Telematics in US Auto Insurance

Telematics has been a common area of interest for technology innovators and auto manufacturers for a long time. In recent times it has found quite a bit of interest among auto insurers as well. Though the adoption has been high among European insurers, the trend is yet to be very popular among US insurers. In US, many still correlate telematics for insurance with 'pay as you drive' only. This paper draws on various research trends and also information gathered from discussions with TCS' insurance customers to present some additional interesting use cases for telematics in insurance. A quick overview of what TCS is doing in its innovation labs to develop offerings that can help insurers in fast-track adoption of telematics is provided. Finally, the paper presents by a detailed discussion on a telematics iPhone app prototype developed in the Insurance Innovation Lab of TCS.
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Introduction

Wikipedia defines telematics and its application as “The integrated use of telecommunications and informatics, for application in vehicles and with control of vehicles on the move". Vehicle telematics can be referred to as a combination of IT, instrumentation and advanced communication technologies aligned to assist efficient management of remote vehicles and drivers. The auto manufacturing industry has been leading the adoption of telematics with primary focus on improving consumer experience. Another early adopter is the fleet management companies (such as those managing fleets of taxis and/or trucks), who have been applying telematics technology for vehicle tracking and routing.

In recent times emergence of advanced telematics systems have also helped in improving driver and vehicle safety. Accident detection and crash notification systems has emerged as an effective approach for reducing traffic fatalities, by reducing the time between when an accident occurs and when emergency assistance personnel are dispatched to the scene of the accident. The “On-Star” system introduced by General Motors in their vehicles is a classic example of this.

Advanced telematics systems also help in collision avoidance and detection, driver monitoring, saving fuel by use of adaptive cruise control. Luxury car manufacturers such as BMW, Mercedes (and many others) have made these available as standard features in their vehicles using telematics technology.

Adoption among insurers

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Today most auto insurance companies use vehicle information such as make, model, year, garaging location etc and driver information such as age, sex, credit score, accident history etc. Some of the European insurers such as Norwich Union, AXA and Allianz have started adopting telematics to obtain driving behavior and usage information for inclusion in rating to improve underwriting processes. Some other countries across the globe such as South Africa (Hollard Insurance, MiWay), Japan (AIOI Insurance) and Australia (Real Insurance) have also witnessed adoption of telematics in auto insurance.

These early adopters tend to use telematics hardware devices which are either stand alone or can be connected to car’s OnBoard Diagnostic ports. The devices which can be attached to car’s telematics systems provide more information for insurance services. Majority of the carriers leverage telematics for operationalizing Pay as You Drive (PAYD) insurance concept where insurance costs may depend not just on how much the insured drives, but how, where and when the insured vehicle is driven.
Potential for Telematics

Pay as You Drive (PAYD) is only the tip of the ice berg. A recent analyst survey indicates that the total North American market for commercial vehicle telematics alone is expected to grow to $6.7 Billion by 2012.

Another survey conducted by LexisNexis Risk Solutions indicates that 75% of auto insurance policy holders in US would welcome any telematics based auto insurance plans if it helps reduce their premium.

Some additional use cases for telematics for auto insurers include:

- **Emergency Services:** In case of an emergency (such as an accident) information from telematics device can be used to trigger emergency services for the insured. This can help in avoiding fatalities, connect with preferred emergency services (such as tow trucks, replacement rental car, etc) thereby also reducing associated claims costs.

- **Vehicle Maintenance Alerts:** Diagnostic information from the vehicle can be used to provide alerts to driver/insured to make preventive maintenance that can help in accident avoidance and/or costlier claims.

- **Product Innovation:** Insurers can also look at offering telematics based risk profiling for appropriate product offering and pricing for insured based on his/her driving profile. Driver profiling can actually be done by applying analytics on various data points from telematics devices instead of any single data point. For example, while insurers do acknowledge that speeding is an indicator of a risky driver, but from an underwriting viewpoint an insured driving at maximum speed limit in an undeveloped road condition is a bigger risk than someone driving at 5 miles/hr over the maximum speed limit on a freeway. Products can be defined to provide appropriate incentives based on multi-factor risk analysis.

