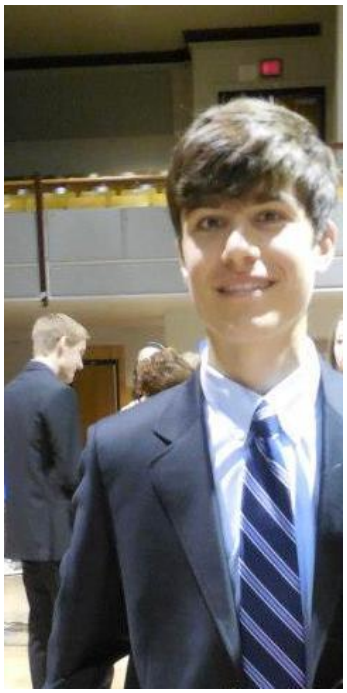
Team 6: Traffic Net

Paving the Road to a New Future for Connected Cars



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Executive Summary

The AT&T Corporation has assigned Team 6 the task of designing a technologically advanced car interface that utilizes the concept of the *Internet of Things*. The final product must provide our customers a smarter, cleaner car that is both connected and energy efficient, and adaptable enough to be implemented in a wide range of consumer vehicles. It must further address driver safety, productivity, and infotainment, all accessible from within the car.

During the concept generation and selection processes, we determined the basis for our design and the optimal components. Various forms of protocol were considered, as well as the type of user interface to display information to the driver.

A major risk intrinsic to designing new features for connected cars is providing more information than the driver needs. Our ergonomic interface will minimize distractions by providing critical information without overloading the user. In addition, preventive measures will be taken to ensure that our system is secure from intrusion. These include limiting the data exchange between vehicles to a maximum range of 30 miles. The information obtained from other vehicles will provide only locations and vehicle speeds.

In order to meet our budget requirements, each possible component to our design was scored with a high weight given to implementation cost. By developing our car to maximize efficiency and minimize cost, it will be competitive in today's global marketplace. Based on the average cost of app development and hardware, we estimate that we will have a design cost of under $2,000, and an implementation cost capping at $1000. The final prototype for our connected car technology is due on May 5, 2014.

Abstract

A connected car is a car that uses the Internet of Things to address driver safety, productivity, and infotainment. It accomplishes this goal through the use of technologically advanced features that enhance the driving experience, while having a minimal design that will reduce driver distraction. The most successful features improve upon driver safety and productivity through the use of new technologies and ways to deliver information to the driver quickly and efficiently.

Introduction

Many of today's leading automotive manufacturers have formed partnerships with technology giants Apple, Google, and AT&T in order to bring the convenience of new technologies to the road. The implementations of these technologies differ, but they usually look to improve a driver's access to information, a car's automatic response to the environment around it, or the interaction between the driver and the vehicle. We have been prompted by AT&T to develop a tool with which one of these objectives can be reached.

Mission Statement

To design a feature based on the Internet of Things that can be implemented in a wide range of connected car models, and that will positively address driver safety, productivity, and infotainment.

Global Marketplace

Connected cars, cars which access the internet to improve the driving experience, are being developed by today's leading car manufacturers. A major source of discussion within the connected car industry is whether the car itself should be connected or whether the smartphone should serve as the vehicle's connectivity hub. In 2013, AT&T began a partnership with Tesla Motors to incorporate their technology into the vehicles' dashboards. The system provides two-way vehicle communications to maximize driver safety, remote engine diagnostics, and infotainment features. As an example of the remote engine diagnostics, the Tesla connected car maintains a real-time log of performance statistics, ensuring that vehicle malfunctions be diagnosed quickly and accurately. Infotainment features provide internet access, including the ability to search the internet, in addition to live weather and traffic updates. Internet access on these vehicles is provided by a modem and a SIM card to connect to cell towers.

According to ABI Research, by 2016 more than half of all new cars globally will have factory-installed telematics, the computer and electronic technology involved in cars. The number of cars connected to the internet worldwide is expected to grow more than six fold to 152 million in the year 2020 from 23 million today. While the consumer market for connected cars is in the early stages of its development, the connected car is considered to be the future of the automotive industry. This is reflected by the decisions of technology companies such as AT&T to aggressively pursue partnerships with today's most innovative car manufacturers.

Other technology companies have adopted similar strategies, such as Google announcing an alliance with GM and Honda to bring the Android operating system to their cars, and Apple integrating their iOS operating system into cars produced by BMW and Mercedes-Benz.

