Report to the US Department of Transportation
Research and Innovative Technology Administration

A Survey of Existing Technologies, Applications, Products, and Services for Geofencing

California PATH Program
University of California at Berkeley

November 12, 2010

Table of Contents

Purpose

This document serves as a survey of the existing commercial technology, applications, products and services on the market that are related to "geofencing", which in this case is technology that reduces distracted driving caused by mobile-phone usage while driving. The geofencing products will be categorized and compared and their technologies will be evaluated in the context of the Networked Traveler Transit and Smart Parking Project.

Method and Findings

The primary method used to collect this information on driver distraction and geofencing involved a comprehensive search of the Internet. The Federal Communications Commission's (FCC) Distracted Driving Information Clearinghouse website (http://www.fcc.gov/cib/driving_clearinghouse.html) lists 15 different products that help with reducing the dangers of distracted driving. We also included other products and technologies that we found from our Internet search. We group various geofencing products by the technologies used and the distracted driving scenarios for which they are helpful.

Application scenarios are also compared to the needs of the existing Networked Traveler project. The technologies used by those products do not have the capability to differentiate driving from taking transit, based on a user's GPS trace data. Therefore, they would not satisfy the needs of the Networked Traveler project. Thus, it was necessary to develop our own geofencing function into the Networked Traveler application that can identify a user's travel mode (i.e., driving versus taking transit). Nonetheless, the technologies of the existing products can still be helpful to reduce distracted driving.

Background

Geofencing is a term that originally referred to a practice of limiting mobile employees to a specific geographic location by tracking their whereabouts via the technology of a GPS. Most initial geofencing applications involved server-based functions, including:

- Fleet management
- Child and elderly location awareness
- Asset (e.g., vehicle) tracking
- Vehicle security

The **Cell Phone Geofencing** concept has recently been developed and involves the use of a GPS signal together with data from an automobile indicating that the user of the phone is driving, and disables use of the phone under these conditions.

Under the **Networked Traveler (NT)** Project, though the 'geofencing' term has been borrowed, it is extended beyond its original and cell phone-related definitions. NT geofencing refers to a function that identifies the types of vehicles in which the cell phone is located (automobile or transit vehicle), and disables the NT applications (i.e., trip planning, next bus/train, and arrival notification) when the cell phone is detected to be likely in a moving automobile, while allowing the application to function when

the cell phone is recognized as being located in an identified and located transit vehicle, in a designated transit parking area, or in a building rather than in a non-transit vehicle moving along a roadway.

This report provides a summary of commercially available **cell phone geofencing** products and services and a brief description of the NT geofencing technology developed under the Networked Traveler Project.

Commercial Geofencing Products and Services

Location-based Geofencing Services

The location-based service (LBS) enables a user to receive notification about the location of a location-aware device when its owner enters or exits a geofenced area. This geofencing notification can be sent to a mobile telephone or an e-mail account. The following commercial products and services are available:

PlaceCast (www.placecast.net): PlaceCast uses geofencing to draw consumers to location-specific businesses. PlaceCast establishes a geofencing perimeter around the location of a business and whenever a consumer enters the geofenced area, he or she receives advertisements for that particular business via a device (smart phone). The cost of this service depends on the volume of advertisements sent to consumers.

ShopKick (www.shopkick.com): ShopKick is a smart phone application that gives users reward points and special offers when a user enters a store or business area. ShopKick uses a combination of GPS, WiFi, and sensors to detect users in a geofenced area.

Zentracker (www.zentracker.net): Zentracker uses Google Latitude to enable its clients to track a cell phone user using a combination of GPS, WiFi network, and cell ID positioning (cell tower triangulation). In order to track a cell phone user, the user must have Google Latitude software installed on his or her smart phone. In terms of geofencing, Zentracker can establish a perimeter in Google Latitude by mapping its GPS coordinates. When a user leaves the geofenced area, zentracker.net will notify its clients via twitter, e-mail, SMS, or Facebook. In addition, Zentracker allows its clients to track up to six smart phone users simultaneously.

