

Analysis of Fastest and Shortest Paths in
an Urban City Using Live Vehicle Data
from a Vehicle-to-Infrastructure Architecture

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IFAC Symposium on Control in Transportation Systems

September 4, 2009

Outline

- Motivation
- Fastest vs Shortest Path Scenario
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Motivation

- Much research has been conducted concerning vehicle-to-infrastructure ITS architectures
- Many applications have been proposed assuming that the speed, location, and direction of vehicles are known
 - Fastest path
 - Incident identification
 - Collision avoidance
 - Congestion avoidance
 - Etc.

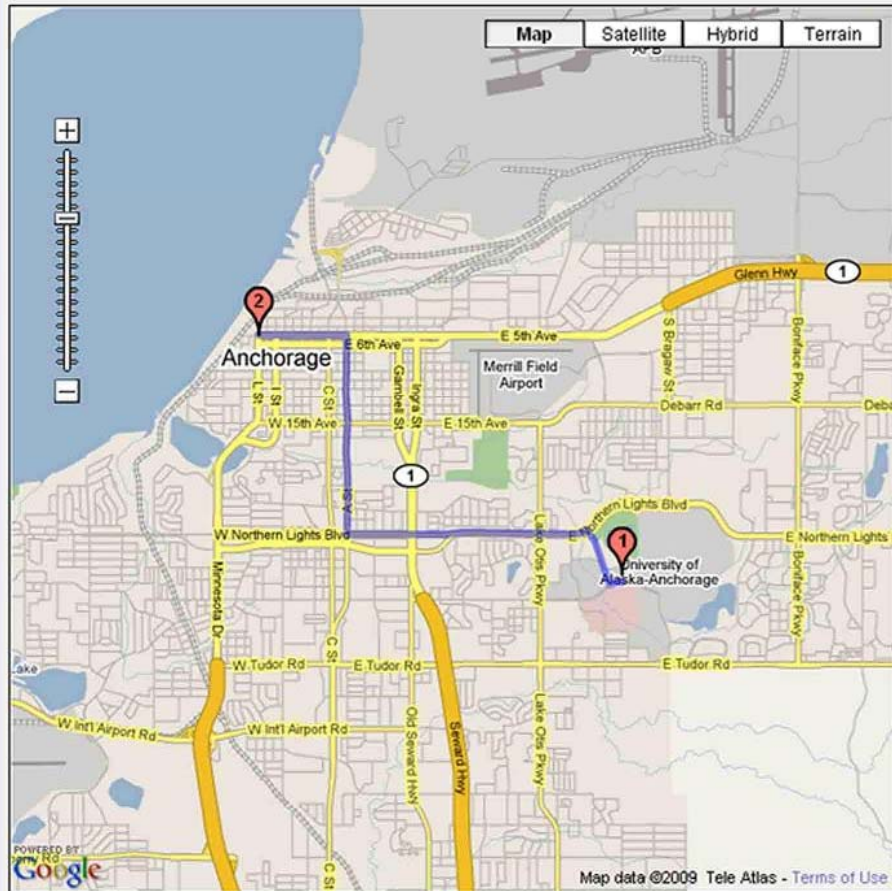
Fastest Path Algorithms

- Single Source Shortest Path Algorithms
 - Dijkstra, Bellman-Ford
- All Pairs Shortest Path Algorithm
 - Floyd-Warshall, Johnson
- Dynamic Fastest Path Algorithms (DynFast)
 - Demetrescu and Italiano, King, Subramamian, Miller and Horowitz
- Dynamic Fastest Path Algorithms with Multiple Unique Destinations (DynFast-MUD)
 - Miller and Ali

Current Testbed

- 15 vehicles in Anchorage are equipped with tracking devices that report speed, location, and direction every 10 seconds to a central server through a V2I architecture
- All of the vehicles originated from the University of Alaska, Anchorage and traveled toward downtown Anchorage

FreeSim



Anchorage Road Network

Freeway System **Anchorage**

Zone Configuration **1 Edge**

Start **UAA_Parking_Garage at 1**

End **5th Street and L Street at 2**

Fastest Path Algorithm **APAP Update**

Messages

Head west on University Drive toward UAA Drive 1
 Turn right at UAA Drive 0.5 mi
 Turn left at E Northern Lights Blvd 1.9 mi
 Turn right at A St 1.5 mi
 Turn left at W 5th Ave 0.7 mi

