Using Smartphones to Detect Car Accidents and Provide Situational Awareness to First Responders

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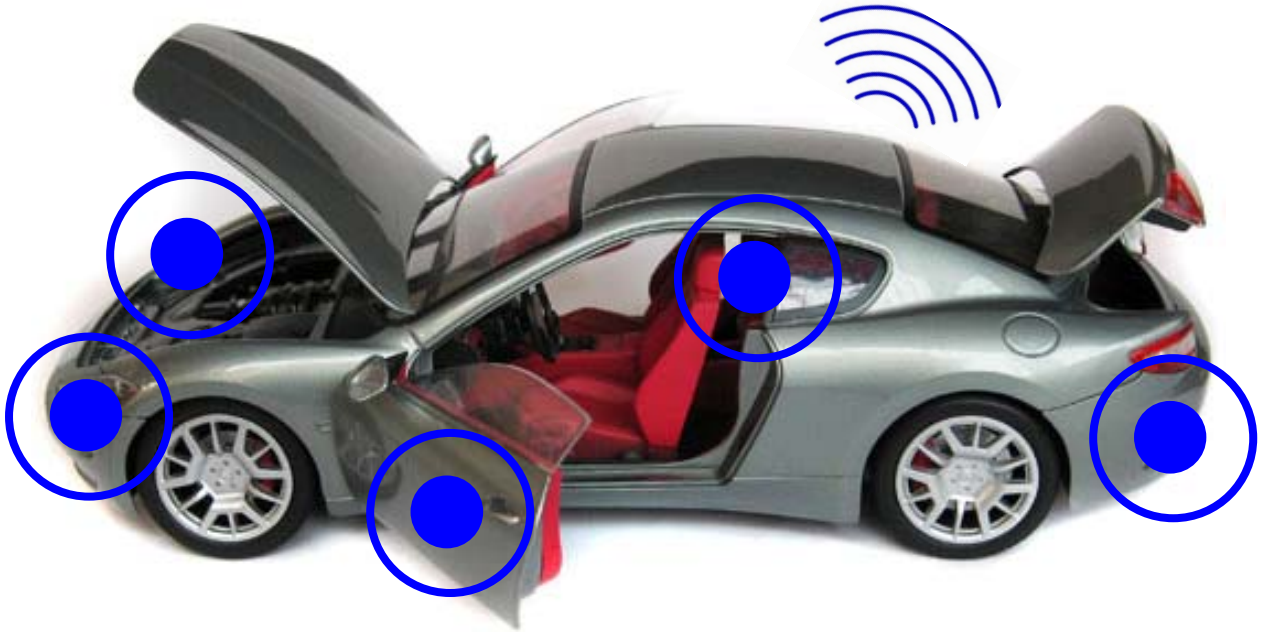
Automatic Crash Notification Systems



- Car accidents are a leading cause of fatalities
- Automatic crash notification systems (ACN) save lives by reducing the time required for emergency responders to arrive
- ACN systems use a network of sensors in a vehicle to detect car accidents and communicate with a monitoring station via a cellular radio

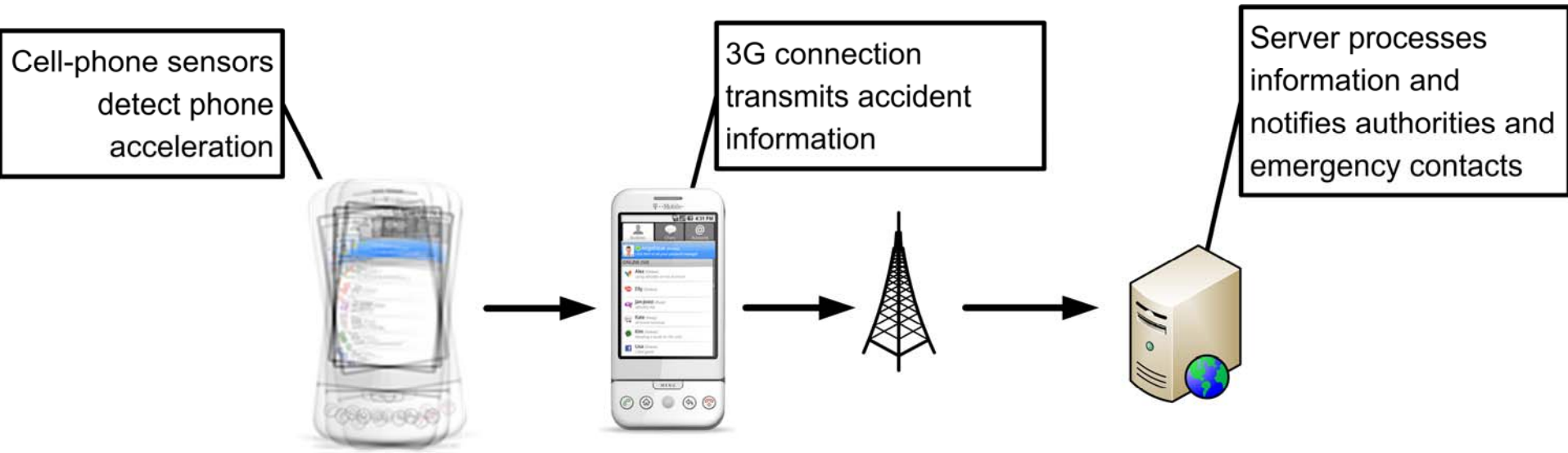
Problem: Conventional ACN systems are expensive and lack portability