- **Vehicle Tracking Services:** This can be a very effective service enabled by insurers for two scenarios that can impact underwriting process and claims costs:
  - Better risk management for fleet insurance
  - Tracking of stolen vehicles

Device variants

**OEM Devices from Auto Manufacturers**

Many of the car manufacturers have come up with telematics system in their vehicles. The notable ones include OnStar (GM cars), Ford SYNC, Safety Connect (Toyota), Command APS (Mercedes-Benz), BMW Assist, Lexus Link.

OnStar provides in-vehicle safety, hands-free calling, turn-by-turn navigations, remote diagnostics and accident detection. Additionally, OnStar notifies emergency responders by utilizing built-in cellular radios. It detects accident by means of in-vehicle sensors, such as accelerometers and airbag deployment monitors. Similar services are offered by other players in market as well.

There are other players in the market who offer solutions for collision avoidance, most of which are GPS based. This includes Hughes Telematics’ Network fleet, Speedshield’s SSV4 ISA, Cyclops Driver Safety system, StreetEagle Safety system. In Japan, Advanced Safety Vehicles (ASV) have vehicle-to-vehicle (V2V)
communication feature to avoid collision. The prototype vehicles using V2V were launched by Honda, Toyota and Nissan.

Most of the telematics systems are subscription-based wherein the subscriber will have to pay approximately $250 for the services which they offer.

**External OBD Models**

In addition to telematics systems by vehicle manufacturers, some players including insurance companies have come up with external devices which can interface with the OnBoard Diagnostic systems.

A car insurance program developed by Progressive Insurance in the US uses an on-board telematic device that transmits driving data to the insurance company. The device connects to a car’s OnBoard Diagnostic (OBD-II) port (all automobiles built after 1996 have an OBD-II) and transmits speed, time of day and number of miles the car is driven. There is no GPS in the Snapshot device, so no location information is collected. Cars that are driven less often, in less risky ways and at less risky times of day can receive large discounts.

Insurethebox, another insurance solution offering adopted by some UK insurers, uses a telematics device known as a Clear Box (slightly bigger than a mobile phone) that is fitted to the insured car. The Clear Box enables the insurer to measure how well and how far the car is driven. Younger drivers who drive well and lower than average mileage drivers can expect significant savings to their car insurance.

The devices which are not capable of interfacing with vehicle’s telematics system can offer only minimal information like speed, location and time of travel.

**Smartphones**

In addition to providing in-vehicular telematics, some of the car manufacturers have come up with smartphone based applications (mainly on iOS and Android) for improving customer experience.

For instance, OnStar and General Motors have released a trio of apps that enable owners of select models to control and monitor cars from their smartphone. Functions include the ability to monitor gas levels, tire pressure, check-engine-lights, find dealers, set parking reminder (with remaining meter time), access to the car’s owner manual, locking and unlocking of the car, as well as engine start.

Likewise, Mercedes and Toyota too have come up with smartphone interface for their telematics system. Ford plans to open their Ford SYNC API to developers, possibly leading to the release of a Sync app store as well as vehicle control of third party mobile apps.

The telematics apps released by car manufactures have tight integration with the telematics system installed in their cars, by means of Bluetooth, internet or OBD port interface.

In addition, there are additional apps for iPhone and Android platforms like Dynolicious, G-tac which helps in measuring vehicle performance like speed, horse power (by means of acceleration) etc. These apps are standalone and do not have any interface with vehicle’s telematics system.
From TCS Innovation Labs
TCS has dedicated efforts focused on Embedded Systems and Telematics offerings for automotive industry as part of Innovation Labs. Some of the key offerings developed as part of these initiatives include (but not limited to) are:

- PAYD tracking and reporting Unit
- “Nirdeshak” – A vehicle tracking solution
- Vehicle Diagnostic Unit
- Diagnostic Data Recorder
- Handheld Diagnostic Units

(The details of these offerings are not covered in scope of this white paper. Please connect with the Embedded Systems team in TCS Innovation Lab for additional reading material and information on all these existing offerings.)

TCS Telematics iPhone App
The current trend in market to use data from conventional vehicular telematics based sensor systems for calculating the premium and accident detection. However, many cars in the US do not have sophisticated telematics system. A key impediment to using these systems is that they are infeasible or prohibitively expensive to install in existing vehicles and add to the initial cost of vehicle.