Start **UAA_Parking_Garage at 1**

End

Speed **65** Lane

File

Messages

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Simulation Time

Scenario

- 13 of the vehicles were able to drive along any route they wanted
- 2 of the vehicles were required to drive from the university to the destination in downtown
 - One of the vehicles was required to drive along the shortest path
 - One of the vehicles was required to drive along the fastest path, as determined by the DynFast algorithm based on data gathered from the other 13 vehicles

Scenario (cont.)

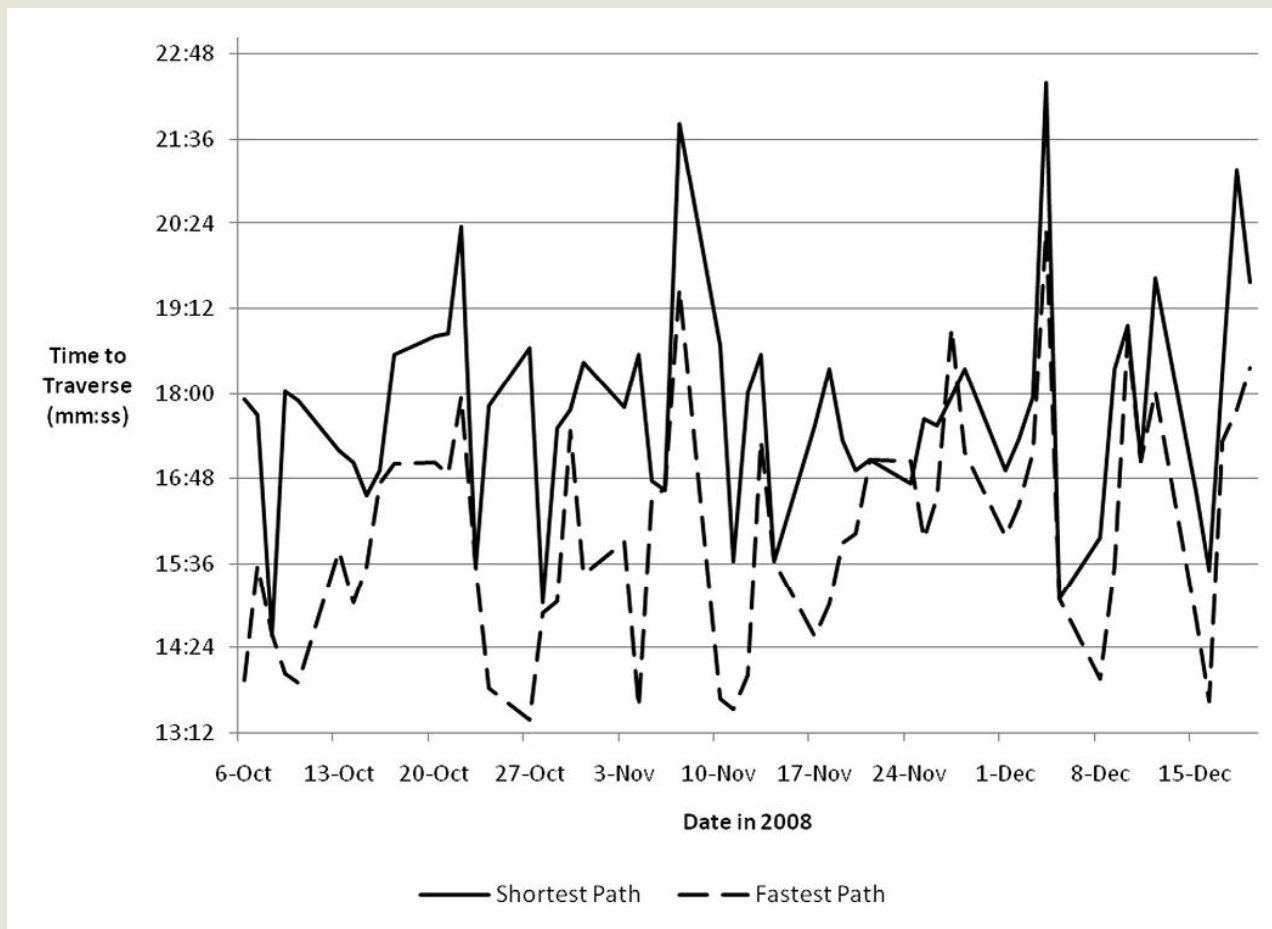
- The vehicles selected to be tracked all left the University between 4:30p.m. to 5:00p.m.
- The vehicle following the fastest path determined the fastest path immediately before leaving the University, then followed that path
 - The fastest path was determined by using the speed data from the current day and the average of the speed data from the same day of the week for the previous 4 weeks
 - If a road did not have a speed from a vehicle, the speed limit of the road was used
 - Only roads with speeds limits of at least 35mph were used
- Along the path, each vehicle reported its speed and location every 10 seconds, from which the time to traverse the path can be determined
- The study took place between October and December in 2008