- ACN systems, such as OnStar are built into the vehicle and are limited to specific types of vehicles
- Lack of portability limits the usefulness to owners and constrains increase in safety to the vehicle in which ACN is installed

Smartphones as sensor nodes

- Modern smartphones possess a wealth of sensors that enable the device to detect in which they are being used, such as accelerometers, GPS, compasses, etc.
- Smartphones maintain a persistent internet connection allowing them to instantly and continuously upload data

Solution Overview



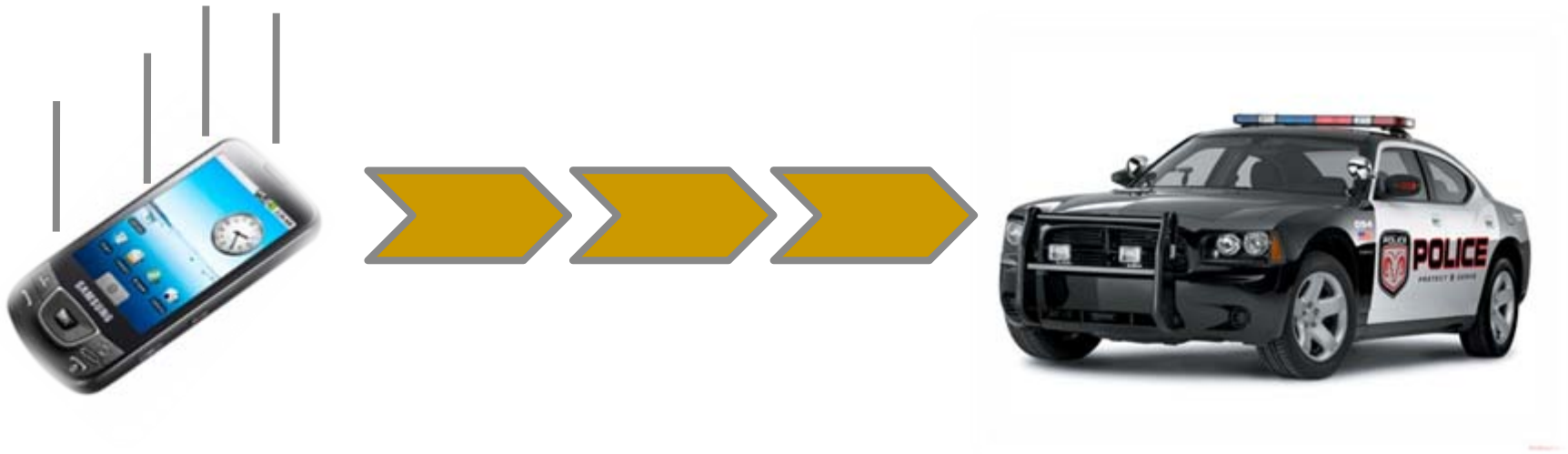
- Goal: Utilize smartphones to detect car accidents to create a portable and vehicle independent ACN system
- Device sensors provide context information to detect car accidents while eliminating false positives
- Smartphone travels with owner, providing always-on protection

Challenges with Developing Smartphone-Based ACN System

Challenge 1: Detecting car accident without electronic control unit (ECU) interaction is hard

- Built-in ACN systems access data directly from the ECU
  - Sensors can detect airbag deployment, acceleration/deceleration, vehicular rollover and other events.
- Smartphone-based systems must provide similar functionality without a direct connection to the vehicle.

