analysis & Hypothesis Testing, Information Technology Planning, Logistics Planning, Marketing Analysis (Elasticity , PODMR , Multivariate Analysis ), Military Equipment Evaluation, Operations Research - Operations Management Modeling, Production Engineering, Software Development, Financial Analysis, Data Design for Database, Mathematical Criminology.

#### **Publications, Presentations, Seminars**

Journal of Micrographics, Volume 10, No. 6, July 1977, "Educational Administration Cost Benefit Analysis for Systems Planning", Edward Lewis, July-August 1977, Publisher: National Micrographic Association

Eleventh International Conference on Mathematical and Computer Modeling and Scientific Computing, April 1997, Washington, D. C., Topic: "Mathematical Programming Applied to the Random Selection of a Matching Population from an Existing Patient Database for Use in Clinical Comparisons"

Leading Edge Conference - Presentation June 2005, Chicago, Illinois, Topic: Business Analytics / Business Intelligence

COGNOS Web Seminar - WEB Based Discussion / Presentation, August 2005, Nashville, Tennessee, Topic: Business Analytics / Business Intelligence

American Payroll Association - Presentation October 2005, Topic: Business Analytics / Business Intelligence



## Accomplishments of the Research Team

## Other Commitments of the Research Team

Currently, each member of the research team performs independent consulting for a variety of public and private companies including the department of defense.

Additionally, the researchers teach within the university setting within the disciplines of engineering, statistics, and operations research.

## Equipment and Facilities

Equipment, facilities, simulation software, development software, data-mining software, statistical software, software modeling, revision control software, as well as hardware server platforms are all provided as required for performing contract. XYZ company will provide processes, standards, policies, equipment, office space, and facilities for each individual with respect to performing the contract.

Facilities and locations:

- (1) Onsite facilities located at 1000 Harvard Street, Forest, Va
  - a. Board room
  - b. Office Spaces
- (2) Collaborative facilities:
  - a. University collaborative facilities
    - i. Virginia Polytechnic an State University, laboratories and research offices
    - ii. Virginia Commonwealth University, laboratories and research offices
    - iii. Liberty University, laboratories and research offices, software development platforms and servers
  - b. Laboratories
    - i. Center for Advanced Engineering Research, forest Virginia
    - ii. US Navy, Dahlgren laboratories

Specific software packages available for mathematical modeling, data structures and integrations:

- (1) MATLAB – specific packages for data mining, statistics, econometrics with integrations capability
- (2) R-Project – statistical and data mining software with integrations capability
- (3) Oracle Database – database software for the purpose of collecting, cleansing, consolidating and housing various original sources of data
- (4) Oracle Fusion – middleware for vast data collection, transformation, and integrations.

Additionally, research and software design personnel have combined access to various laboratories including:

(1) Virginia Tech Statistical Software Laboratories:

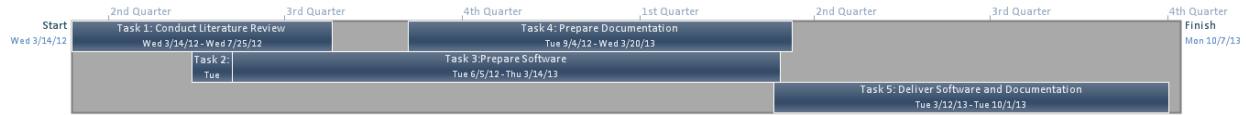
- a. SPSS and SAS
- b. JMP, Mathematica, PASW
- c. Minitab, and R

(2) Liberty University Integrated Servers

- a. Oracle Database (RAC)
- b. Software Code development, Revision Control,
- c. Cloud based Software Development, Revision Control, and Versioning

## Time Requirements

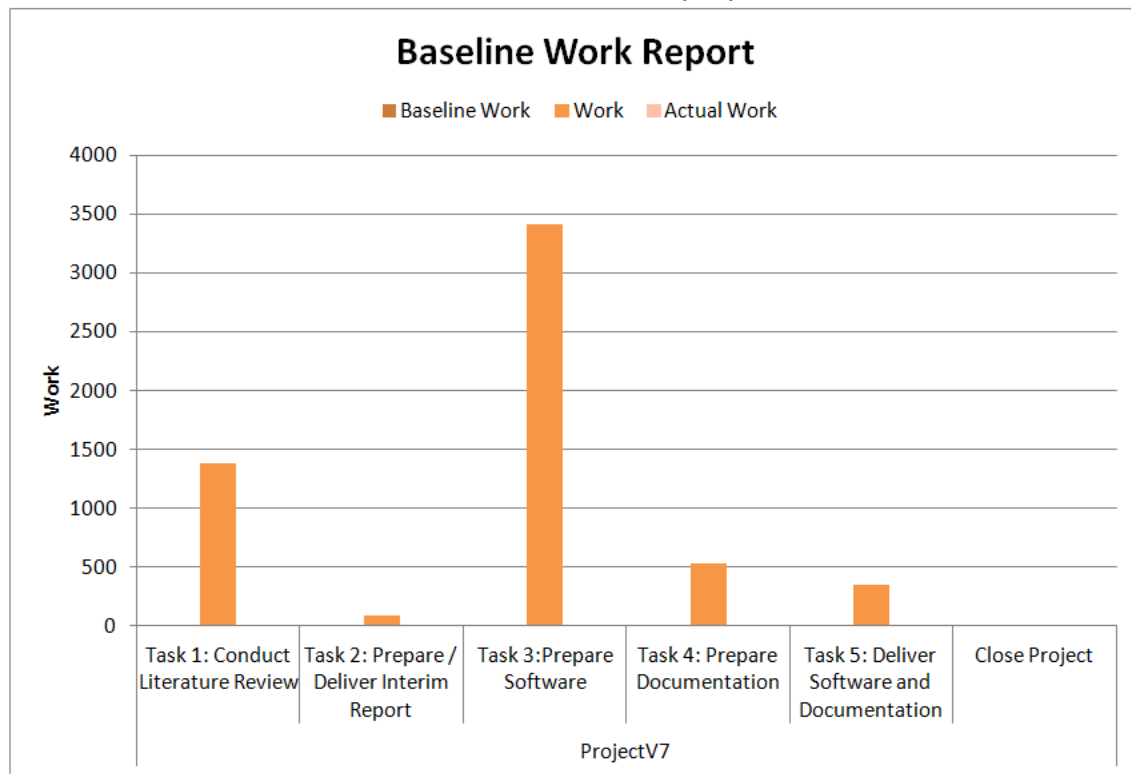
The project is currently scheduled to span approximately 200 days starting in 2<sup>nd</sup> quarter 2012 and ending 3<sup>rd</sup> quarter 2013. Highlighted task due dates are depicted below on the timeline as related to the entire project time.



Task Name	Start	Finish
<b>Task 1: Conduct Literature Review</b>	<b>Wed 3/14/12</b>	<b>Wed 7/25/12</b>
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>Tue 5/15/12</b>	<b>Mon 6/4/12</b>
<b>Task 3: Prepare Software</b>	<b>Tue 6/5/12</b>	<b>Thu 3/14/13</b>
<b>Task 4: Prepare Documentation</b>	<b>Tue 9/4/12</b>	<b>Wed 3/20/13</b>
<b>Task 5: Deliver Software and Documentation</b>	<b>Tue 3/12/13</b>	<b>Tue 10/1/13</b>
Close Project	Tue 10/1/13	Mon 10/7/13