Despite the high expectations and potential, there are issues which stagnate the growth of the connected car market including the cost of hardware, security vulnerabilities, and the risk of driver distraction. Recently, Tesla security consultant, Nitesh Dhanjani, announced a flaw in their vehicle's security systems. Hackers could remotely unlock the car and steal information contained within the car's computer systems by using a command transmitted over the internet.

With regard to driver safety, the connected car must provide the optimal amount of information to the driver without compromising safety. One technology currently under development is a call management interface that will monitor brainwaves to determine whether a driver is too distracted by traffic to take a phone call. If the driver is distracted, the caller will automatically be told to call back later. Another will project directions onto the windshield, so users never have to take their eyes off the road when using a GPS.

Benchmarking

We examined various concepts currently implemented or being developed in connected cars today as part of the benchmarking process. The index below provides the most promising of these innovations.

Existing Concepts for Connected Cars by Company:

Tesla Motors

<u>Model S</u>

Mobile app offers access to the car's climate control system, enabling you to preheat the car from your iPhone or Android phone before you drive.

Touchscreen controls enable the driver to raise or lower the vehicle to change the car's aerodynamics. This allows for more effective travel in thick snow or when pulling into a steep driveway. The touchscreen user interface also provides media, navigation, web, phone, and energy data.

Electronic power steering automatically adjusts to road conditions. Also includes automatic traction and stability control.

Aluminum-intensive design minimizes weight and maximizes efficiency.

Toyota

<u>2014 Lexus LS</u>

Navigation and Mobile Connectivity system includes NavTraffic and NavWeather apps, Bing Internet Search, and Pandora Internet Radio.

Electroluminescent instrumentation automatically adjusts to lighting conditions to provide a sharp, luminous display.

Sensors detect your smart access card key, which allows the driver to lock and unlock the doors, open the trunk, and start the ignition automatically.

HomeLink universal transceiver operates your garage, home lighting, and home security systems.

Includes electronic brakeforce distribution technology─ a computer controlled system that modulates the amount of pressure to the brakes to enhance control during breaking.

Brake assist applies increased brake pressure based on the input of sensors that assess whether the driver is in a panic-stop scenario.

Smart-stop technology reduces engine power when the brake pedal is firmly applied.

Safety features include automatic collision notification, lane-keep assist, pre-collision system with dynamic radar cruise control, and a pedestrian-detection system using infrared technology.

> -Lane-keep assist provides a visual and audible alert to the driver when lane departure is detected in addition to a slight automatic steering force.

Toyota's night view features include Pedestrian Detection.

External Research

The essential aspects of our design were researched to determine how they should be implemented in a connected car.

GPS: http://gpsinformation.net/main/gpsspeed.htm

GPS (Global Positioning System) is a technology with which a user can track the position of one's device or the devices of others. It is also adept at calculating the velocity of those devices. Looking into the accuracy with which GPS can track a vehicle, it was found that GPS can calculate velocities with an accuracy of within 0.1 mph in good conditions and 0.5 mph in rougher conditions. It is also capable of calculating velocities up to 999 mph.

WIFI:

802.11n is the most widely implemented coding with which wifi is transmitted. It can transmit up to 104 megabits per second per stream and can manage up to four streams, allowing for our project to have little worries about transmitting data.

Internet of Things:

The Internet of Things is a concept of physical objects becoming embedded with sensors and detectors so they are allowed to communicate with electronic devices and databases. From traffic information to global news communication and even to health procedures in the form of pacemakers, the Internet of Things allows for more information about the world around and computes this information into useful statistics and models. In our situation, the concept of the Internet of Things allows for very precise data to be communicated between the app and the car and can be easily accessed by the user.

Patent Search

Advances in connected car components have been patented by both technology companies and automotive manufacturers. The list below describes important patents found in our research by inventor/company.

Apple

Patents Covering Car Instrumentation and Telematics

Patent No. 8,482,535: Capacitive Touch Display

"Tactile, programmable touchscreen display for improved vehicle instrumentation."

Rohit Talati, Junnosuke Kurihara, David Kryze, Jae Jung

Patent No. US20130038437 A1: Display automatically updates to provide road/environmental conditions.

"A processor-controlled display provides visual notifications of notifications and tasks according to a dynamically prioritized queue which takes into account environmental conditions and driving context and available driver attention."