Challenges with Developing Smartphone-Based ACN System



Challenge 2: Preventing false positives is hard

•Smartphones can be dropped, etc.

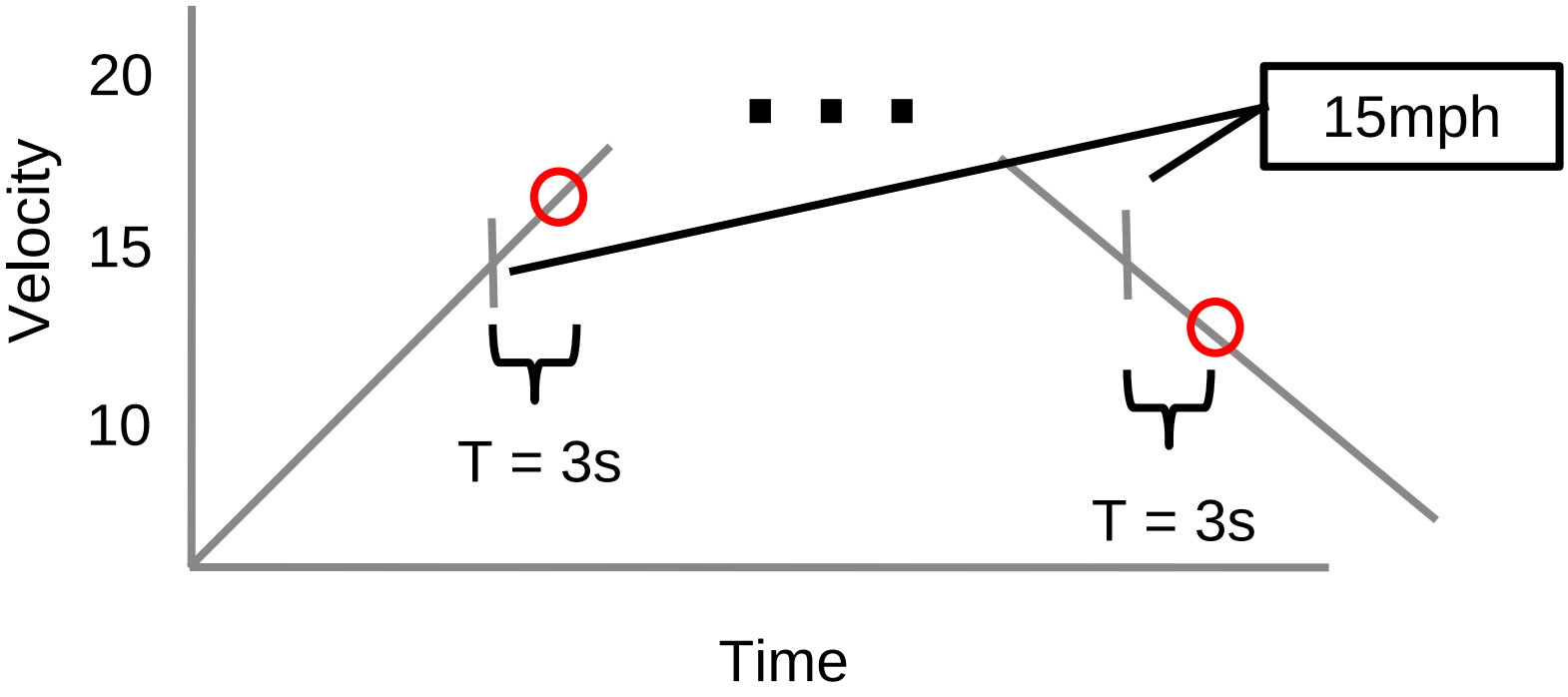
- In-vehicle systems can assume instances of high acceleration are collisions

•False positives could reduce the usability of a smartphone-based ACN by overwhelming emergency responders

Solution Approach: Utilizing Context to Prevent False Positives

- Application only enables monitoring when plugged in
- Device monitors speed to determine whether smartphone is in a vehicle