## Summary of Hours by Task

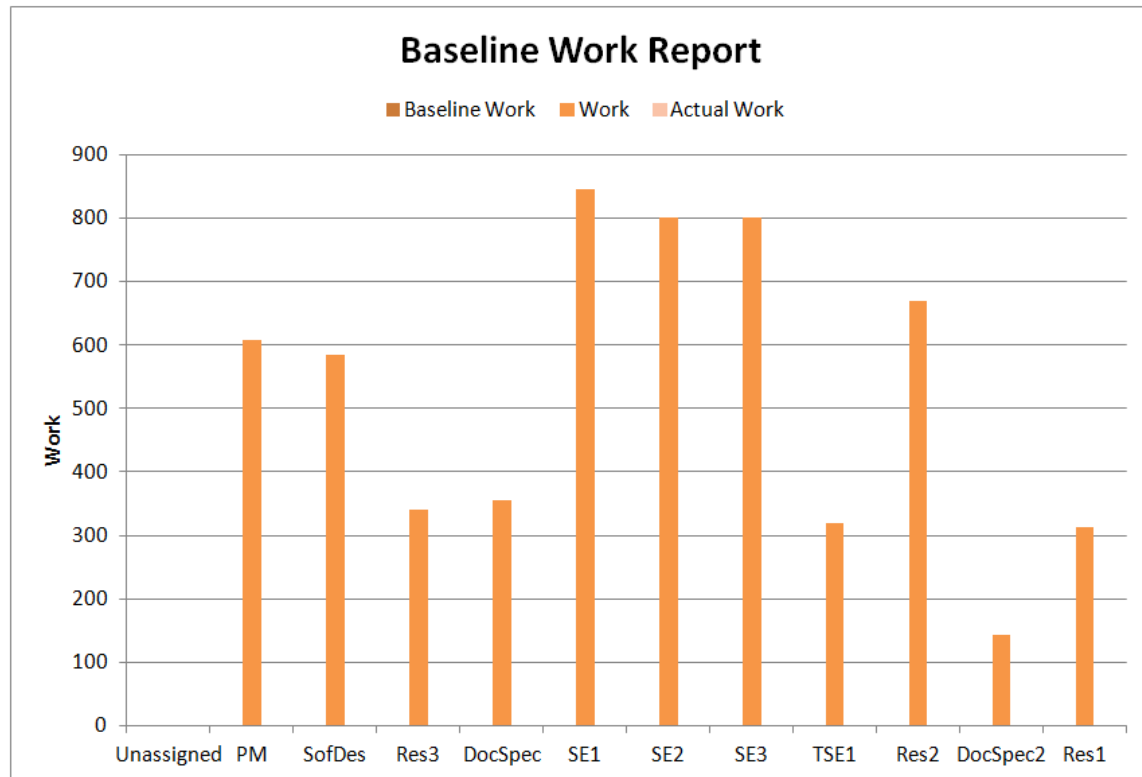
Each of the tasks depicted below is shown by time and cost. Each of the tasks below shows the amount of work allocated to the task. The two tasks requiring the largest allocation of total work are literature review and prepare software.



### Allotted Hours /Task

Task Name	Work
<b>Task 1: Conduct Literature Review</b>	<b>1,388 hrs</b>
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>92 hrs</b>
<b>Task 3: Prepare Software</b>	<b>3,416.4 hrs</b>
<b>Task 4: Prepare Documentation</b>	<b>528.4 hrs</b>
<b>Task 5: Deliver Software and Documentation</b>	<b>346.4 hrs</b>

Close Project	8 hrs
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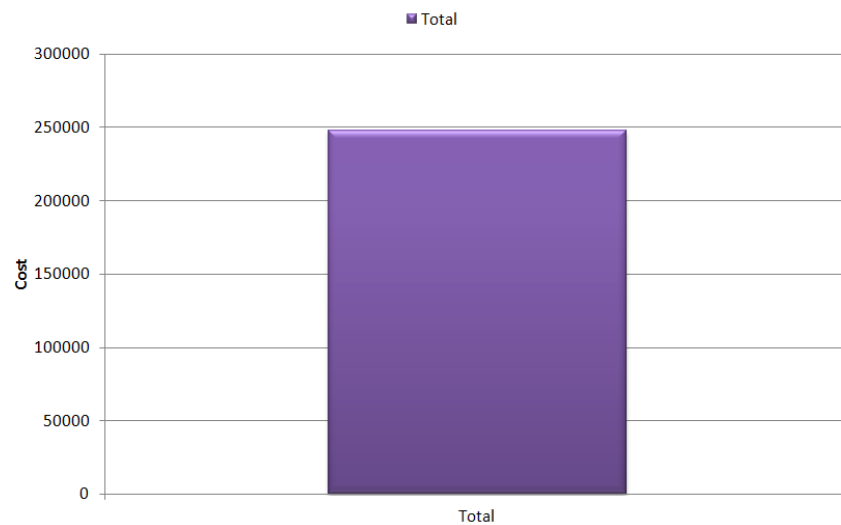


## Itemized Budget

The graphs below depict the cost breakdown by quarter, cost breakdown by task as well as cost breakdown by resources