Date Filed: 8 August 2011

Microsoft Corporation

Publication No. US20090006694 A1: Multi-Tasking Interface Model

"A multi-tasking interference system is provided to enhance an entertainment experience by filtering interruptions, and delivering desired interruptions in an optimal method, format, and at an opportune time. In one aspect, a gatekeeper receives a primary input (such as a television program) and a secondary input (such as a telephone call) and, based on user preferences, allows or disallows the secondary input to interrupt the primary input."

Date Filed: 29 June 2007

Honda Motor Co.

Patent No. US20050271037 A1: Enabling the user to control a car from a remote location.

"Method and system for controlling the exchange of vehicle related messages."

Date Filed: 6 April 2005

Ford Global Technologies

Publication No. US20120028599 A1: Communicate emergency information to a vehicle using an in-car computer system that filters data based on GPS location.

"A computer may receive one or more emergency notifications issued by a government agency. Additionally, a geographic location of a vehicle may be determined based on GPS data."

Date Filed: 27 July 2010

Customer Needs Analysis

The customer needs were determined and then converted into needs statements. The relative importance of each customer need is given in parentheses.

Customer Need	Need Statement
Create a product that addresses (Making the car smarter, Making it cleaner, Making it Connected [IoT], making it efficient (1)	The project must utilize the Internet of Things. The project must be easy to use.
Must be usable while driving/ in car(2)	The project must provide minimal distraction to the user.
Must address Driver safety, Productivity, AND Infotainment, AND minimize driver distraction.(3)	The project must not negatively inhibit driver safety. The project must increase driver productivity. The project must not cause cognitive overload. The project must be electronically secure.
Worth the COST of UPGRADE to a connected car.(4)	The project must be adaptable for different vehicle models. The project must not elevate costs beyond a reasonable level. The project must have an aesthetically pleasing design.

Needs/Metrics Matrix

The need statements were analyzed according to their corresponding metrics in a needs/metrics matrix. Most of the customer needs can be met by utilizing an effective information medium and display type, as well as a universal protocol with adequate range for a car to car connection.

Metrics	Information Medium	Protocol Type and Range (mi)	Range of Car-Installed App (mi)	Internal Hardware	Type of Visual Display	Ergonomic User Interface	Voiceover
Needs							
Utilizes the Internet of Things (IoT)		X	X	X			
Easy to Use Interface	X				X		
Minimal Distraction to the Driver	X				X		
May not Inhibit Driver Safety/Cause Cognitive Overload	X				X		X
Increases Driver Productivity	X						
Electronically Secure		X	X				
Aesthetically Pleasing User Interface					X	X	