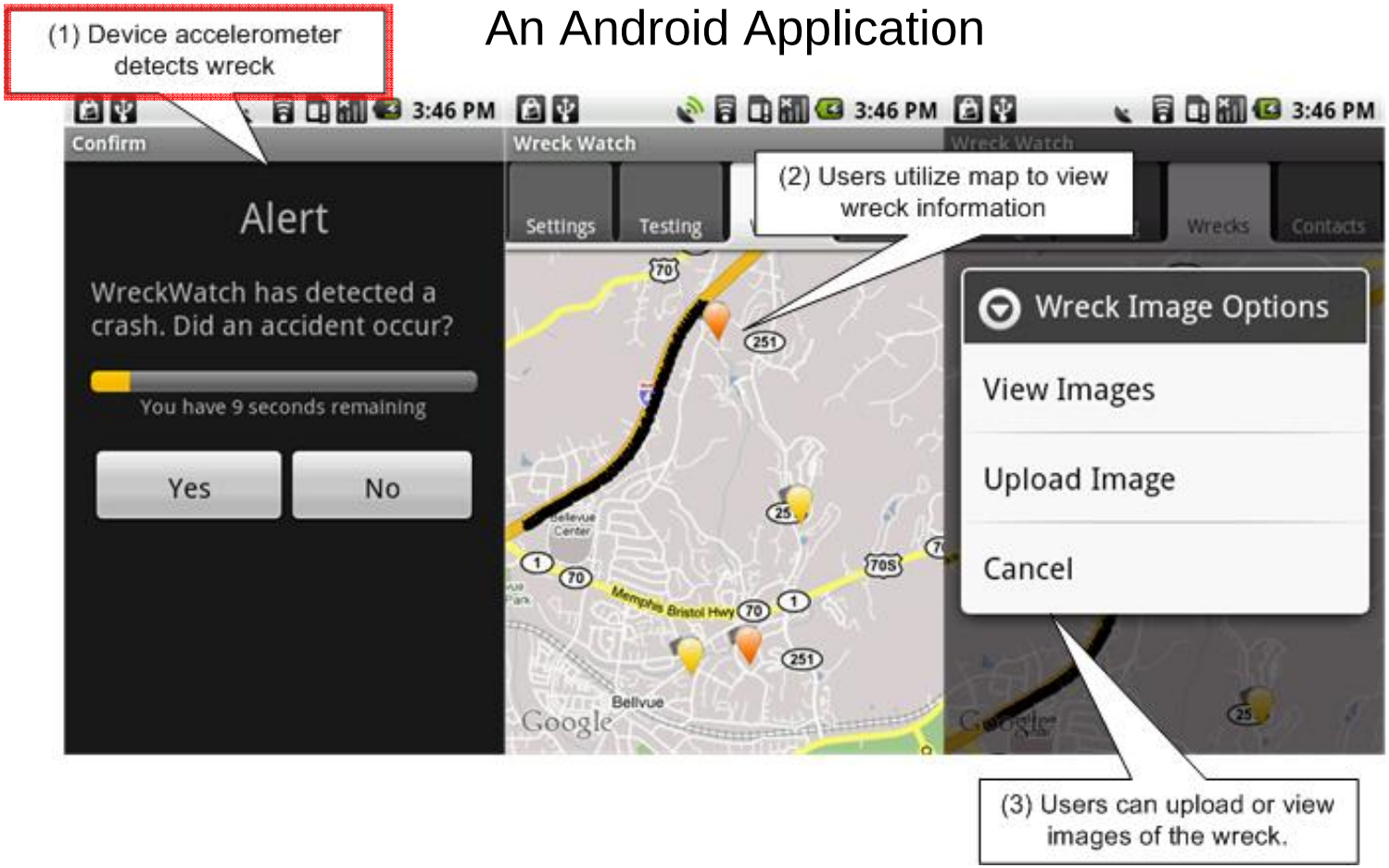
Solution Approach: Utilizing Context to Prevent False Positives



- Application detects sustained motion above 15 mph and “arms” accident detection algorithm
- Application monitors sensors for events indicative of collision