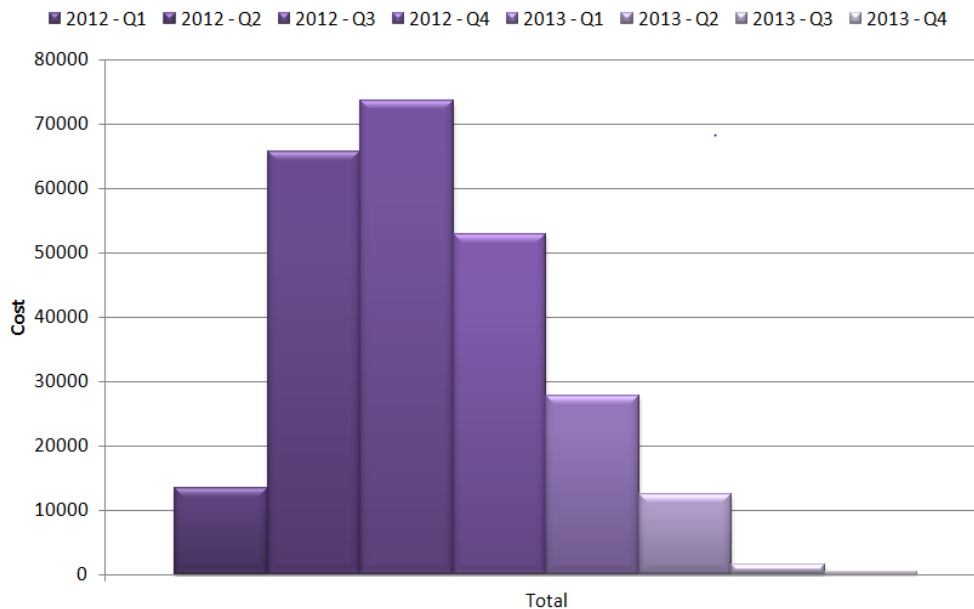
Total Cost: \$250,000

**Baseline Cost Report**



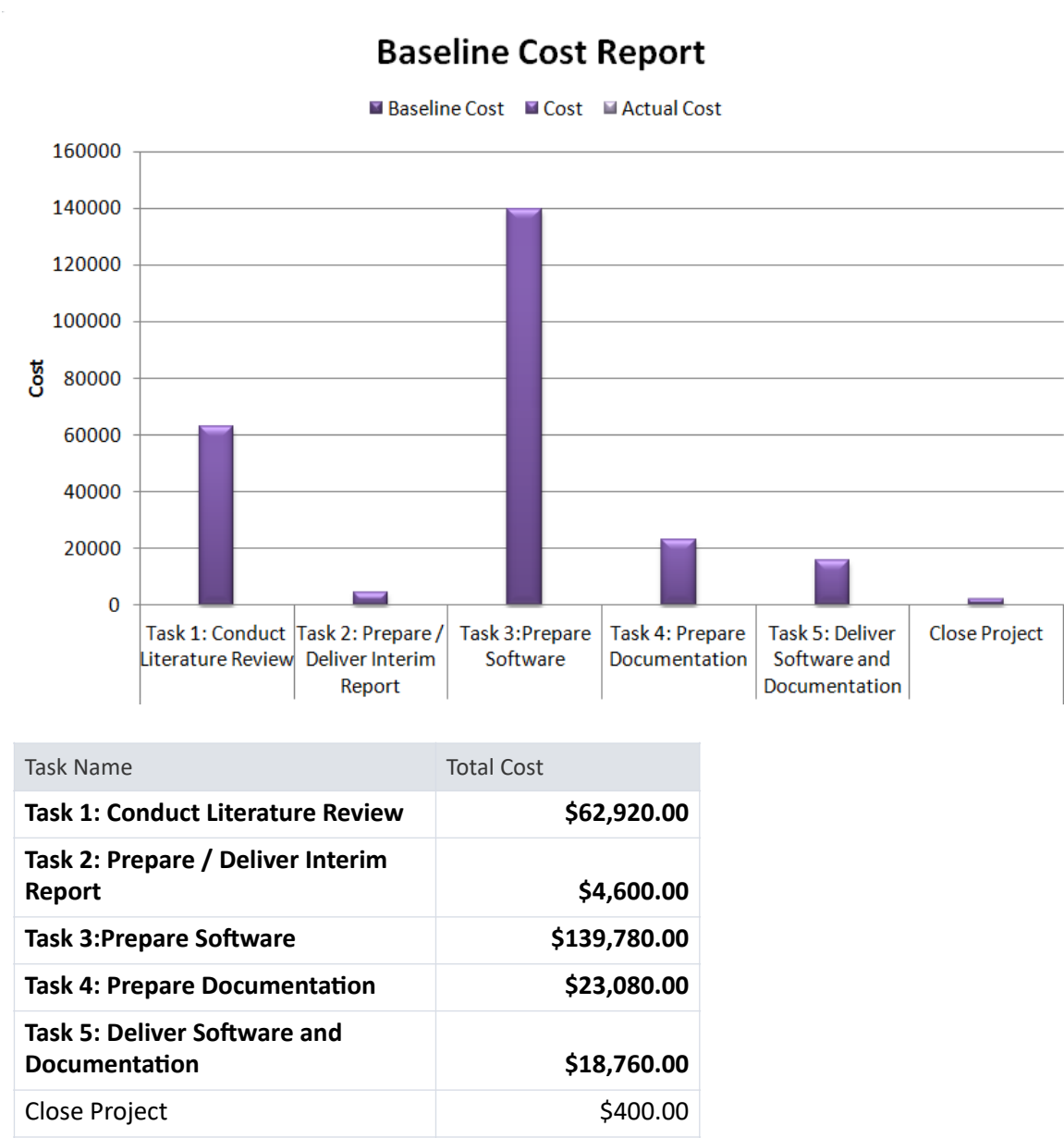
### **Cost by Quarter**

**Baseline Cost Report**

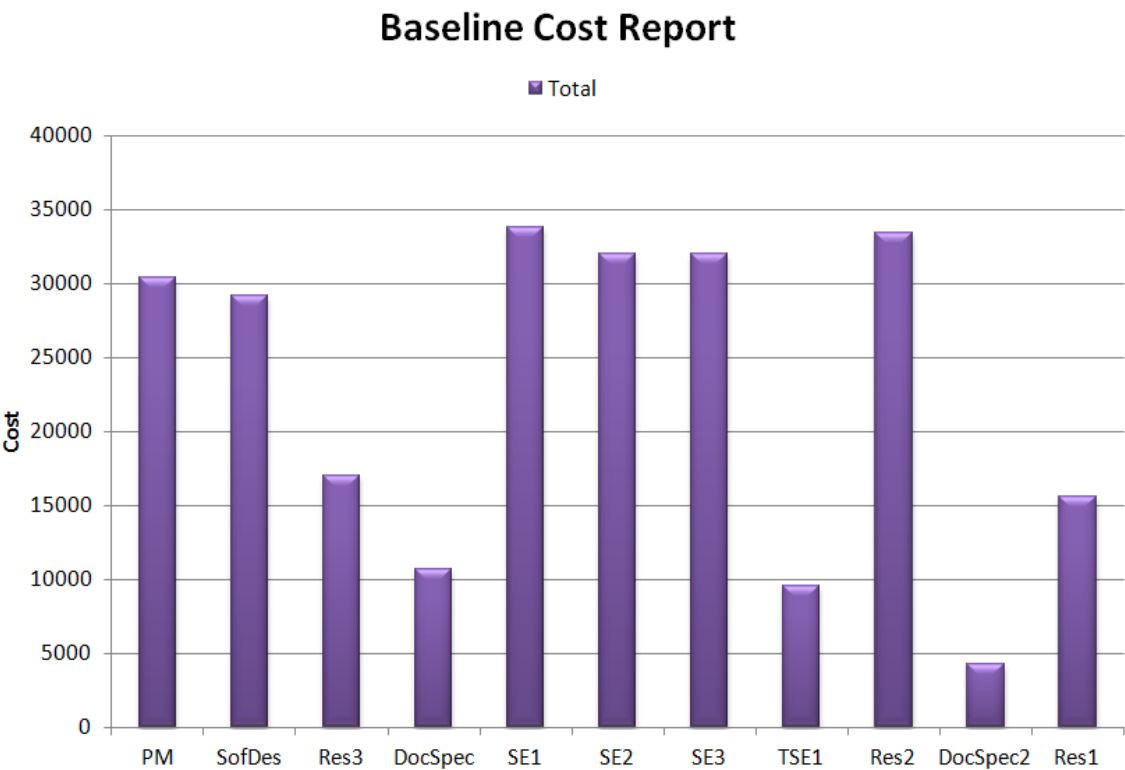




Cost by Task



Cost by Resource





## Disadvantaged Business Enterprise (DBE) Plan

Service disabled veteran owned small business

## Cooperative Features

## Appendices A (Detailed Draft Project Plan)

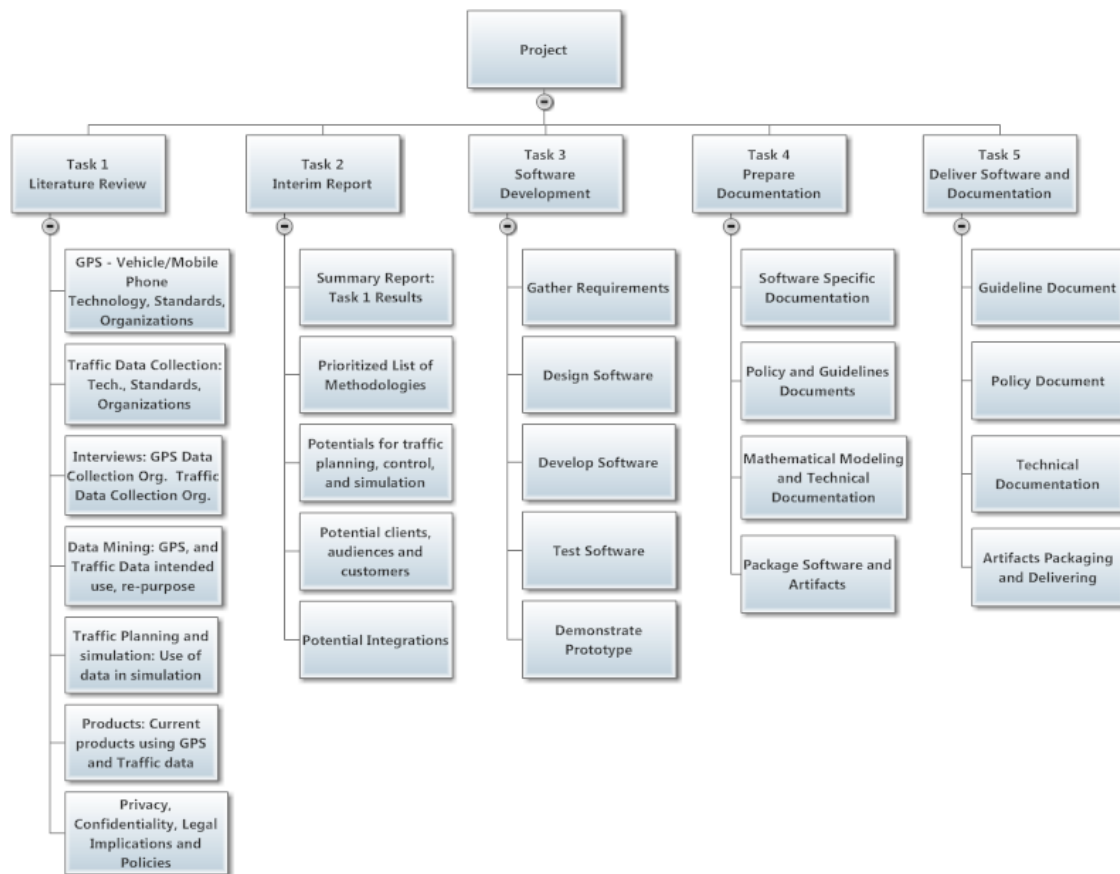
### **Detailed Summary Project Plan**

The draft project plan provided herein provides a detailed time and cost estimate for resources and activities pertinent to the project plan and task deliverables. The schedule encompasses roughly 200 days (4 and ½ quarters) starting second quarter 2012 and ending in the middle of second quarter 2013. The baseline costs are composed primarily of direct work resources to include researchers, software designers, software engineers as well as technical documentation writers. Current estimates of \$250,000 are for the research, design, development, testing and packaging of simulation software for the repurposing of GPS data to traffic planning and simulation software.