Average Amount of Time to Traverse Paths

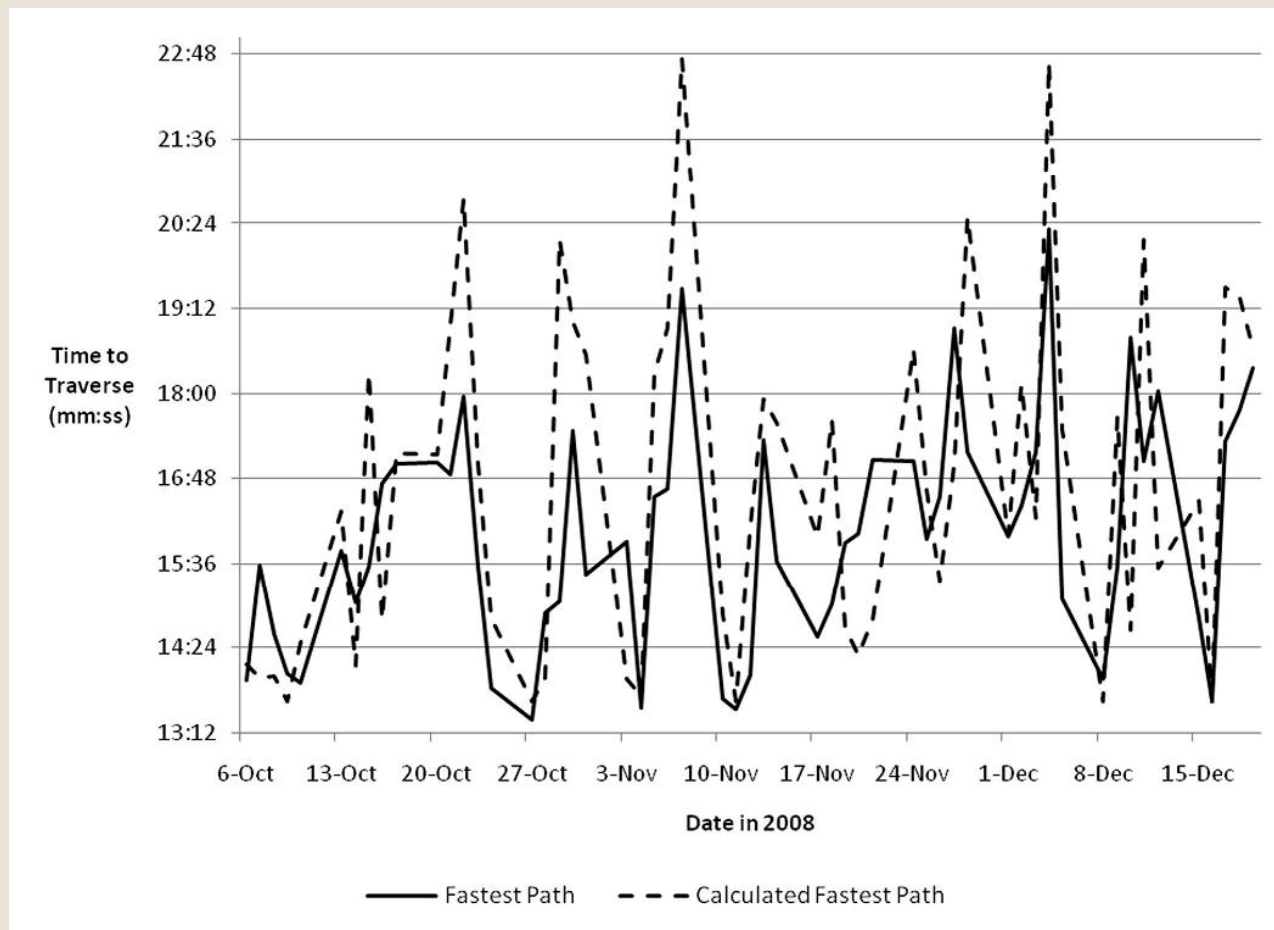
Day of Week	Actual Time to Traverse Shortest Path	Calculated Time to Traverse Fastest Path	Actual Time to Traverse Fastest Path
Monday	17:32	15:06	15:32
Tuesday	17:16	15:05	15:39
Wednesday	17:37	16:18	17:05
Thursday	18:05	17:04	17:42
Friday	18:10	16:27	17:28