Solution Approach: WreckWatch

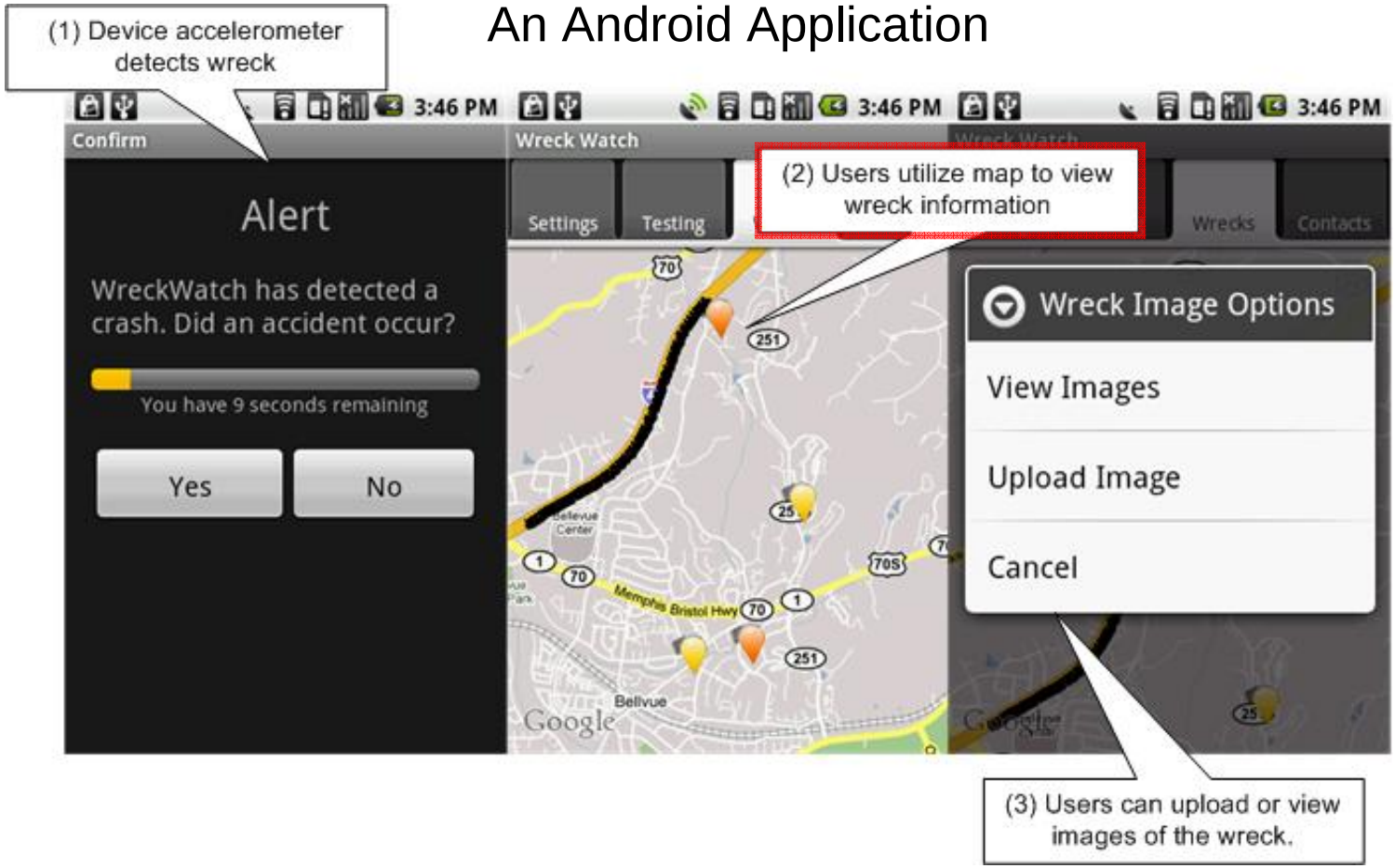
An Android Application



- WreckWatch utilizes device sensors to detect traffic accidents and notify first responders, much like a portable OnStar system.
- Accidents are displayed on mobile devices and through a web page providing first responders instant access to information about the accident

Solution Approach: WreckWatch

An Android Application



- Other motorists can view accident locations immediately and avoid accident locations
- Decreasing the volume of traffic passing the accident reduces risk to first responders and victims

Solution Approach: WreckWatch

An Android Application

- Witnesses can upload images of the accident to the WreckWatch server to provide first responders with additional information pertaining to the accident
- First responders are able to understand injuries and potential complications before arriving on scene

Solution Approach: WreckWatch

- Utilizes a RESTful web services architecture to communicate between mobile devices (clients) and central monitoring center (server)
- Client and server communicate over standard HTTP operations (POST and GET)