The data which is exposed by telematics devices that doesn't have interface with vehicle's onboard unit can alternately be captured using smartphones such as iPhone and Google Android based phones. Thus the large and growing base of smartphone users presents a significant opportunity to extend the reach of insurance telematics based systems. Smartphones travel with their owners, and can offer the telematics based insurance services, whether or not vehicle is equipped with sophisticated telematics system.

This paper describes an approach for using smartphones to offer insurance services similar to that enabled by vehicle telematics system. A telematics smartphone application can convert the phone to a data recorder, accident detection system and automatic emergency notification mechanism. The ability to use smartphone as a viable telematics device has become possible with the advancement in processing power and sensors deployed in the newer generation of smartphones. For example, the iPhone4 (which is the latest version of iPhone, at the time of writing this paper), includes a GPS system for determining the geographic position of the phone, an accelerometer for measuring forces applied to the phone, a three (3) axis gyroscope for detecting phone's orientation, a magnetometer which shows direction precisely. Additionally, smartphones now possess significant data processing power that can support real-time execution of sensor data noise filtering and analysis algorithms.

The main challenge in using smartphone as a viable telematics device for auto insurance is to filter false positives, due to the fact that phones can get dropped and are not directly connected to the vehicle.

This paper shows the approach adopted by TCS innovation labs in the creation of an iPhone based Telematics system for auto insurance by lowering false positives by adding contextual information.
Challenges
Following are some of the challenges associated with using iPhone app as a telematics system for auto-insurance:

In-Vehicle Presence identification
Detecting whether the user is travelling in a vehicle without using Electronic Control Unit Interaction is a key challenge. Conventional vehicular telematics systems rely on data from car’s electronic control units to detect the movement, speed and direction of the car. The standalone insurance telematics devices which are not interfaced with vehicular systems rely on GPS data to determine the speed, location and direction. Smartphone based system too must provide similar information.

Many of the luxury cars provide provision to connect to OnBoard diagnostics and reporting systems by means of OnBoard Diagnostic (OBD-II) ports or via Bluetooth. However, it is unrealistic and undesirable to expect drivers to connect their smartphones to these devices every time they get into the car. Moreover, a smartphone based applications which require interface with OBD will be useless in cars that lacked one.

Even though, a GPS based smartphone application can provide information on vehicle location, speed and time at which the user travels, it becomes inoperable in case the user doesn’t run the application while driving.

Activation at Driving
Continually monitoring the user when the insured is actually the vehicle is another challenge. A phone based telematics system will not be useful unless it comes to active/running state when the user is driving. With the emergence of iOS 4 for iPhone, it is now feasible to run location based applications in background which can monitor the speed, location and direction in which the user (carrying the phone) travels. By calculating the speed at which the phone is travelling, the phone can determine whether the user is travelling in a vehicle. However, GPS based application which continuously polls for location updates will drain the battery of the phone. Additionally, it’s not efficient to poll location updates when the user is not really travelling.

Detecting Accidents
Vehicle’s telematics systems detect accidents by relying on sensor networks throughout the car. These sensors can detect acceleration/deceleration, airbag deployment and communicate with emergency response units. A smartphone based telematics system too needs to sense crash or an accident and communicate with emergency units. If the smartphone is not connected to the OBD port, it has to rely on alternate ways (such as sudden change in acceleration) for detecting such accident scenarios.

Preventing False Alarms
The vehicle telematics system senses high acceleration/deceleration due to large forces acting on vehicle over a short period of time. Since the onboard systems analysis data from a wide range of sensor (such as airbag deployment monitors), the alarms (to emergency units) will be seldom incorrect. Since smartphones are portable, however, it is possible that phone may experience acceleration events that were not experienced by the user. For instance, the same effect as a vehicle accident can result from the phone being accidently dropped from a height.
Solution Approach
This section describes an iPhone-based telematics app prototype which is being developed by Insurance Innovation lab. The solution focuses on three key strategies for applying telematics for auto-insurance:

- Usage Based Insurance
- Accident Prevention
- Accident Detection and Emergency Services

Enabling Usage Based Insurance Model
Usage based insurance differs from traditional insurance, wherein “safe drivers” are rewarded by giving them lower premiums.