Concept Generation

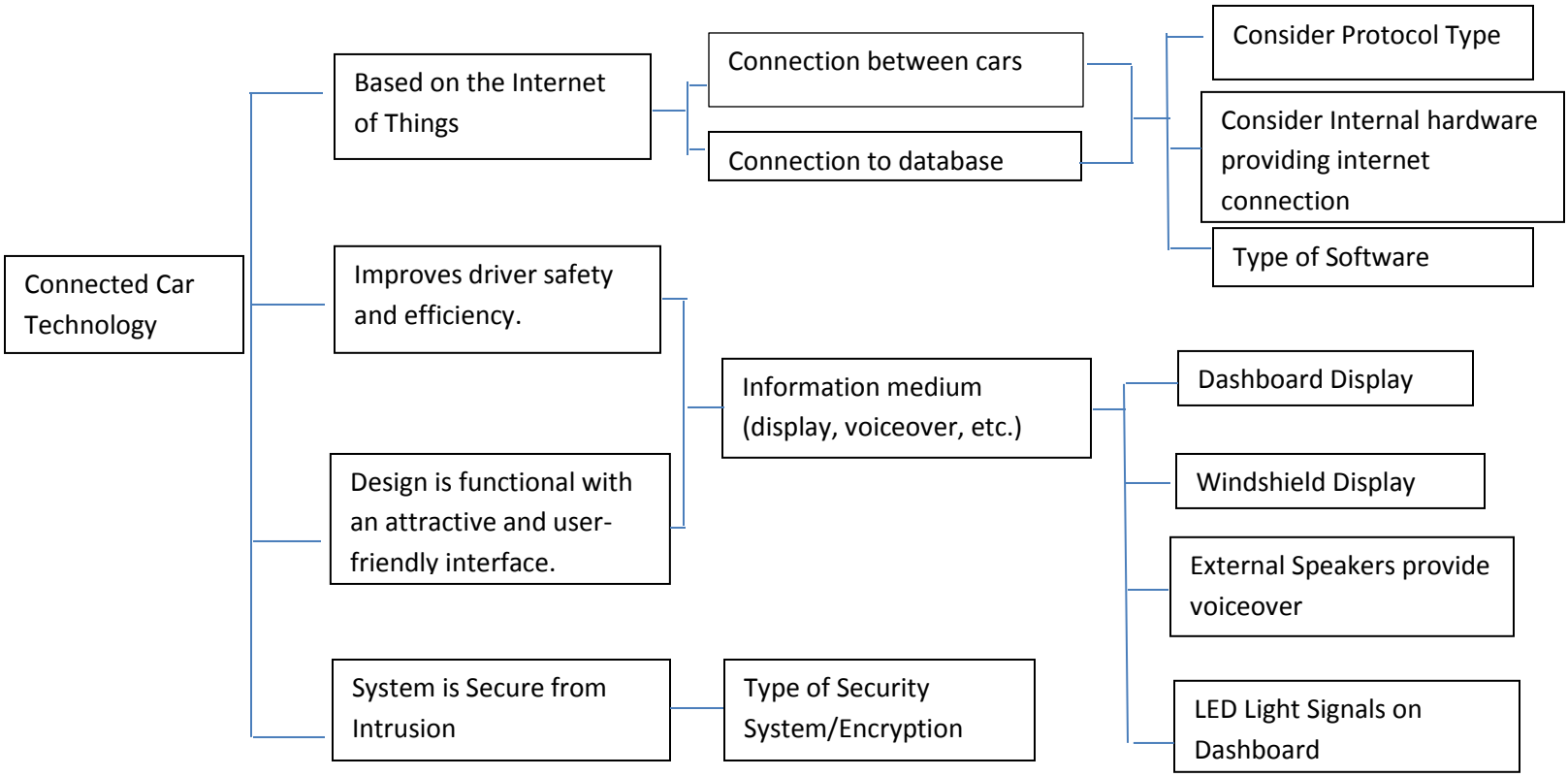
The feature for our connected car must be based on the Internet of Things and improve driver safety and efficiency. The functional diagram outlines important considerations such as the type of protocol and information medium that will allow us to meet these expectations.

Preliminary Brainstorming Ideas

Concept 1: LED lights (dim red to bright red in severity) alert driver of approaching obstacle (car, pedestrians, etc.)

Concept 2: Traffic alerts and road conditions over speaker based on external database.

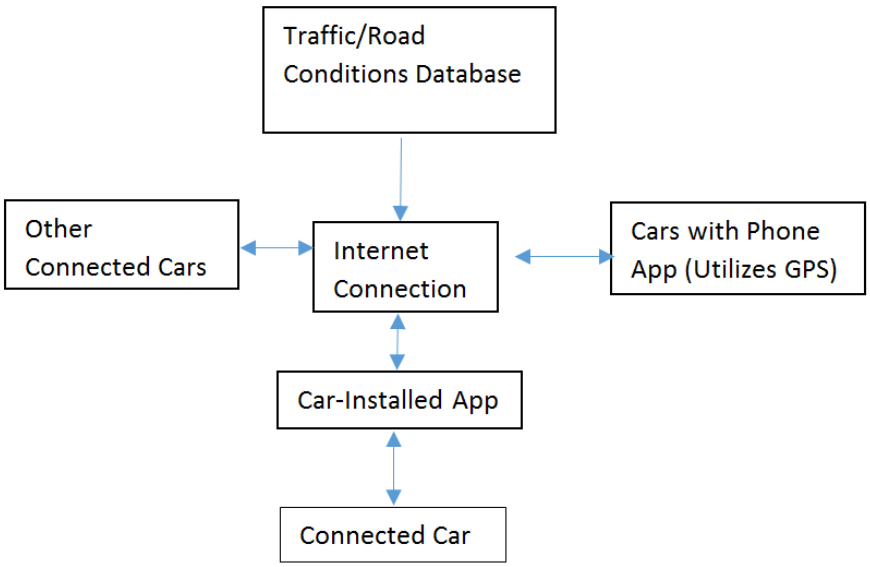
Concept 3: Connected car detects the smartphone signal of other drivers to determine their positions and speeds. Voiceover provides updates on important information.



Concept Generation (Continued)

Our design concept is a connection between cars that will enable a driver to determine the positions and velocities of other vehicles on the road. The connected car's built-in app connects to an external server that links it to other connected cars on the road. From this connection, the driver also receives traffic updates.