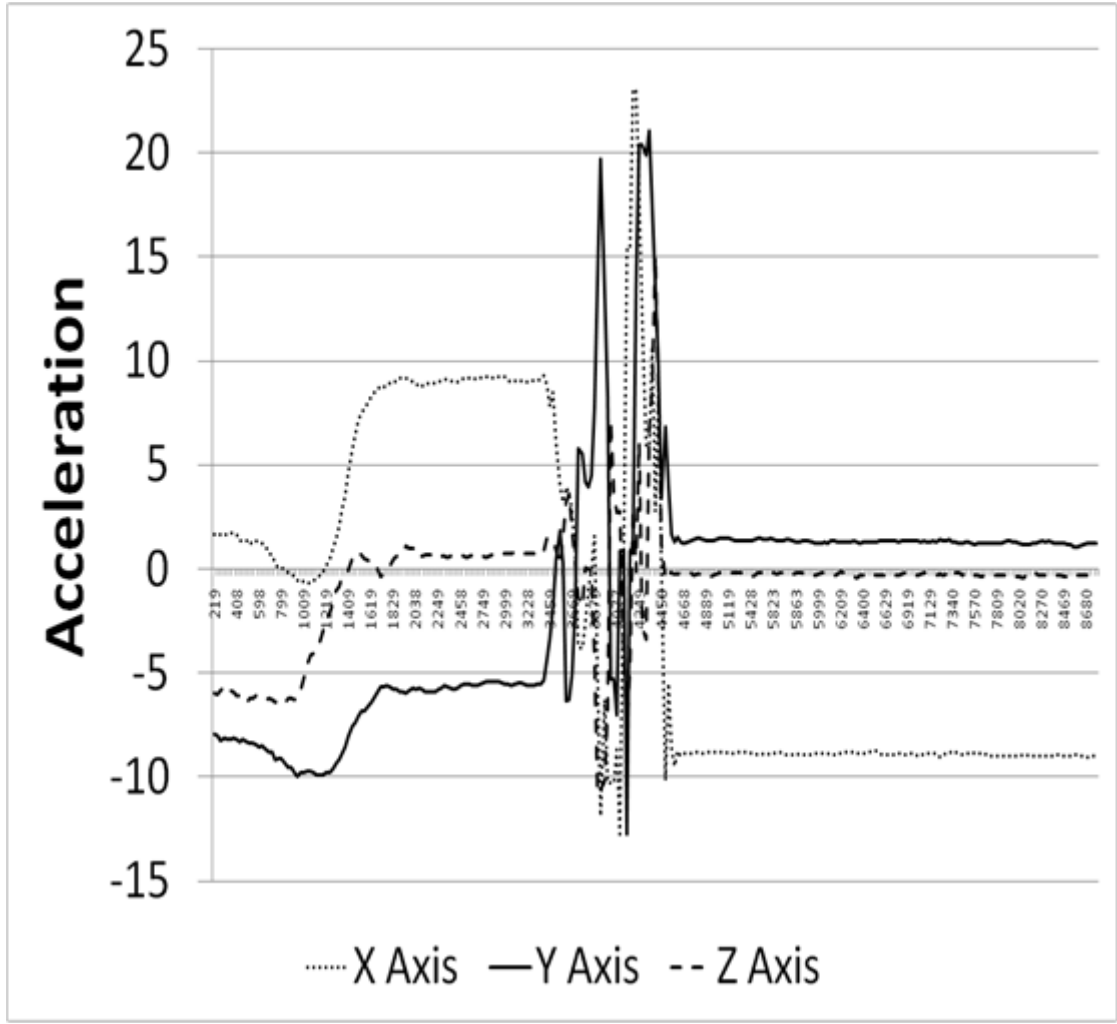
Solution Approach: WreckWatch

- Server and clients built on open-source technologies
  - Jetty, MySQL, Spring Framework, Android, Xstream
- Server is designed to allow dynamic creation of additional functionality without recompiling code in order to minimize downtime