GeoFencing Products that Use Cell Phone GPS Speed / Location

This category of geofencing products monitors GPS speeds and location in real-time and records dangerous behavior for later review; some can even send alerts to a server or a third party. The following commercial products and services are available:

CellSafety (WebSafety) (www.websafety.com/cell-safety): CellSafety is a software-only solution that provides parents the ability to monitor almost every aspect of their children's use of smart phones, including driving speed and location history. It also prevents the usage of a phone while it is detected to be moving faster than a certain speed by disabling phone calls and text messaging. The solution uses GPS and 3G communications to transfer real-time information from the child's phone to the main data center, and to forward it to the parent's smart phone via e-mail or text notification. CellSafety software is compatible with BlackBerrys, Android phones, and Nokia S60 phones.

DriveAssist (www.aegismobility.com): The DriveAssist mobile client runs in the background of a user's smart phone. It uses GPS and other sensors, along with algorithms based on movement of the mobile phone, to determine whether the user is driving. The service automatically activates when driving is detected and usage of the mobile phone is restricted except for emergency calls, enabling the driver to focus on the road. Once the service detects that the user has stopped driving, it automatically deactivates. The solution is designed with various optional features that can be customized based on the user's needs.

Guardian Angel MP (http://www.trinitynoble.com): This product is a phone-based application that locks the keys of a cell phone while a vehicle is traveling above a certain speed. Guardian Angel MP can tell the difference between the cell phone of a driver and the cell phone of a passenger (requires an external GPS receiver).

iZUP (www.illumesoftware.com): iZup is a mobile application developed by Illume Software that helps a driver avoid distractions caused by his or her mobile phone. When the application is turned on, iZUP utilizes GPS signals to detect when the phone is traveling faster than five miles per hour. It shuts off almost all functions of the phone at higher speeds except for emergency 911 calls. Even when the vehicle is stopped, the iZUP application allows only a few seconds for the user to make calls or text. It is available on both Android and BlackBerry platforms.

PhonEnforcer (http://turnoffthecellphone.com/): Automatically turns off the phone when the user is driving. Available as a software application for Windows Mobile phones, Android phones and Blackberry phones. PhonEnforcer uses GPS technology.

Teen Tracker (Apple Apps Store): Teen Tracker is an Apple iPhone application that tracks movement of teenagers through their phone. The application is installed in both the parents' and the teenager's phone. Though the marketed functions are geofencing-specific, products of this kind have the capability to trigger warnings based on preset geofenced areas (areas that drivers are not allowed to enter or leave).

TxtBlocker (www.txtblocker.com): TxtBlocker is very similar to iZUP in terms of functionality. The software is currently available only for the BlackBerry platform, but according to its website, they plan to be compatible with the iPhone, Palm Pre, and Android phones in the near future.

Geofencing Technologies that Use On-board Device to Prevent Distracted Driving

This category of geofencing products use external devices to detect cell phone use while driving and then disables the cell phone functions. The following commercial products and services are available:

CellControl (www.cellcontrol.com): CellControl is very similar to Key2SafeDriving, using software and hardware that disables smart phone use while driving via Bluetooth communications and software. The software works on most HTC, Motorola, Nokia, Pantech, BlackBerry, and Samsung smart phones.

Key2SafeDriving (www.key2safedriving.com): Key2SafeDriving uses both software and hardware solutions to disable the use of a smart phone while driving. Developed by the University of Utah, Key2SafeDriving has two parts: (1) a device that is plugged into a car's on-board diagnostic system, and (2) software that is installed on the cell phone. When the car is turned on, the device automatically disables the smart phone via Bluetooth communications. Key2SafeDriving does not use GPS. The user is limited to making only emergency calls. The software supports a limited number of major brand smart phones, including BlackBerry, HTC, Nokia, and Samsung. A list of supported smart phones can be found at http://www.key2safedriving.com/phonelist.html.

OCK (Try Safe First Inc.): The OCK is a unique two-part automotive and cell phone safety device designed to eliminate cell phone driver distraction. The device includes a downloadable cell phone application along with two sensors installed in the car. Whenever the car is started and in gear, a signal is sent to the cell phone to disable either texting or e-mailing, or all functions of the phone.