In addition to the car-to-car connection, information will be streamed to the driver directly from a traffic/road condition database. The diagram below shows the relationship among various interconnected parts of our Traffic Net system.



Concept Selection

The key components to our design, including the types of hardware and information mediums, were selected based on these screening and scoring matrices.

Type of Hardware (Screening)

	Built in Modem	Phone to Phone Connection	SIM card	Built in Computer
Requires Wi-Fi	0	+	+	0
Cost of Internal Hardware	0	+	0	(-)
Reliability	0	0	0	+
Operating Range	0	+	+	+
Includes GPS Capability	0	0	(-)	+
Total +s	0	3	2	3
Total 0s	5	2	2	1
Total -s	0	0	1	1
Score	0	3	1	2
Rank	**4**	**1**	**3**	**2**

Type of Hardware (Scoring)

		Phone to Phone Connection		Built in Computer	
Criteria	**Weight**	**Rating (1 to 3)**	**Weighted Score**	**Rating (1 to 3)**	**Weighted Score**
Requires Wi-Fi	10%	3	0.3	2	0.2
Cost of Internal Hardware	40%	3	1.2	1	0.4
Reliability	20%	2	0.4	3	0.6
Operating Range	15%	3	0.45	3	0.45
Includes GPS Capability	15%	2	0.3	3	0.45
		Total Score	**2.65**		**2.1**
		Rank	**1**		**2**

Concept Selection (Continued)

Type of Information Medium (Screening)					
	Dashboard Display	Windshield Display	Voiceover with External Speakers	Voiceover with Built in Speakers	LED Light Signals
Minimizes Driver Distraction	0	0	(-)	+	0
Improves Driving Experience	0	+	+	+	+
Clarity of Audio/ Visual System	0	+	+	+	+
Occupied Space on Display	0	+	(-)	+	+
Cost	0	(-)	(+)	0	0
Total +s	0	3	3	4	3
Total 0s	5	1	0	1	2
Total -s	0	1	2	0	0
Score	0	2	1	4	3
Rank	5	3	4	1	2

Type of Information Medium (Scoring)							
		Voiceover with Built in Speakers		LED Light Signals		Windshield Display	
Criteria	Weight	Rating (1 to 3)	Weighted Score	Rating (1 to 3)	Weighted Score	Rating (1 to 3)	Weighted Score
Minimizes Driver Distraction	25%	3	0.75	2	0.5	2	0.5
Improves Driving Experience	30%	3	0.9	3	0.9	3	0.9
Clarity of Audio/ Visual System	15%	3	0.45	3	0.45	3	0.45
Occupied Space on Display	10%	3	0.3	3	0.3	3	0.3
Cost	20%	2	0.4	2	0.4	1	0.2
		Total Score	**2.8**		**2.55**		**2.35**
		Rank	**1**		**2**		**3**

Concept Selection (Continued)

A built in computer combined with voiceover and LED Light Signals proved optimal for our design. We believe that eventually our design will extend to a mobile app that connects the smartphones of all drivers on the road. This would greatly increase the sample size, and produce traffic updates with greater accuracy. Our current system links only drivers who have connected cars installed with the Traffic Net System.

Cost Analysis

Based on the average cost of app development and hardware, we estimate that we will have a design cost of under $2,000, and an implementation cost capping at $1000. This is within the necessary margin needed to make our connected car competitive and worth the upgrade for potential buyers.

App – Specialized firms can develop and app for around $1000 or more according to how complex the app is.