Results: False Positive Analysis

Dropped Cell Phone

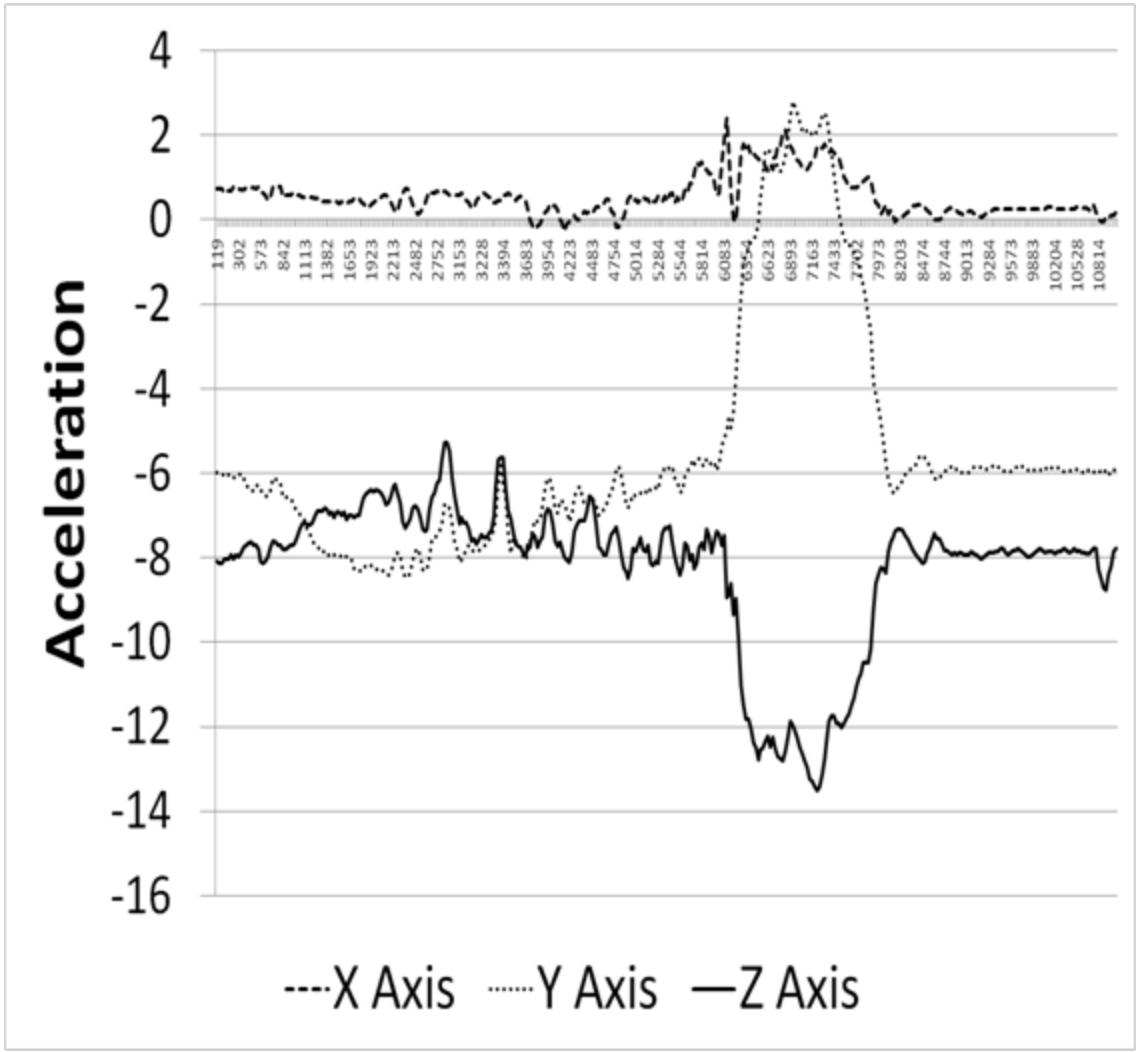
- Forces experienced during fall were between 2 and 3 Gs
- Car accidents are typically in excess of 60Gs
- Airbag sensors use 3Gs as a “bias” to deploy airbags
- Supports use of 4G filter to prevent false positives



Results: False Positive Analysis

Sudden Stop

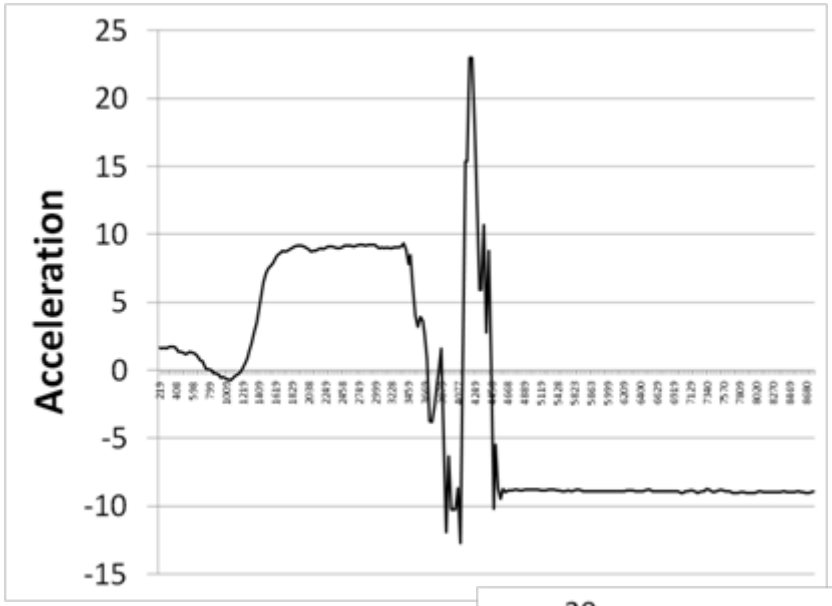
- Forces experienced during stop were approximately 1G
- Stop generated less force than fall and supports use of 4G filter
- Difference due to larger duration of time over which the change in speed occurred



