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The Connected Traveler

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Motivation

- Traffic Safety
 - Heavy Road Infrastructure Investments
 - Stage I
 - In-pavement sensor
 - Radar detectors
 - Stage II
 - Road-side communication hotspots (RSU)
 - Dedicated bandwidth (DSRC)
 - In-vehicle communication devices (OBU)

Motivation

- Traffic Safety
 - Mobile Devices
 - Growing processing power
 - Several communication radios (GSM, WiFi, Bluetooth, IR,...)
 - Location-based devices (GPS, Power triangulation, RFID tags...)
 - Everybody has them!!!

Motivation

- Crowd Computing
 - Give data in
 - Receive service out

Why not for Traffic Applications!!!

Networked Traveler

- Play a movie (1.5 min)
- Discuss the movie
- Challenges involved in Transportation LBS
 - Data challenges
 - User experience challenges
- Networked Traveler approach in addressing the challenges
 - Location models for traffic data
 - Learning user behavior by location

Networked Travel (alpha release)



Description of the application

- I – Defining your route
 - Choose destination
 - Choose type of route (Quickest or Eco)
- II – Receive information on your route
 - Route definition is required to receive relevant information
 - Information (alerts) is also filtered based on your user profile (filled out on a website)
 - Slow traffic
 - Incidents
 - Work Zones
 - Lane closures
 - Transit alternative (bus or train)
 - Parking availability at transit location
 - If you don't like the alert, tap on it, and we will learn your preference
- III – Meanwhile
 - We are recording where you are
 - We are recording your feedback to alerts

Networked Traveler as an LBS

- Based on where you are, you receive information catered for your preference
- “Based on where you are” is dynamic
 - Safety information is sensitive to 100 msec (Active Safety Traffic Applications)
 - We limit to Soft Safety information in the order of 50-60 sec latency → 1.5 km (108 kph)
 - Every 1.5 km you have a different set of services providing you different types of information

Data Challenges (Slow Traffic)

- Three sources of data to get real time traffic conditions (real time = 30 sec delay)
 - Traffic links identified as avg. speed over a length of 1-5 miles
 - Speed Info data give point speed every 15-30 sec
 - Other networked traveler drivers every 30 sec
- How to map those different sources into a unified location parameter that can be consumed by the cell phone?
 - Cell phone is a GPS point
 - Can we convert the 3 sources to a GPS point representation of speed?
 - Can we expand the cell phone location to be more than just a GPS point?

User Experience Challenge (Slow Traffic)

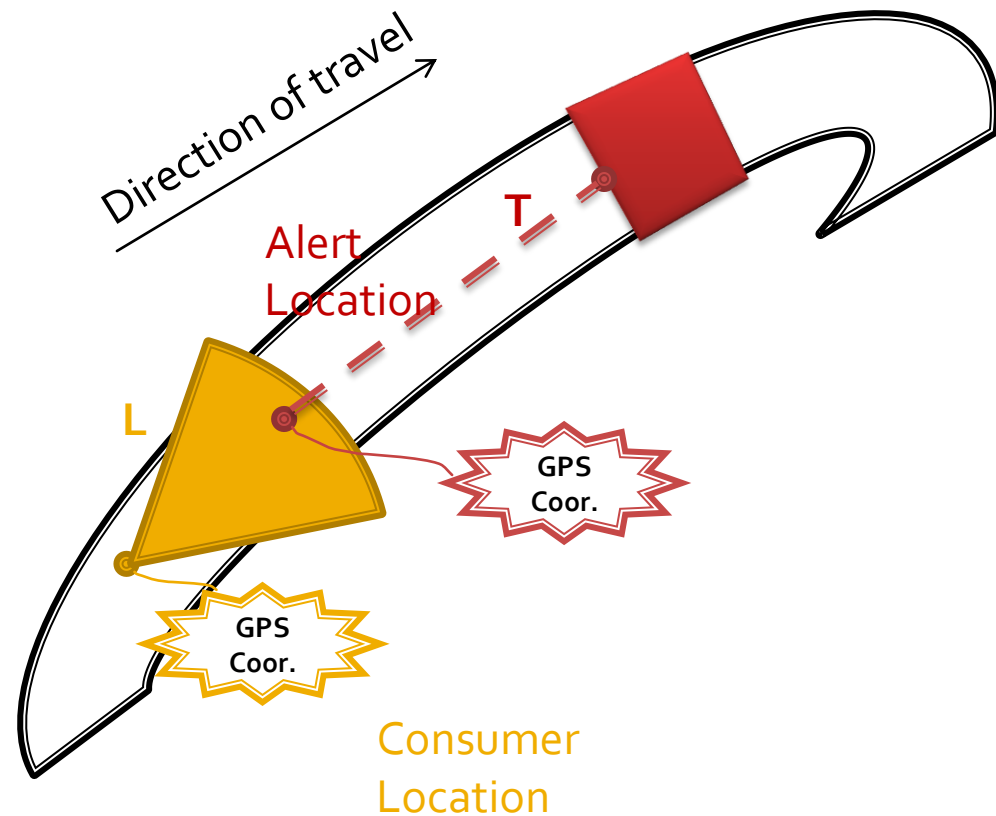
- How far upstream from the event should the user be alerted?
 - Identifying the user's sweet spot is difficult
 - Sweet spots vary by user age, gender, driving experience, etc
 - They also vary in the same user by time of day, day of week, time spent on road, etc
 - They also vary by LOCATION of event causing the alert
 - From human factors crash studies we know the optimum distance needed to stop the car safely, but that too depends on human perception-reaction times (1 - 6 sec)