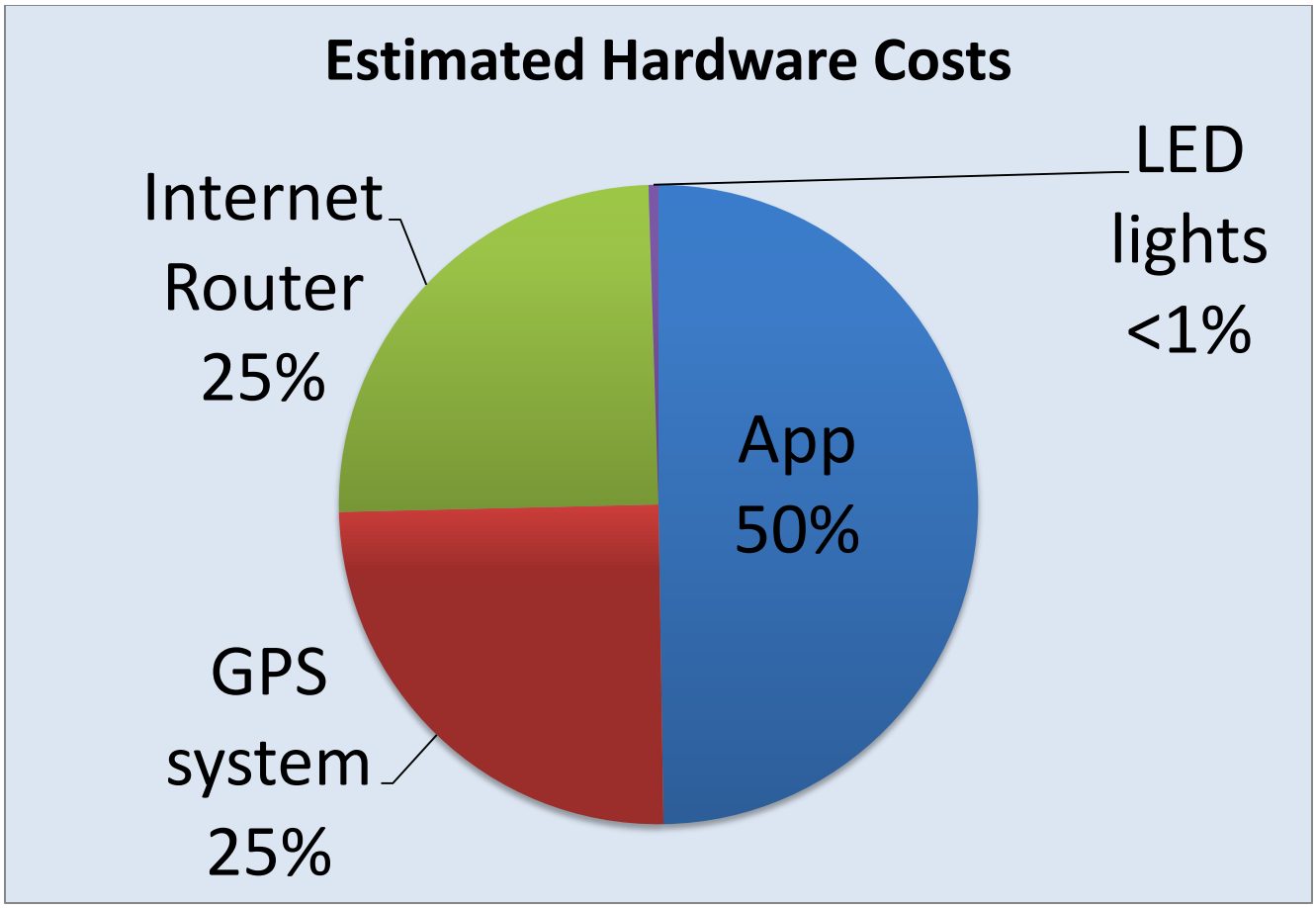
http://www.bluecloudsolutions.com/blog/cost-develop-app/#total

Installed GPS system – would cost an average of $500

Internet Router - $500

http://www.nbcnews.com/id/30998458/ns/technology_and_science-tech_and_gadgets/t/mobile-internet-makes-its-way-cars/#.U1bhur-Nwxo