The enclosed summary Risk management plan provides an overview of typical risks associated with research and software development type projects including the risk rating and impacts to each major task area. The risks identified herein are also provided a risk recourse plan to mitigate the risk for both customer and project team.

A summary Quality Assurance Plan provides a level of detail necessary to illustrate the process and performance metrics required to manage and sustain quality in the software development process. The plan is based on industry best practices for quality software development.

## Work Breakdown Structure (WBS)



*Work Breakdown Structure – Task Deliverables*

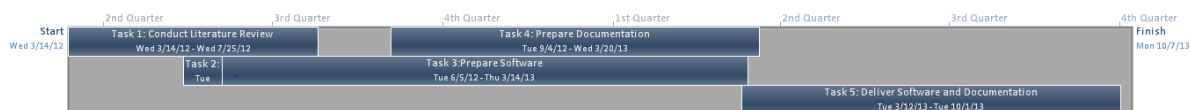
## Work Packages (Deliverables)

Work Packages based on Work Breakdown Structure

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## Schedule by Task

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Close Project	Tue 10/1/13	Mon 10/7/13



## Detailed Schedule by task and activity

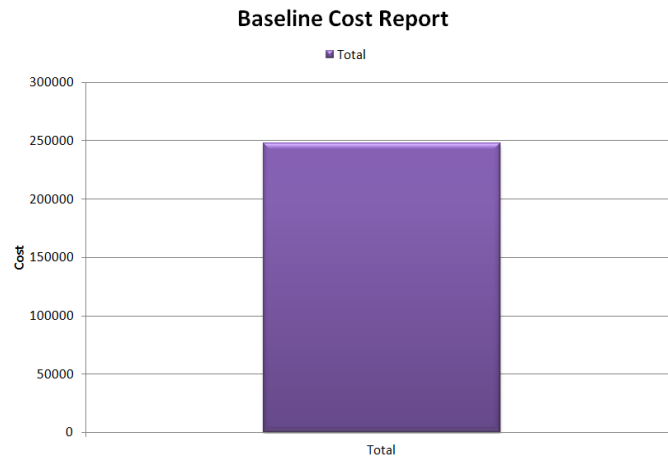
Task Name	Start	Finish
<b>Task 1: Conduct Literature Review</b>	<b>Wed 3/14/12</b>	<b>Wed 7/25/12</b>
Research GPS Technologies / Systems	Wed 3/14/12	Tue 6/26/12
Research Traffic Technologies / Systems	Wed 3/14/12	Tue 6/5/12
Interview GPS and Traffic Data Providers and Users	Wed 3/14/12	Wed 7/25/12
Research Travel / Traffic Planning utilizing GPS Data	Wed 3/14/12	Tue 6/5/12
Research Products Utilizing GPS / Traffic Data	Wed 3/14/12	Tue 4/24/12
Research Policy, Confidentiality, and Privacy Issues with GPS Data	Wed 3/14/12	Mon 4/30/12
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>Tue 5/15/12</b>	<b>Mon 6/4/12</b>
Prepare Summary Literature Review	Tue 5/1/12	Mon 5/21/12
Prepare Prioritized List of Methodologies for Planning	Tue 5/1/12	Mon 5/21/12
Prepare Prioritize List of Potential Clients / Re-purpose	Tue 5/1/12	Mon 5/7/12
Prepare Prioritized List of Potential Integrations	Tue 5/1/12	Mon 5/7/12
<b>Task 3: Prepare Software</b>	<b>Tue 6/5/12</b>	<b>Thu 3/14/13</b>
Gather Requirements	Tue 5/22/12	Mon 6/18/12
Design Software	Tue 6/19/12	Mon 7/16/12
Develop Software	Tue 7/17/12	Mon 12/3/12
Test Software	Tue 12/4/12	Mon 1/28/13
Demonstrate Software	Tue 1/29/13	Wed 2/6/13
Demonstrate Prioritized List of Planning Methodologies in Software	Tue 1/29/13	Wed 2/6/13
<b>Task 4: Prepare Documentation</b>	<b>Tue 9/4/12</b>	<b>Wed 3/20/13</b>
Prepare Software Documents	Tue 9/4/12	Mon 10/15/12
Prepare Guideline Documents	Mon 6/4/12	Fri 11/16/12

Prepare Technical Documents	Tue 1/29/13	Mon 3/11/13
Package Software	Thu 2/7/13	Wed 3/20/13
<b>Task 5: Deliver Software and Documentation</b>	<b>Tue 3/12/13</b>	<b>Tue 10/1/13</b>
Deliver Guidelines and Policy Documentation	Thu 3/21/13	Wed 6/12/13
Deliver Software Technical Documentation	Thu 3/21/13	Wed 6/12/13
Deliver Process Technical Documentation	Thu 3/21/13	Wed 6/12/13
Deliver Packaged Software	Thu 3/21/13	Wed 6/12/13
Deliver Software Installation Instructions	Thu 3/21/13	Wed 6/12/13
Deliver Software End-User Documentation	Thu 3/21/13	Wed 6/12/13
Await Response	Thu 6/13/13	Tue 10/1/13
Close Project	Tue 10/1/13	Mon 10/7/13

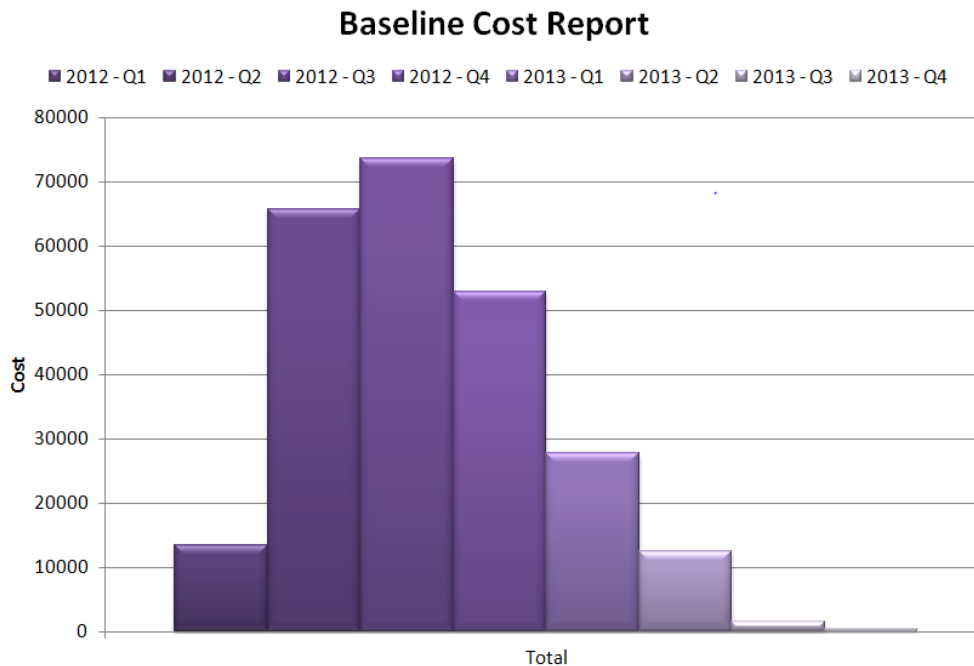
## Costs/Budget

The baseline costs are composed primarily of direct work resources to include researchers, software designers, software engineers as well as technical documentation writers. Current estimates of approximately \$250,000 are for the research, design, development, testing and packaging of simulation software for the repurposing of GPS data to traffic planning and simulation software.