Apple’s iOS 4 supports background processing for location based applications. The telematics solution will reside in the background even if user closes the app by pressing the home button. The app will not perform any computation in the background unless triggered by the scenario mentioned below.

iOS 4 provides notifications based on “significant location changes”. These notifications are issued only when there is significant change in the location coupled with cell tower signal changes. The telematics app will be pushed to background running state in case it receives significant location change notification. The significant location change notifications are “accurate to 500 meters”, which keeps the app in sleep state for foot traffic. This will prevent the app from draining the battery by running in background when the user is not travelling in vehicle.

Below graph has been plotted based on a study (by a group of freelancers) using 8 devices in three locales which depicts the frequency of “significant location” trigger from iOS with change in distance. The study has been conducted in Melbourne (Australia), Tokyo (Japan) and Chicago (United States):

Figure 1. Distance Vs Significant Location Trigger.
After travelling 2,500 meters (1.55 miles), there is a 95% probability that iPhone will generate a significant location update event. Often times, movement of 250 to 500 meters are enough to trigger the app.

When the app comes to background (running) state, the location information is validated by the application. If the location is a road or a lane, then the app turns on the GPS of the phone and calculates the speed at which the phone is travelling. If the speed is greater than 15 miles/ hour, the application confirms that the user is on a vehicle.

Even though application can confirm that the user is travelling on a vehicle based on contextual information, there is a possibility that the user is not the driver. In order to negate this possibility, the application (which is currently running in the background) issues a local push notification to the user indicating that the app started recording driving patterns. The notification will have the option to cancel the background monitoring. A person who is not driving is more likely to cancel the monitoring activity, failing which app continues to record the driving patterns.

The iphone app will now compare the user’s speed with the speed limit of the road. The 511 data traffic feed (from Metropolitan Transport Commission of US government) provides current speed limits of all the navigable routes within the US. Since the data feed is in a legacy format, a server side component is required which can transform the feed to iphone recognizable message format. The server side of the app resides on cloud and when the iphone app requests for speed limit information of current latitude and longitude, it communicates with 511 traffic data feed and provides the response in JSON format (JavaScript Object Notation), which iPhone app can parse in a swift manner.

The app validates the information and computes whether the user travels within the speed limits. A tolerance of 10 mph is provided.

The app calculates the DriveSafe points/credits based on this information. For every 50 miles travelled within range of +/−10 mph of speed limit, the user will be credited 1 DriveSafe point.
Violation of speed limits will earn negative points. The user will lose three (3) DriveSafe points in case he/she makes 10 mph violation above tolerance level. The deduction will double with every increase of 10 mph above tolerance level. These settings will be configurable by the insurer. The insurance companies can define algorithms based on DriveSafe points for dynamic calculation of premium.

The user’s location or speed information will not be communicated to the server. Only the DriveSafe points will be updated in the server database. The privacy of the user is well within the limits of the personal phone.

In case the user is commuting at undesirable time of the day, he/she will receive only half the DriveSafe points on adherence to the speed limits. For any violation, he/she will lose double the points which they would have lost during normal timings.

In case, the phone is unable to connect to data network, the app will use the freeway speed limit of the particular state as the maximum speed limit. This data will reside in phone’s database and will be synced with the server in case of any updates.

The user can also check the details of history of his/her violations using the application (after launching it to foreground).

Due to the low price and availability of portable car chargers for iPhone in market, most of the users might keep the phone in charging mode while driving the vehicle. The application need not run in restrictive mode, when the phone is being charged, since there are no battery charge constraints. If the phone is being charged while travelling, the app issues a local push notification requesting permission from the user to switch to foreground/active state. If the user agrees, the app will switch from “significant location monitoring” mode to “GPS mode” wherein the location updates will be very frequent and precise. The speed calculated too will be precise in such a scenario.

In addition to this, user can manually turn to “GPS mode” from application “Settings”, which lets the app to use “GPS” even if it’s running in background state. However, this mode is not recommended since it can drain out battery (when the phone is not being charged).

**Accident Prevention**
The app also helps in accident prevention by providing alerts to the user beforehand regarding inclement weather conditions and incidents in the route.