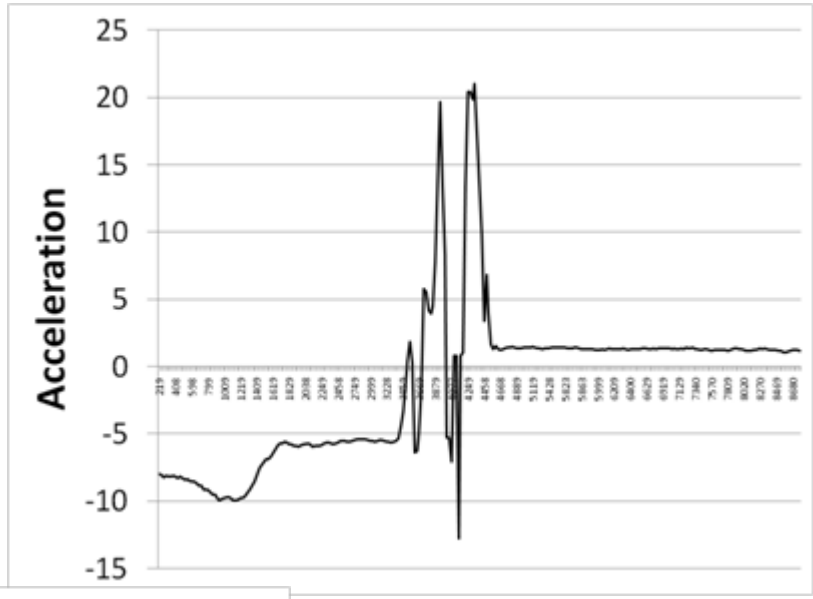
Accident Reconstruction

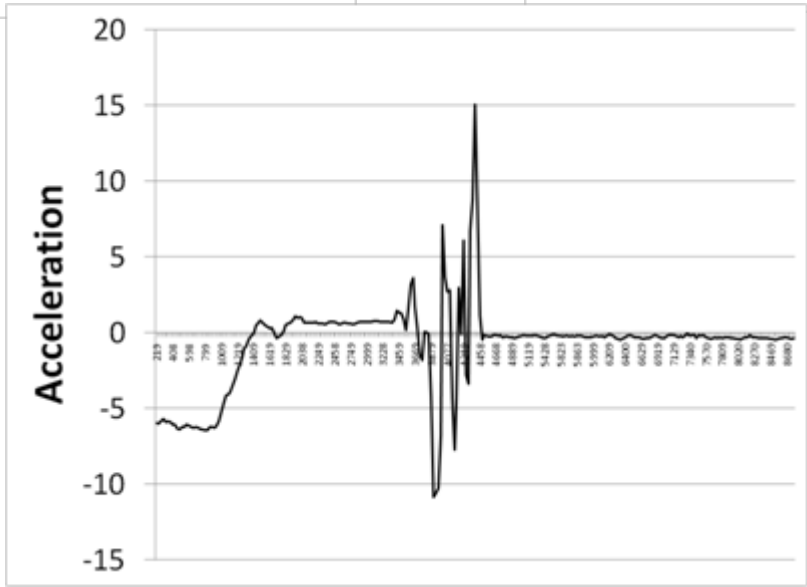
Accident Reconstruction

X-Axis



Y-Axis





Z-Axis

Future Work

Bluetooth ECU connection connects automatically

- Extend client applications to additional platforms
- Perform empirical analysis in real-crash scenarios
- Explore integration with ODBII (ECU) connector via Bluetooth hardware
- Explore additional methods for detecting low-grade collisions

Concluding Remarks

- In the event of an extreme accident, the smartphone could be destroyed
- Accidents exert extreme forces on smartphones that cannot easily be replicated by dropping them
- Smartphones can surpass the functionality if in-vehicle ACN systems
- It may not be possible to detect all accidents with smartphones
- In-vehicle Bluetooth radios can increase the potential for smartphone-based ACN systems
- WreckWatch is available under the Apache 2.0 License at http://vuphone.googlecode.com