### Overview of Total Cost: \$250,000.00



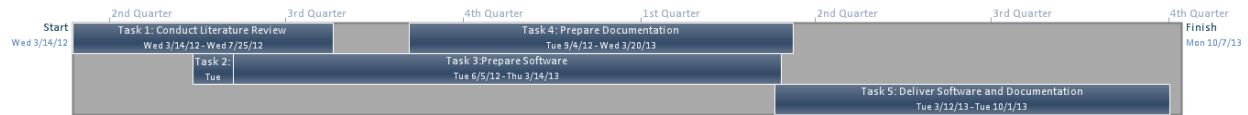
### Cost Breakdown by Quarter





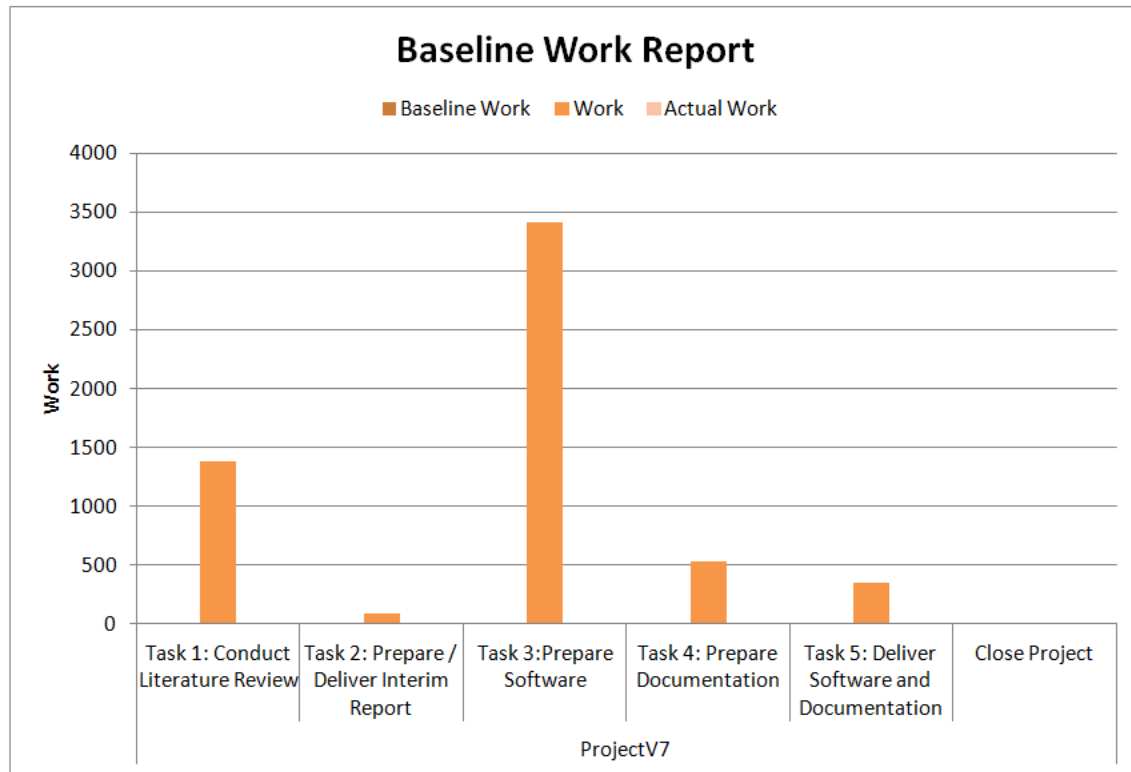
## Time Requirements

The project is currently scheduled to span approximately 200 days starting in 2<sup>nd</sup> quarter 2012 and ending 2<sup>nd</sup> quarter 2013. Highlighted task due dates are depicted below on the timeline as related to the entire project time.



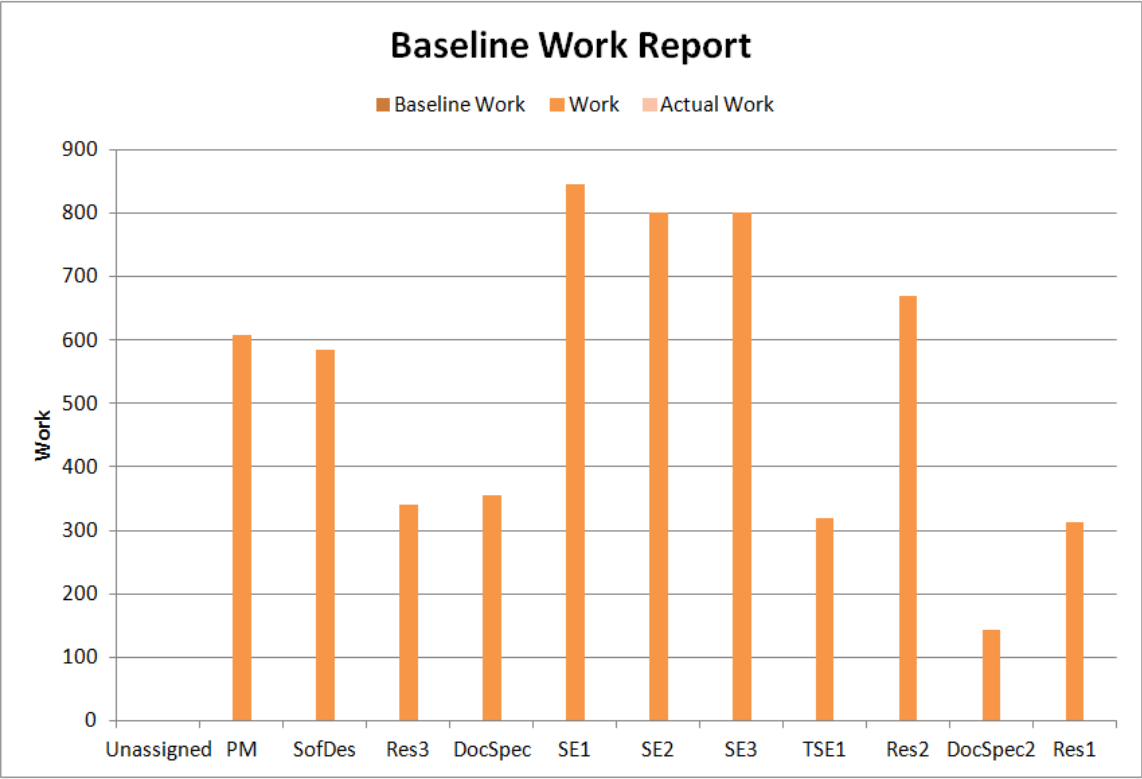
## Summary of Hours by Task

Each of the tasks depicted below is shown by time and cost. Each of the tasks below shows the amount of work allocated to the task. The two tasks requiring the largest allocation of total work are literature review and prepare software.



### Allotted Hours /Task

Task Name	Work
<b>Task 1: Conduct Literature Review</b>	<b>1,388 hrs</b>
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>92 hrs</b>
<b>Task 3: Prepare Software</b>	<b>3,416.4 hrs</b>
<b>Task 4: Prepare Documentation</b>	<b>528.4 hrs</b>
<b>Task 5: Deliver Software and Documentation</b>	<b>346.4 hrs</b>
Close Project	8 hrs



## Summary of work by task and activity

Task Name	Work	Task Name	Work
<b>Task 1: Conduct Literature Review</b>	<b>1,388 hrs</b>	<b>Task 4: Prepare Documentation</b>	<b>528.4 hrs</b>
Research GPS Technologies / Systems	420 hrs	Prepare Software Documents	72 hrs
Research Traffic Technologies / Systems	336 hrs	Prepare Guideline Documents	96 hrs
Interview GPS and Traffic Data Providers and Users	192 hrs	Prepare Technical Documents	96 hrs
Research Travel / Traffic Planning utilizing GPS Data	120 hrs	Package Software	94 hrs
Research Products Utilizing GPS / Traffic Data	96 hrs	<b>Task 5: Deliver Software and Documentation</b>	<b>346.4 hrs</b>
Research Policy, Confidentiality, and Privacy Issues with GPS Data	108.8 hrs	Deliver Guidelines and Policy Documentation	96 hrs
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>92 hrs</b>	Deliver Software Technical Documentation	24 hrs
Prepare Summary Literature Review	30 hrs	Deliver Process Technical Documentation	24 hrs
Prepare Prioritized List of Methodologies for Planning	30 hrs	Deliver Packaged Software	48 hrs
Prepare Prioritize List of Potential Clients / Re-purpose	10 hrs	Deliver Software Installation Instructions	48 hrs
Prepare Prioritized List of Potential Integrations	10 hrs	Deliver Software End-User Documentation	48 hrs
<b>Task 3: Prepare Software</b>	<b>3,416.4 hrs</b>	Await Response	0 hrs
Gather Requirements	192 hrs	Close Project	8 hrs
Design Software	160 hrs		
Develop Software	2,400 hrs		
Test Software	320 hrs		
Demonstrate Software	28 hrs		
Demonstrate Prioritized List of Planning Methodologies in Software	72.8 hrs		