LED lights - $10



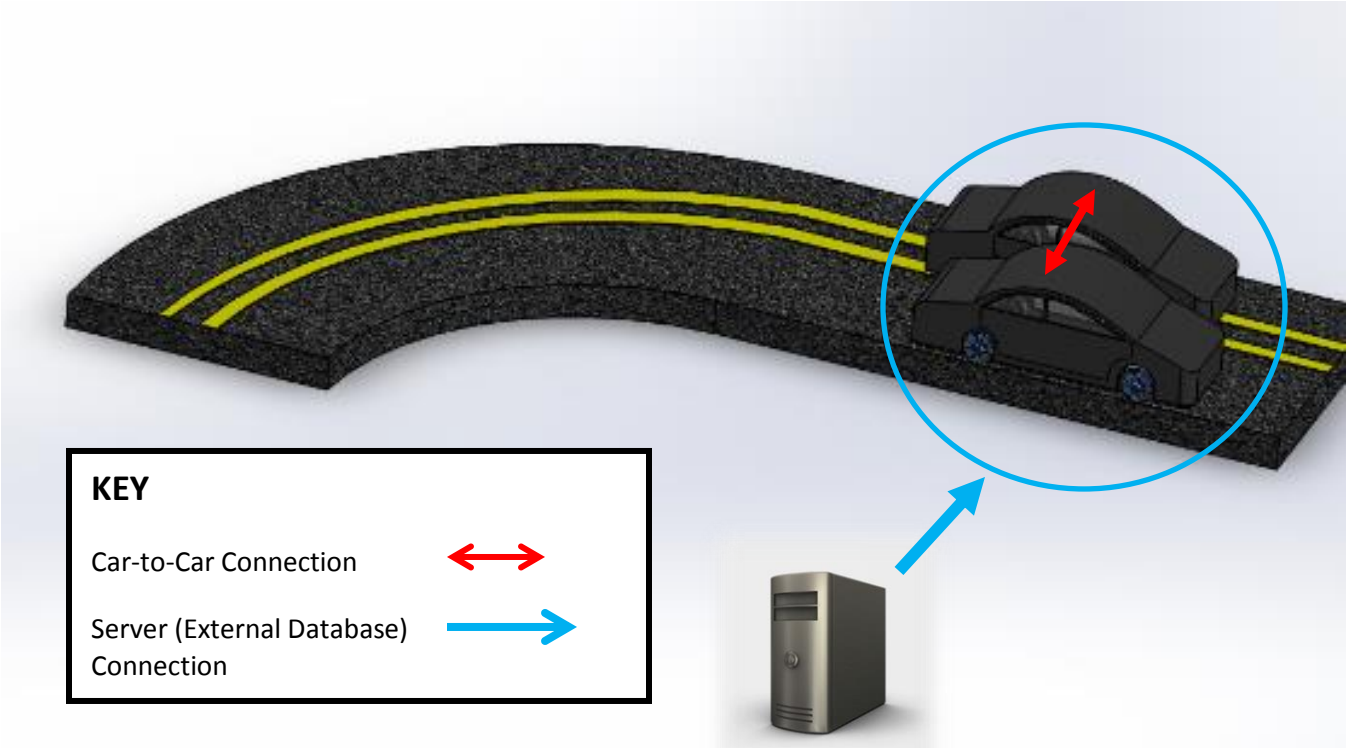
Annual average consumer Data plan Cost for Potential Phone-to-Phone Connection:

T-Mobile - $80

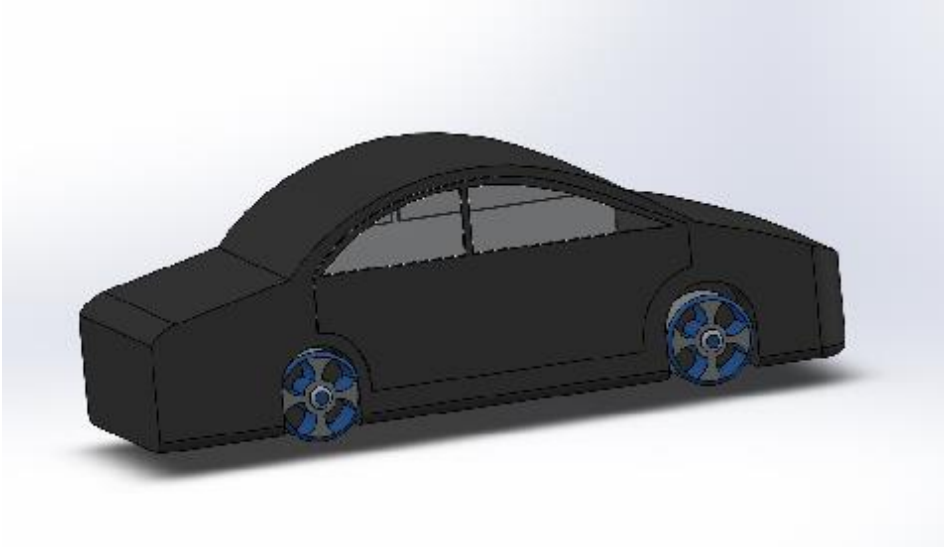
Verizon- $60

Final Concept Visualization

Our GPS car-to-car connection operates over a range of approximately thirty miles, delivering to the driver the instantaneous positions and speeds of other vehicles on the road. Additionally, important weather and road conditions data is streamed directly onto the dashboard display from an external database via the built-in 4G cellular connection.



- Each connected car knows the other vehicle's position and speed. Here a voice alert and visual display would signal to the driver that the other vehicle is drifting into his lane.