Location models for traffic data

- GPS coordinates don't work in sensitive location based services
- We define "location" as the space you occupy within the time frame you need the LBS information
 - Distance of roadway travelled
 - Changes by speed of the consumer
 - Identified by the GPS coordinate of the consumer, a 40 degree forward heading, and length

Location models for traffic data

- Alert source is reduced to a GPS point if not already a GPS point
- The Alert source GPS point is projected to an upstream GPS trigger point to represent the Alert location

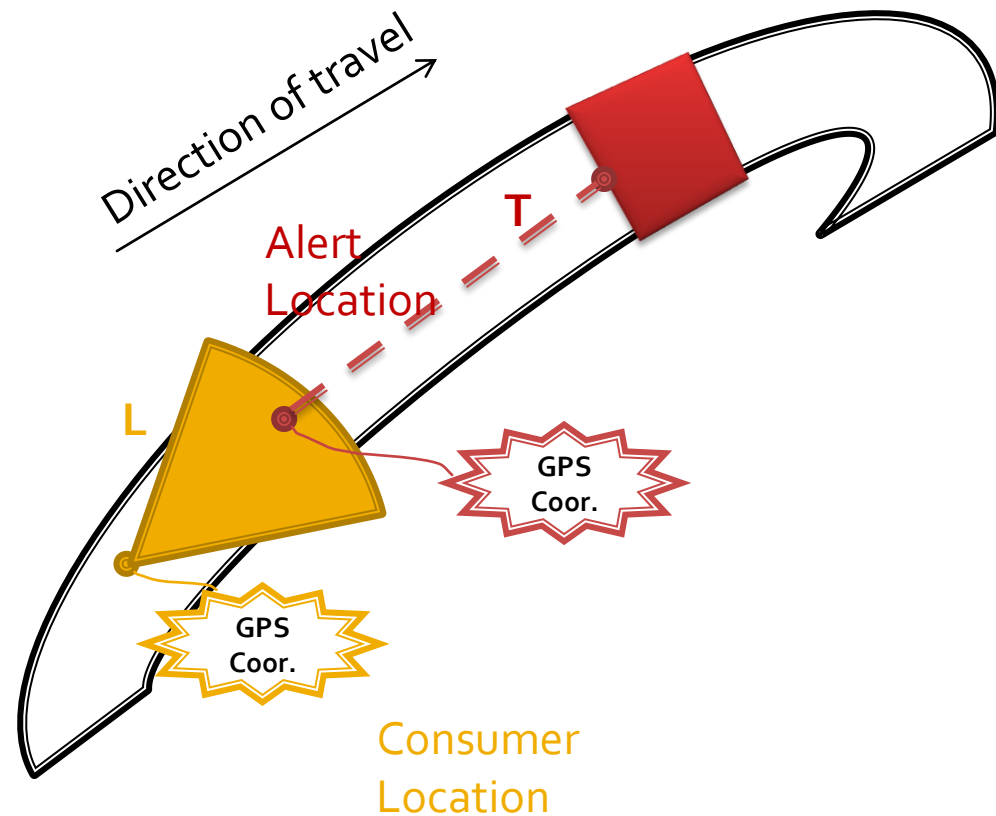


Learning user behavior by location

- Quick intro to “machine learning”
 - Given a set of data made of attributes and outcomes e.g.
 - person age, sex, body mass index, and had a heart attack as attribute; will have a heart attack in the next 7 years as outcome
 - One can learn the relation of the outcome to the attributes
 - Generate a learning model
 - Apply the model to new attributes to predict the outcome
- Some simple models
 - Logit (logistic regression), perceptron
- More advanced AI models
 - Bayesian Predictor
 - Support Vector Machines

Learning user behavior by location

- L and T vary by:
 - Driver
 - Location
 - Type of alert
 - Time
 - Etc.



Learning user behavior by location

- Assumption 1: T is “location” dependant (we expect to see similar T values across drivers)
- Assumption 2: L is driver specific (we expect to see similar L values for various locations by the same driver)
- 2 learning models:
 - one for T and location specific
 - one for L and driver specific

T Learning Model

- We generate random T values for the same location
- Collect multi-user feedback for that location
- Attributes: T value, time of day, raining or not
- Outcome: positive or negative feedback
- Run a support vector machine to figure out the T threshold for that location.
- Performed as a post-processing job at the end of each day

L Learning Model

- General random L values for each driver
- Collect single user feedback from various locations
- Attributes: L value, time of day, day of week, speed, time on road
- Outcome: positive or negative feedback
- Run a support vector machine to figure out the model parameters – done once a day
- Every time a new alert comes in: feed in the attributes above into the model to predict the output
- Solicit user feedback to compare to predicted output and recalibrate the model at the end of the day

Current and Near Future Work

- Field Test 500 users starting June
 - Complete remaining data sources
 - Improve learning capabilities to include
 - Destination learning
 - Route preference learning
- Support for voice commands for feedback input
- Improved web site profile management

Questions/Discussion