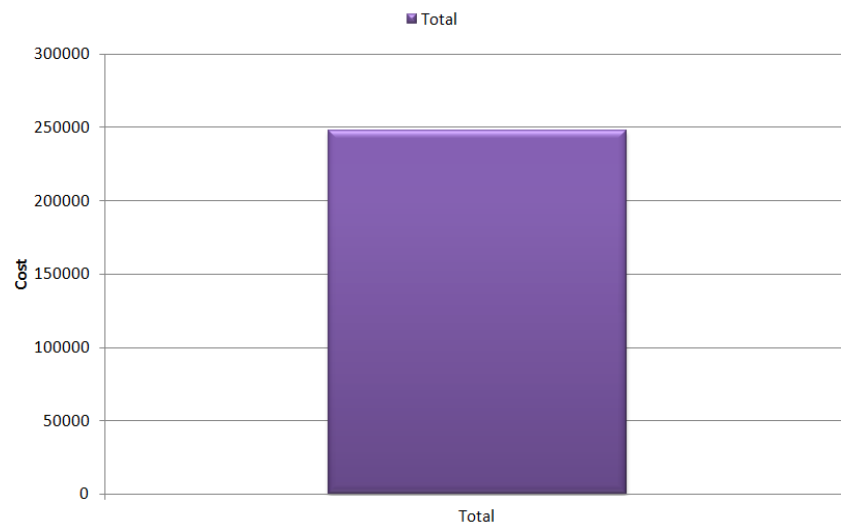


## Itemized Budget

The graphs below depict the cost breakdown by quarter, cost breakdown by task as well as cost breakdown by resources