Our Connected Car Model

Design Analysis

The quality function deployment diagram below was used to analyze the most important aspects of our design and indicated how well we met our customer requirements.

	Technical Requirements					
Customer Requirements	**Utilizes Internet of Things**	**Electronically Secure**	**Limits Cognitive Overload**	**Functional Interface**	**Large Protocol Range**	**Effective Visual and Audio Systems**
Smart, Clean, Connected, Energy Efficient Vehicle	●	■				
Fully usable While Driving		●		■	●	■
Minimizes Driver Distraction			●			▲
Addresses driver productivity and Infotainment	■		▲	■		
Worth the Cost of Upgrade to a Connected Car		■		▲	■	●

●	Strong Dependence
■	Moderate Dependence
▲	Weak Dependence

Conclusion

After interpreting the customer needs into needs statements and matrixes our group came up with the concept of a mobile app that connects the driver to the cars around him. Using the concept of the Internet of Things, the cars will be able to communicate among one another as well as connect to a central database to obtain road and traffic conditions. The data is then relayed back to the driver in a way that minimizes driver distraction by combining a dashboard display with high-quality voiceover. Information such as traffic speeds and congested areas as well as special road conditions like construction will aid the driver in finding the quickest and safest route to the destination. The connected car will come installed with a GPS system, with the app included, along with an internet router and LED lights to alert the driver of serious road conditions. All of the customer needs were met when designing this product and our technology will be presented to the AT&T board for review.

Additional Materials

Below is one of our initial meeting agendas, providing a close look at how we conducted brainstorming and research. Summarizing our progress for each meeting helped keep our group organized as we compiled the final report.

EDSGN 100 Section 16

Team 6

Meeting 1: Saturday March 29th

Prerequisites:

Background Info – Bill

Tech Survey- Bill

Customer Complaints survey Michael

Sale Statistics Survey - Sean

Marketplace Research -Michael

Discussion

Time		Topic
1	4:30 – 4:35	Background Info
2	4:35- 4:40	Surveys
3	4:40-4:45	Marketplace Research
4	4:45-5:00	Review 1.) Analysis of Customer Needs
5	5:00-5:20	Begin 2.) Establish Target Specification

Project Items

Background Info- The term Smart car came from Mercedes Manufacturer Smart, defining the smart car as small, energy efficient, low maintenance cars. For the purpose of this project connected is a much more appropriate term. A major concern for connected cars is information security.
Tech Survey – Common technology found in connected cars usually includes applications such as siri integration, music apps, weather apps, parking cameras, or handless phone calling.
Other Surveys – Customer complaints Survey No data collected Sale Statistics No data collected
Research of Marketplace- Took a look at several concepts that are could be implemented in a connected car in the future, but are not yet implemented. Will inspect other connected car companies to see what is in production (ex: Tesla) Tuesday
Needs Statements- We translated the customer statements into customer needs and then into eleven distinct needs statements.

Summary

We discussed the group's initial research into connected cars and refined the customer statements into the corresponding customer needs. We also discussed preliminary design concepts each of which improves the connected car in differing ways. For Tuesday we are looking to have specific project ideas and discuss the merits of each, ending with a finalized project decision. This is different than our concept generation, as this will define the scope of our project, not the design.

For Wednesday we will have the Product Metrics and Matrix started and finished by the end of class, we will also develop a cost model and review the second section of the Project Plan.

Specific Project Ideas - Group Tuesday

Product Spec Metrics & Matrix - Wednesday

Benchmarking – Michael Tuesday

Develop a cost model- Wednesday

Review Saturday.

References

Customer Needs Analysis:

"Overview: Executive Summary." *2013 Report Card on America's Infrastructure*.

Cost Analysis:

"How much does it cost to develop an app?" *Fueled*.

Patent Research:

Google Patents: "Connected Cars." *Google.com.*

Internet of Things:

Fairhead, Harry. "Why The Internet of Things Has a Problem." *I Programmer*.

Connected Cars Overview:

"AT&T: The Connected Car: Making Cars Smarter and Safer."
http://www.att.com/Common/about_us/pdf/att_connected_car.pdf

"Connected Vehicle Research." *RITA: US Department of Transportation: Research and Innovation Technology Administration.*

Global Marketplace Research:

Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years. GSMA Connected Living Programme: *mAutomotive.*

Benchmarking:

"Model S." TESLA Motors, Inc.
http://www.teslamotors.com/models
"2014 Lexus LS."
http://www.lexus.com/models/LS/hybrid/