NOTE: The shortest path was 4.6 miles long and takes 13:39 to traverse with average delays for traffic signals

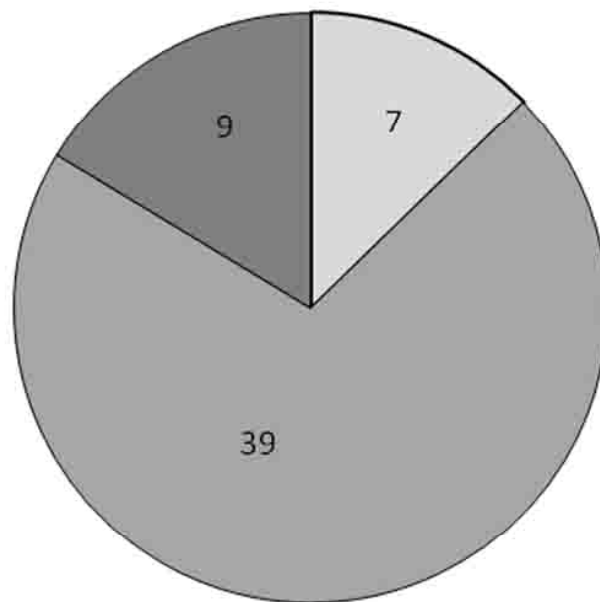
Actual Time to Traverse Shortest and Fastest Path



Actual Time to Traverse Fastest Path versus Calculated Fastest Path



Calculated Fastest Path vs Shortest Path



- # Times Calculated Fastest Path was the Shortest Path
- # Times Calculated Fastest Path was Faster than Shortest Path
- # Times Shortest Path was Faster than Calculated Fastest path

- The time to traverse the computed fastest path was faster than the time to traverse the shortest path 84% of the time
- The time to traverse the computed fastest path was faster than or equal to the time to traverse the shortest path 96% of the time

Conclusion

- This study used live distributed data gathered through a V2I architecture to analyze traffic flow
- The time to traverse the fastest path being faster or the same as the time to traverse the shortest path 96% of the time proves that strategically placing vehicle-tracking devices can allow a significant savings in commute times

Conclusion

- Since the fastest path was calculated before the vehicle left the University, the fastest path may not always be faster than the shortest path because of changing traffic conditions
 - Incremental path updates sent to vehicles while traversing a path would aid in improving this inaccuracy
- As more vehicles are equipped with tracking devices (which will be at least 50 in Anchorage by the end of the year), the transportation network will be more accurately represented
 - How many vehicles need to be equipped with the tracking devices to obtain an accurate representation of the transportation network?

Future Work

- Install tracking devices in additional vehicles
- Exposing the vehicle data for other researchers to exploit in their own applications
- Incorporating vehicle data from vehicles that are already tracked for other purposes (such as emergency response vehicles, taxi fleets, delivery fleets, etc.)
- Gathering additional vehicle information to be transmitted with the location and speed data (such as fuel consumption, accessory status, engine temperature, engine RPMs, level of impact in event of incident, etc.)