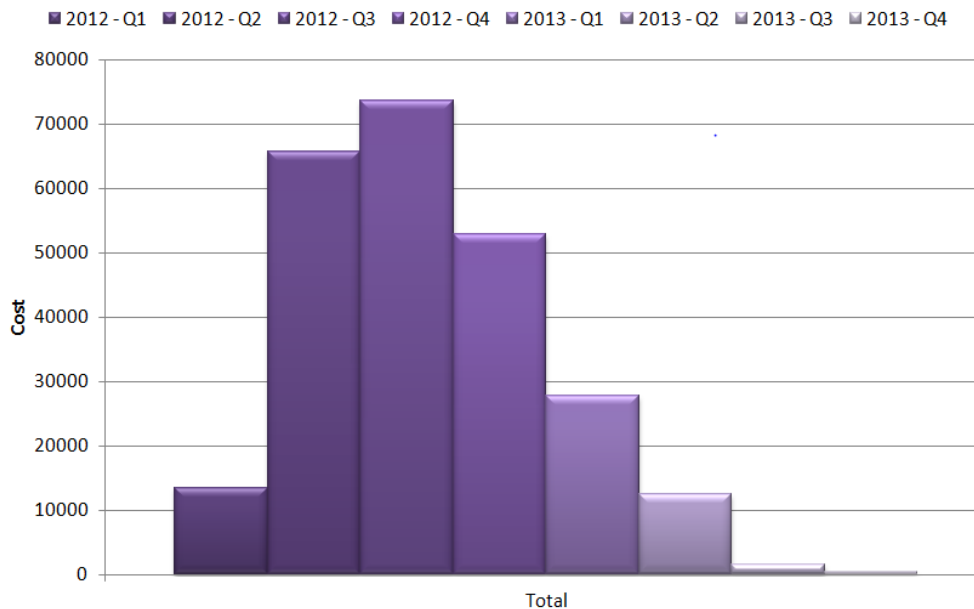
Total Cost: \$250,000

**Baseline Cost Report**

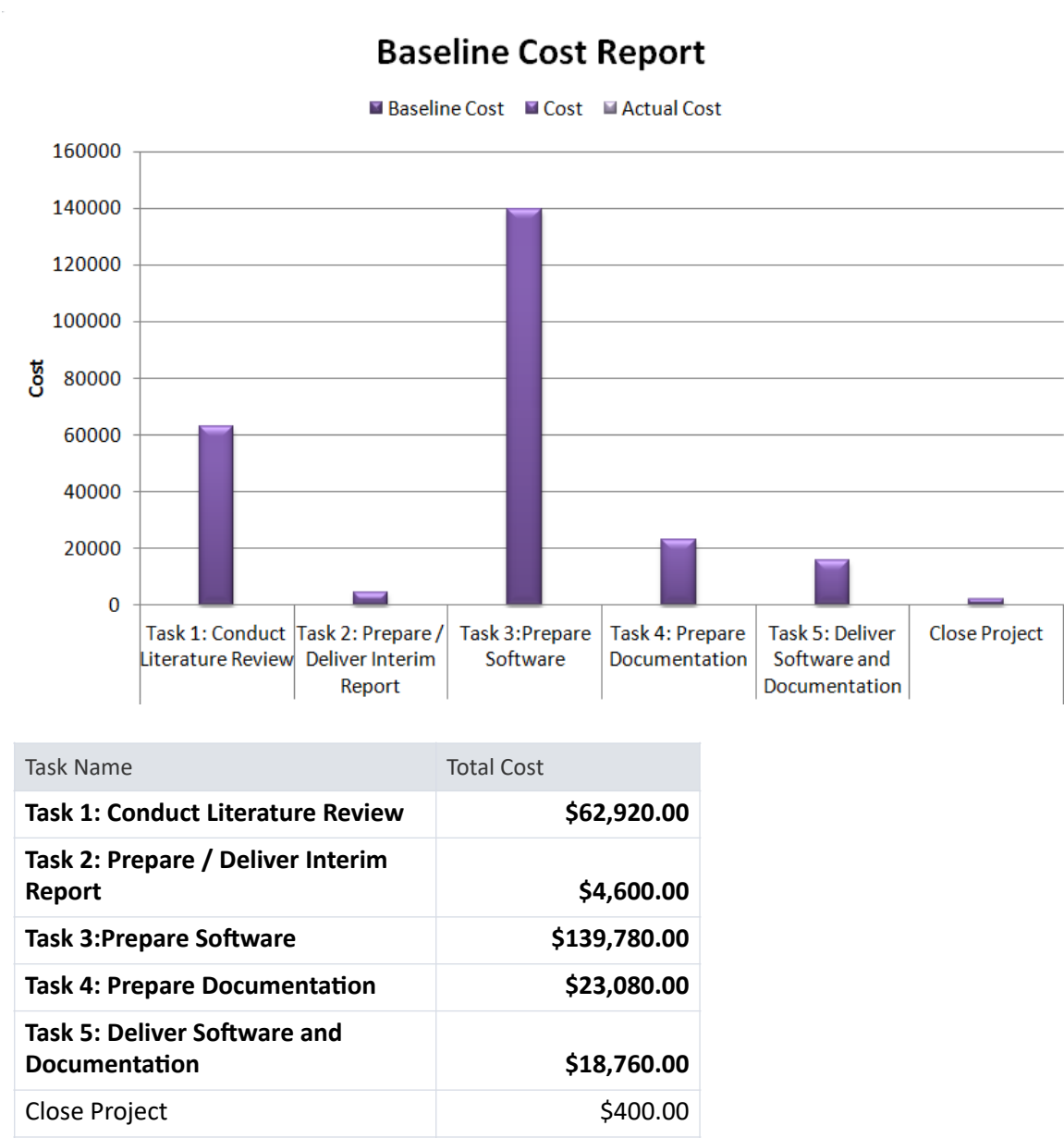


### **Cost by Quarter**

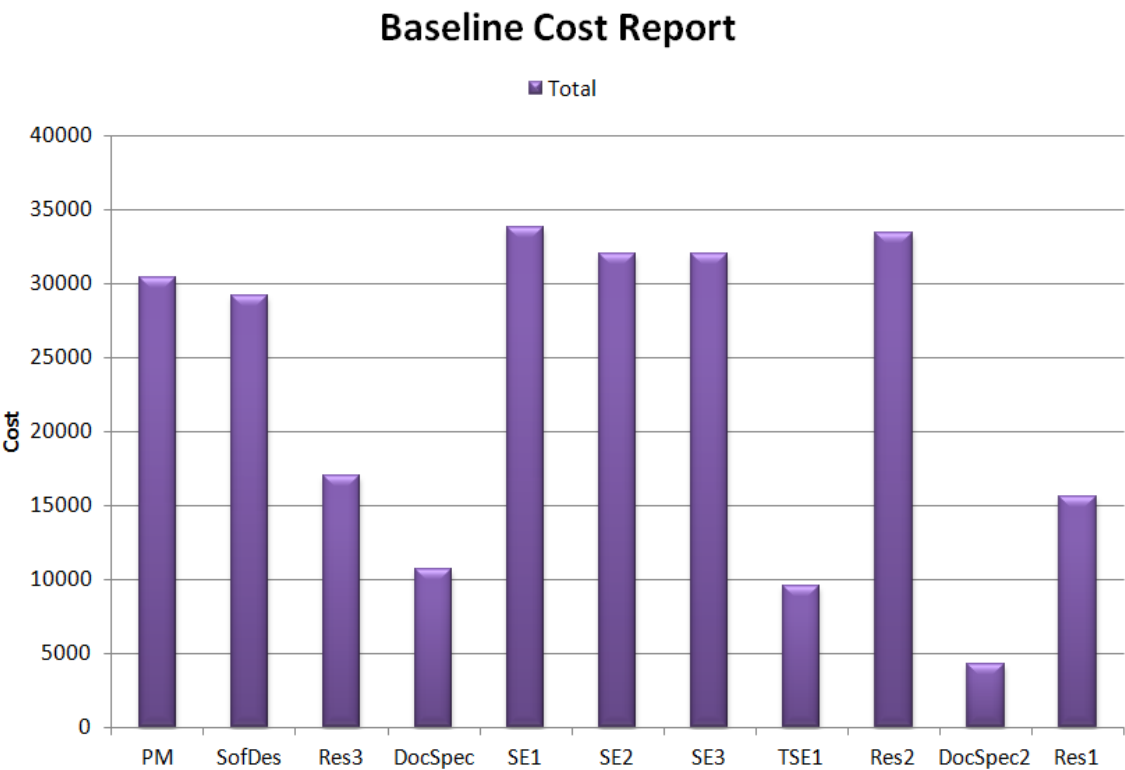
**Baseline Cost Report**



Cost by Task



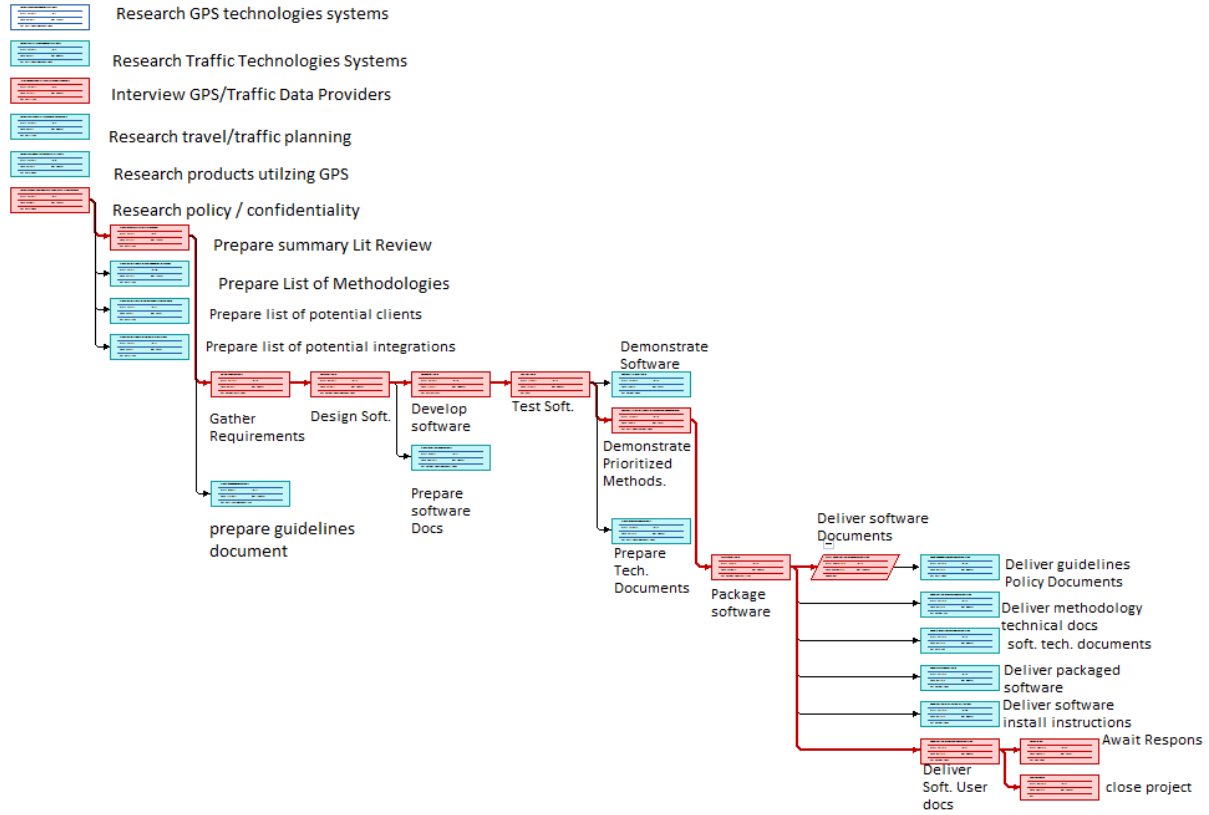
Cost by Resource



## Detailed Cost by Task and Activity

Task Name	Total Cost	Task Name	Total Cost
<b>Task 1: Conduct Literature Review</b>	<b>\$62,920.00</b>	<b>Task 4: Prepare Documentation</b>	<b>\$23,080.00</b>
Research GPS Technologies / Systems	\$17,400.00	Prepare Software Documents	\$2,640.00
Research Traffic Technologies / Systems	\$13,920.00	Prepare Guideline Documents	\$3,840.00
Interview GPS and Traffic Data Providers and Users	\$9,600.00	Prepare Technical Documents	\$3,840.00
Research Travel / Traffic Planning utilizing GPS Data	\$6,000.00	Package Software	\$4,240.00
Research Products Utilizing GPS / Traffic Data	\$4,800.00	<b>Task 5: Deliver Software and Documentation</b>	<b>\$18,760.00</b>
Research Policy, Confidentiality, and Privacy Issues with GPS Data	\$5,440.00	Deliver Guidelines and Policy Documentation	\$4,800.00
<b>Task 2: Prepare / Deliver Interim Report</b>	<b>\$4,600.00</b>	Deliver Software Technical Documentation	\$1,200.00
Prepare Summary Literature Review	\$1,500.00	Deliver Process Technical Documentation	\$1,200.00
Prepare Prioritized List of Methodologies for Planning	\$1,500.00	Deliver Packaged Software	\$2,400.00
Prepare Prioritize List of Potential Clients / Re-purpose	\$500.00	Deliver Software Installation Instructions	\$2,400.00
Prepare Prioritized List of Potential Integrations	\$500.00	Deliver Software End-User Documentation	\$3,840.00
<b>Task 3: Prepare Software</b>	<b>\$139,780.00</b>	Await Response	\$0.00
Gather Requirements	\$9,600.00	Close Project	\$400.00
Design Software	\$7,360.00		
Develop Software	\$96,000.00		
Test Software	\$9,600.00		
Demonstrate Software	\$1,400.00		
Demonstrate Prioritized List of Planning Methodologies in Software	\$3,640.00		

## Activities Diagram (critical path in highlighted in red)



## Risk Management Plan

### Risk Categories Matrix

The categories of risks are identified based on the potential impacts to one or more critical areas of the project. Each risk is associated to one or more of the impact areas to help ascertain the overall impact level risk may require. Additionally, the matrix provides an overview of the level of impact that all risks may have on the major areas of concern.

Risk Categories:

Impact	Impact Area Id	High (7-10)	Medium (4-6)	Low (1-4)	Total Impact
Budget	B				
Timeline	T				
Scope	S				
Product life-cycle	Plc				
Product acceptance	Pa				
Product testing	Pt				
Product manufacturing	Pm				
Personnel	P				
Stakeholders	S				
Program	Pr				
Client	C				
<b>Total Impact</b>					

### Risk Identification, Probability and Impact

The following risks have been identified with respect to software engineering and research related project types. These risks are common to many software development projects and are provided to describe various contingency mechanisms to help mitigate, reduce, or avoid such risks.