Signal Safe (http://www.nodriverdistraction.com/Home_Page.php): For this product, a device is installed in the car to issue a visual warning to the driver whenever there are phone calls or text messages from the cell phone of the driver (on the driver seat). There is no embedded software in the cell phone.

SimpleTrack (http://www.drivertelematics.com/pages/profile.html): For this product, a device is mounted in the diagnostic port under the dashboard. This system monitors risky driving habits, such as speeding, hard braking, and acceleration, and the data is transmitted in real-time to the safety data center. Instant alerts are also sent out to parents via text or e-mail when the device is triggered by risky driving or if the vehicle is leaving a predefined geofenced area.

ZoomSafer (www.zoomsafer.com): Zoomsafer has a solution similar to the iZUP application, using GPS signals and speed. It includes Bluetooth technology to pair a user's cell phone with the car so the application will be automatically turned on when car ignition is on. It also includes enhanced features such as hands-free restriction (Bluetooth use only), e-mail or text message forwarding options, and voice recognition and voice reading of e-mails and text. Zoomsafer has multiple products that meet different needs for commercial enterprises, families, and individuals. The software runs only on BlackBerry smart phones.

Table 1 summarizes these geofencing commercial products and services based on their technological components.

Summary of Geofencing Products and Services by Technological Components

Table 1 ***Summary of Geofencing Products and Services***

Technological Component(s)	Product/Service	Type of Service	Type of solution	SmartPhone Compatibility	Cost
Location-based Geofencing (GPS, WiFi, and Cell ID positioning)	PlaceCast	Commercial advertising geofencing	Software	Any	based on advertisement volume
	ShopKick	GeoFencing/Consumer Reward	Software	Iphone	free
	Zentracker	Geofencing/GPS tracking	Google Latitude (Software)	Any	free
Geofencing based on Cell phone GPS speed and Location	Cell Safety	Teenage / Fleet Monitoring Driving Distraction Prevention	Software	Blackberries, Android, Nokia S60 phones-	
	DriveAssist	Driving Distraction Prevention	Software (GPS and other sensors to detect speed)	Blackberry	N/A
	iZUP	Driving Distraction Prevention	Software (using GPS Speed)	android and blackberry	$5/month
	PhonEnforce	Driving Distraction Prevention	Software	Blackberries, Android, Windows	
	Teentracker	Teenage Monitoring	Software	Iphone	$4.99
	TxtBlocker	Driving Distraction Prevention	Software (using GPS Speed)	Blackerry, Iphone, Android, Palm Pre	$9.99/month +$24.99 activation fee
Geofencing technologies that use on-board device to prevent distracted driving	CellControl	Driving Distraction Prevention	Software and Hardware (use in-vehicle Bluetooth device to disable phone usage)	HTC, Motorola, Nokia, Pantech, Blackberry, and Samsung	24.95 for phone activation, $89.95 for device, and $107.40 for one year subscription
	Key2SafeDriving	Driving Distraction Prevention	Software and Hardware (Can use in-vehicle Bluetooth device to disable phone usage)	Blackberry, HTC, Nokia and Samsung	$99.95 for device and software
	OCK	Driving distraction prevention	Software + hardware in car (sensors installed in the car to detect car ignition, and disable phone usage)		

	Signal Safe	Driving distraction prevention	Hardware (device installed in the car to issue visual warning)	Compatible with all phones	
	SimpleTrack	Monitoring risky driving + distracted driving prevention	Hardware installed in the car		
	ZoomSafer	Driving Distraction Prevention	Software (using GPS signal and speed) and Bluetooth device in the car	Blackberry	depend on type of product (private or commercial use)

Geofencing and the Networked Traveler Project

Geofencing Requirements of the Networked Traveler Project

Under the Networked Traveler Project, the NT geofencing addresses the following traveler/cell phone use scenarios:

(1) **Disabling the NT application when the user is driving –** Under this scenario, the application will be disabled to ensure safety.
(2) **Enabling the application when the user is riding transit –** Under this scenario, the application will be allowed to be used.