Whenever the app receives significant location change notification, it connects to Online Traffic Data API to get information on traffic/weather/incident information for the particular ZIP code. Online Traffic Data feed provides severity associated with each alert. Severity values range from 1 to 5 (ascending order). In case of more severe alerts (greater than or equal to severity level 4), the app provides local push notification to the user. For instance, user will receive alerts when un-drivable conditions prevail on the road due to weather conditions like heavy snow or ice. These can help the driver avoid potential scenarios that are likely to increase the risk of an accident.
Online traffic data API was chosen over 511 data feed for weather/incident alerts in order to improve the performance. Online API offers JSON output, and hence no transformation is required in between.

In case the app issues an alert to the user regarding severe events on the route, the app marks the latitude and longitude for which the alert has been issued as un-drivable. If the user still drives through the marked location, the app reduces 2 DriveSafe points from user's credit. This can then provide additional inputs to refine the usage based insurance models deployed by the insurer.

**Accident Detection and Emergency Services**

The accident detection model is made possible with the data from the sensors available in iPhone like accelerometer, gyroscope etc, coupled with the extent of contextual information which the phone can provide. The app senses whether the user is travelling in vehicle by means of the algorithm mentioned in section 6.2.1.

The primary sensor which is being used for accident detection is the accelerometer in iPhone, which records the forces acting on the device in terms of G-forces. The android version of the app can have this feature too work in the background (though its processor intensive and can drain battery). The iPhone version will support only foreground execution (as of now). The latest version of iOS (which is iOS 4.2.1, at the time of writing this paper) doesn't support the use of accelerometer in background (but it is expected in future version of the iOS).

The accident detection scenario is triggered when the iPhone is travelling above a threshold speed associated with being inside a car. In this situation, an accident is detected if the iPhone experiences a violent acceleration event indicating a probable collision.

The threshold G-force (from accelerometer) which will be set as the trigger is derived from different experiments based on sampling the readings from accelerometer. The gyroscope readings too will be validated in such a scenario to analyze whether phone experienced a free fall (in order to filter such a scenario). The mathematical equation for forces acting on different axis of accelerometer and gyroscope constitute collision detection algorithm. The algorithm negates the forces acting on the device in normal conditions which are again derived based on experiments. In case gyroscope is not available in the device (only iPhone4 version has got gyroscope), the algorithm makes use of accelerometer data alone. The collision detection algorithm will eliminate scenarios of accidental falls or non-emergency braking. Additionally, the acceleration experienced by a smartphone when dropped would be substantially less than a car accident.

Once the app receives a trigger, it checks for the current speed of the vehicle and speed before 30 seconds. It validates whether the phone experienced a sudden deceleration. If the deceleration is substantial (a threshold change of 30 mph in 3 seconds), the app cross checks the speed limit of the current location based on 511 data (as mentioned in section 6.2.1). If the speed of the car is much less than the speed limit (25 mph less than speed limit), then the app retrieves traffic information for the location coordinates corresponding to the current location. If no traffic incident/ construction is reported in the current location, the app initiates notification process. If any of the above validations evaluates to false, the notification process will not be initiated.
The first step of the notification process is showing an alert to the user indicating that the app detected a collision and two options will be provided for the user: one for initiating 911 call and other to cancel the process. The alert will be displayed with a countdown of 30 seconds. If the user doesn't cancel the alert within 30 seconds, the app tries to send emergency notification to the cloud server with all the required information like the location, travel speed, impact of collision (based on collision detection algorithm). The cloud server takes care of dispatching the notifications to concerned parties which includes emergency response units (for example insurance company, towing agency, rental car etc) or other parties (for example friends/family which is configurable by the insured in the app). In case data network is not available, the app automatically calls 911.

Integrating with Telematics Devices
The app can also be integrated with external Telematics Devices hooked onto the vehicles OBD port. This can be either through a Bluetooth based interface or standard USB interface. This can port of vehicle specific information to enable value added services such as:
- Provide insured with information such as vehicle’s gas or air pressure in tires for trip planning before he/she actually boards the vehicle
- Provide maintenance alerts to the insured based on vehicle diagnostic information

Conclusion
Insurers can leverage existing and emerging telematics technologies to innovate in both underwriting processes and provide value added services for their customers. Such services can also help in prevent or help in extending assistance in accident scenarios to the insured thereby reducing claim costs. TCS is constantly investing in developing/prototyping innovative solutions to accelerate the adoption of telematics by insurers as a strategic partner.

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