1. Software Related (Product)
  - a. Continuous changes in design or requirements
  - b. Developing the wrong functionality
  - c. Developing wrong GUI
  - d. Straining computer science technologies
  - e. Real-time performance shortfalls
  - f. Inability to support product after acceptance
  - g. Shortfalls in externally provided libraries, interfaces, and development environments
  - h. Shortfalls in externally or outsourced tasking
2. Schedule Related Risks
  - a. Unrealistic schedule
  - b. Schedule changes
3. Budget Related Risk
  - a. Unrealistic Budget
  - b. Cost overruns
4. Personnel Related
  - a. Shortfalls in internal personnel
  - b. Shortfalls in external personnel
  - c. Shortfalls in client personnel
5. Specific Risks for Research
  - a. Shortfalls of research information available
  - b. Inability to transfer theoretical concepts to practical ideas
  - c. Unforeseen research delays
6. Specific Risks for GPS type data collection
  - a. Shortfalls of data (errors, structural reliability, statistical reliability)
  - b. Shortfalls of collections and integrations facets
  - c. Inability to translate mathematical models into computer algorithms
  - d. Unforeseen data delays

Risk Register (Software Development and Research)											
Risk Number	Risk Category	Risk	Prob. Occurrence (1-10)	Impact (1-10)	Detection (1-10)	RPN	Area Impact	Owner	Date Identified	Date Resolved	COA
1.a	Product	Change	5	6	1	30	Pa, Pt, Pm, S, T				
1.b	Product	Functionality	2	4	3	24	Pt, Pa				
1.c	Product	GUI	2	4	2	16	Pt, Pa				
1.d	Product	Comp. Science	2	6	1	12	Pa, Pt, Pm, S, T				
1.e	Product	Performance	3	3	3	27	Pt, Pa, Plc				
1.f	Product	External Lib.	3	3	3	27	Pa, Pt, Pm, S, T				
1.g	Product	External Outsource	3	3	3	27	Pa, Pt, Pm, S, T				
2.a	Schedule	Unrealistic	4	5	2	40	Pa, Pt, Plc, T, B				
2.b	Schedule	Change	4	5	2	40	Pa, Pt, Plc, Pm T, B				
3.a	Budget	Unrealistic	3	5	2	30	Plc, B				
3.b	Budget	Overruns	3	5	2	30	Plc, T, B				
4.a	Personnel	Internal Pers.	2	5	2	20	Plc, Pm				
4.b	Personnel	External Pers.	3	5	3	45	Pm				
4.c	Personnel	Client Pers.	3	4	3	36	Pm, Pt, Pa				
5.a	Research	Information	3	6	1	18	B, T, Pa, Pt, Pm, C				
5.b	Research	Theoretical /Practical	3	6	2	36	B, T, Pa, Pt, Pm, C				
5.c	Research	Delays	2	6	3	36	B, T, Pa, Pt, Pm, C				
6.a	Data	Data	3	4	4	48	B, T, Pa, Pt, Pm, C				
6.b	Data	Integrations	4	5	4	80	B, T, Pa, Pt, Pm, C				
6.c	Data	Translations	3	4	4	48	B, T, Pa, Pt, Pm, C				
6.d	Data	Data Delays	4	6	3	72	B, T, Pa, Pt, Pm, C				





## Risk Mitigation Strategies and Courses of Action (Risk Response)

Risk CoA (Software Development and Research)									
Risk No	Risk Category	Risk	RPN	CoA Type	CoA No.	CoA Description	Date Identified	Date Resolve	Activity Association
1.a	Product	Change	30	Mitigate		Change requests will be evaluated to changes in product, timeline and budget. Must be approved by client and program manager			Produce Software
1.b	Product	Functionality	24	Mitigate		Emphasis on software design and early testing on core functionality			Produce Software
1.c	Product	GUI	16	Mitigate		Emphasis on software design and early testing on GUI functionality with client			Produce Software
1.d	Product	Comp. Science	12	Mitigate		Proj. Manager evaluates with Research team implications of computer science			Lit. Review; Produce Software
1.e	Product	Performance	27	Wait					
1.f	Product	External Lib.	27	Mitigate		Proj Manager identifies list of proven libraries and vendors for program			Lit Review
1.g	Product	External Outsource	27	Wait					
2.a	Schedule	Unrealistic	40	Mitigate		Review schedule with client; utilize PERT			Lit Review
2.b	Schedule	Change	40	Mitigate		Change requests will be evaluated to changes in product, timeline and budget. Must be approved by client and program manager			All
3.a	Budget	Unrealistic	30	Wait					
3.b	Budget	Overruns	30	Wait					
4.a	Personnel	Internal Pers.	20	Wait					
4.b	Personnel	External Pers.	45	Wait					
4.c	Personnel	Client Pers.	36	Wait					
5.a	Research	Information	18	Wait					
5.b	Research	Theoretical /Practical	36	Mitigate		Research team provides preliminary study on applications of theory			Lit Review
5.c	Research	Delays	36	Wait					
6.a	Data	Data	48	Mitigate					
6.b	Data	Integrations	80	Mitigate		Research team provides preliminary study on data integration capability			Lit Review

6.c	Data	Translations	48	Wait				
6.d	Data	Data Delays	72	Mitigate		Research team determines availability of data		Lit Review

## Risk Control

Risk control includes the activities, policies, procedure, guidelines and metrics utilized in the identification, analysis and control of risks related to the project. Primary artifacts used in risk management and control include: (1) risk register, (2) governance policies/procedures, (3) timeline, budget, and performance metrics, (4) communications and meetings associated with risks, (5) and course of action (risk response) plans.

Specific to this project, the following risk related control metrics are provided:

Risk Metric	Metric Description
Timeline: Critical Path Trajectory	Provides an analysis of current time utilized to projected time for set of activities along critical path
Timeline: Data Trajectory	Provides an analysis of current time utilized to projected time for set of activities to data collection, migration, transformation, analysis
Timeline: Data integrations Trajectory	Provides an analysis of current time utilized to projected time for set of activities for integrating real data to software
Budget: Research Trajectory	Provides an analysis of current budget utilized to projected budget for set of activities related to research
Budget: Software Production Trajectory	Provides an analysis of current budget utilized to projected budget for set of activities related to software production
Product Acceptance Rating	A metric for the customer to analyze at various software production stages whether or not the functionality, GUI, or end product will meet acceptance criteria
Overall Rating: Earned Value	Provides an overall rating for the project based primarily on timeline and budget trajectories



## Quality Requirements and Standards

Product (Software) Quality Requirements and Standards				
Quality No	Quality Requirement or Standard	Requirement / Standard Description	How Measured	Quality Recourse
1	Req: Software development platform	Software will be developed on a COTS industry standard platform for simulation type applications	Design team selects from top development platforms	TBD
2	Req: Software Integrations platform	Software platform will allow for efficient integrations with open source type GPS data using top rated integrations technologies	Design team selects from top Integrations platforms	TBD
3	Req: Software design will be managed in industry standard design platform (cloud based)	Software platform will allow for efficient integrations with open source type GPS data using top rated integrations technologies	Design team selects from top configuration management platforms	TBD
4	Req: Software configuration will be housed in industry standard configuration management platform (cloud based)	Software configuration management software will allow for efficient management of software changes, version control, packaging, releases, etc. using top rated configuration platform	Design team selects configuration platform that meets baseline requirements	TBD
5	Req: All requirements will be managed in requirements management software	Requirements Software will handle requirement number, description, importance and associated to product functionality, testing and project activity	Design team select requirements software that meets baseline requirements	TBD
6	Standard: IEEE83- 1998	IEE830 – 1998, IEEE Recommended practice for Software Requirements Specifications	Design team follows standards as required	TBD
7	Standard: IEEE1220-1998	IEEE 1220-1998 – Application and Management of the Systems Engineering Process	Design team follows standards as required	TBD
8	Standard: IEEE 1233-199	IEEE 1233-1998 – Guide for Developing System Requirements Specifications	Design team follows standards as required	TBD

## Quality Control

Quality control includes the activities, policies, procedure, guidelines and metrics utilized in the identification, analysis and control of quality (standards and requirements) related to the project. Primary artifacts used in quality management and control include: (1) Quality list, (2) quality policies/procedures, (3) timeline, budget, and performance metrics, (4) communications and meetings associated with quality, (5) and course of action (quality response) plans that may be associated to product re-work.

## **References**

Transportation Research Board, Guidelines for proposals  
<http://onlinepubs.trb.org/onlinepubs/crp/docs/ProposalPrep.pdf>