Review of Existing Products for Networked Traveler Geofencing

The commercially available cell phone geofencing products reviewed in this document that are based on GPS speed, geo-locations or extra hardware devices are able to disable the usage of the phone while driving.

When applying the geofencing products for the NT project, however, the products that use the GPS speed for driver distraction prevention will NOT work because they will be falsely triggered when used on a transit vehicle, which are times when the application should not be disabled. Therefore, the existing geofencing technologies based on detecting GPS speed or locations (either software only or software and hardware solutions) will not fit into the NT project's needs.

However, the products that use an additional in-vehicle device for distracted driving prevention can conditionally solve the problem for cars that have the device installed. The requirement of installing an extra device is more costly, and therefore is a less desirable solution for the geofencing needs of the project. For the NT project, we developed a geofencing function as part of the mobile software so that the use of the application can be disabled whenever the user is detected to be driving based on the GPS tracks and itineraries.

Geofencing Developed for Networked Traveler Project

The NT application uses the different movement characteristics for transit users/vehicles compared with that of private automobiles to differentiate the two travel modes (c.f. Figure 1). This is different from existing geofencing commercial solutions in the following ways:

(1) NT geofencing does not aim to provide a "driving detection" function for the phone; rather, when the NT application is activated, NT geofencing disables the application if the user is detected to be in a moving vehicle, other than a recognized transit vehicle. NT geofencing does not block phone calls or texting.
(2) When a trip has been submitted to the NT server, NT geofencing differentiates driving an automobile versus riding on a transit vehicle, and allows the use of the application on a transit vehicle to deliver real-time passenger information updates. Since this geofencing function is part of the Networked Traveler system and has access to the user's trip itinerary data, it is able to identify the mode of the user, while general purpose geofencing software is not able to do so.

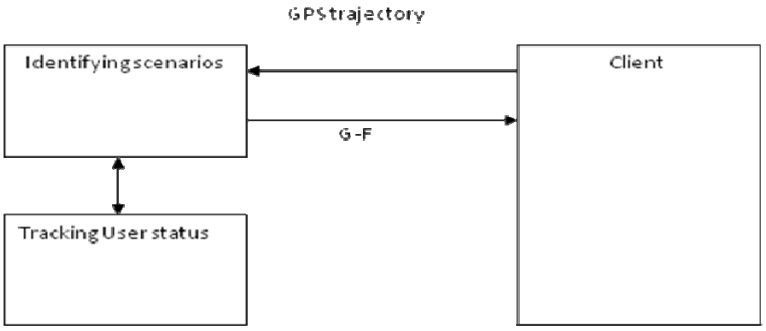

Figure 1 NT geofencing functional flow

Conclusions

This document presents a review of various existing geofencing products and services that are marketed on the web, and provides a brief overview of the geofencing function developed for the Networked Traveler Project.

Most of the geofencing products and services are developed for driver-oriented applications. The technologies behind these products are similar: they use a combination of geo-location, speed and/or Bluetooth communication devices to detect where the user is, whether the user is driving or not, and then take action based on that detection to block usage of the phone (either partially or fully) and in some cases, alert the user or parents.

It is noted that simple geofencing concepts (i.e., methods based on location and/or vehicle speed alone) are unsuitable for the Networked Traveler Project, which seeks to provide traveler information when used on transit vehicles, but does not allow use while driving. Therefore, when only a software solution is applied, none of the above listed commercial products fit the needs of Networked Traveler, since these technologies can only detect whether or not the phone is in motion, but not the mode (driving versus riding on transit). With only the GPS location and speed, reliable mode detection is very difficult. Knowing the real-time GPS information from all buses and trains, with the aid of user itinerary information, can help make the mode detection much more reliable. Therefore, the geofencing module needs to be an integrated part of the NT system such that GPS location for travelers and transit vehicles can be linked. This is the method currently employed in the Networked Traveler Project.

If additional hardware in the vehicle could be used to disable phone usage via Bluetooth communications or other devices that are connected in the car, then some commercially available geofencing technologies, such as those used by Key2SafeDriving and CellControl, would support NT geofencing.