Using Technology to Revolutionize Public Transportation

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ETH Zurich
Dec. 12, 2011

Agenda

- OneBusAway User Survey
- Wait Time Study
- Explore
- Value Sensitive Design
- Bus Driver Impact
- Future Work

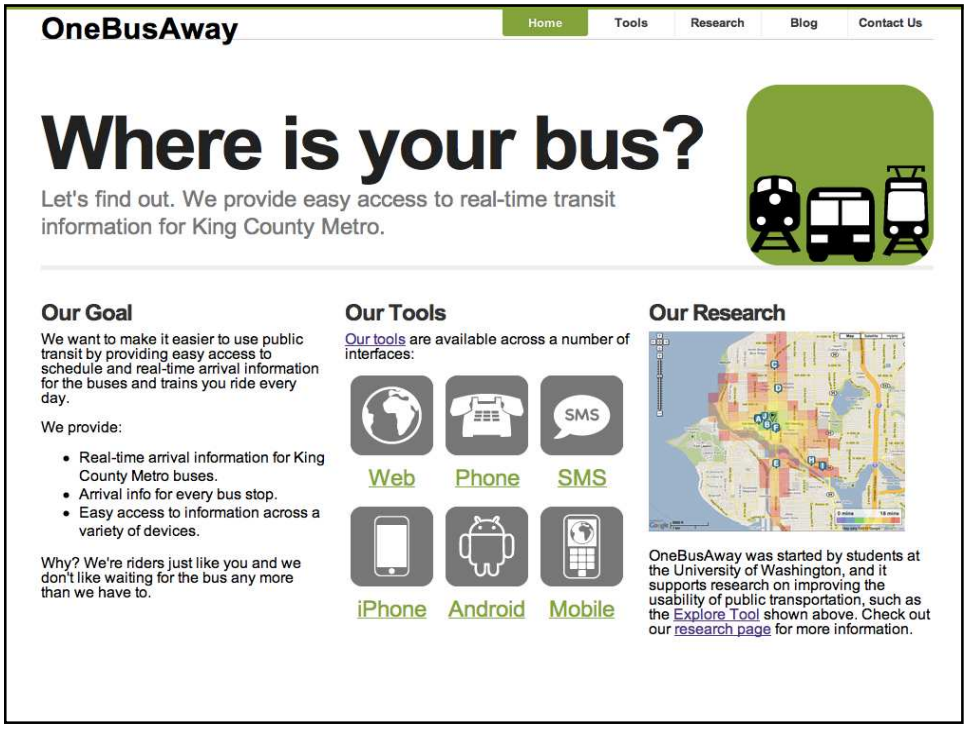
Benefits of transit

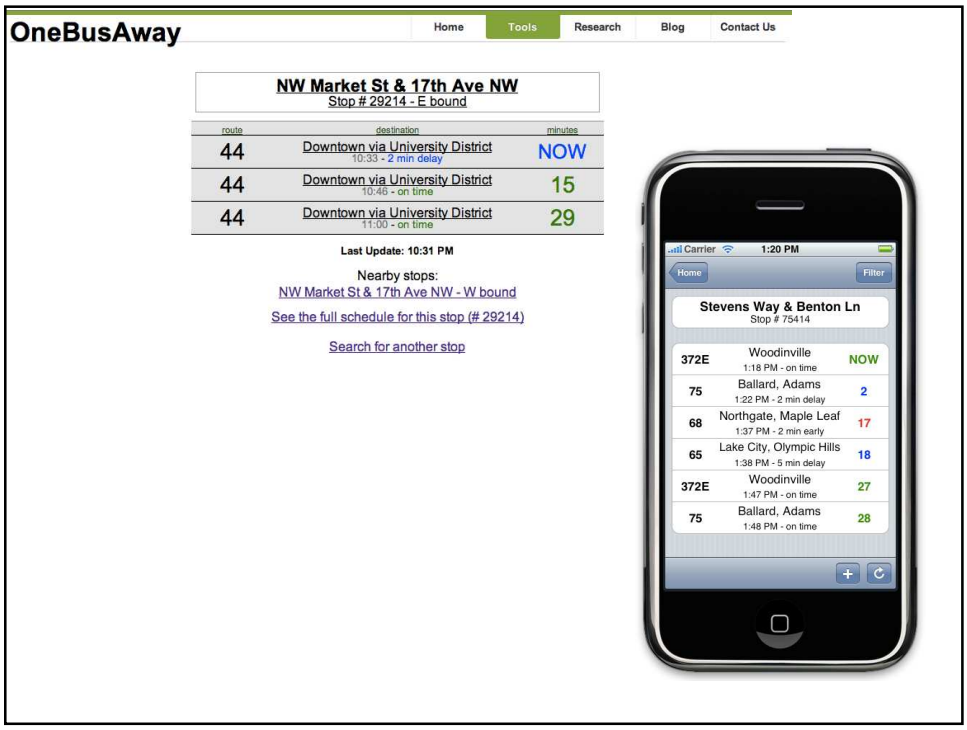
- Societal Benefits
  - Congestion reduction
  - Reduced gasoline consumption
  - Reduced emissions
  - Mobility to non-drivers
  - Compact sustainable communities
- BUT to customer - transit must be

  fast, comfortable and reliable

Motivation

- The goal of OneBusAway is to help provide a better experience for transit riders, and to encourage more people to use public transit.
- Focus on:
  - Real-time arrival information
  - Innovative technical solutions
  - Usability
  - Free and open


OneBusAway
Home
Tools
Research
Blog
Contact Us
Where is your bus?
Let's find out. We provide easy access to real-time transit information for King County Metro.
Our Goal
We want to make it easier to use public transit by providing easy access to schedule and real-time arrival information for the buses and trains you ride every day.
We provide:
Real-time arrival information for King County Metro buses.
Arrival info for every bus stop.
Easy access to information across a variety of devices.
Why? We're riders just like you and we don't like waiting for the bus any more than we have to.
Our Tools
Our tools are available across a number of interfaces:
SMS
Web
Phone
SMS
iPhone
Android
Mobile
Our Research
OneBusAway was started by students at the University of Washington, and it supports research on improving the usability of public transportation, such as the Explore Tool shown above. Check out our research page for more information.


OneBusAway
Home
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NW Market St & 17th Ave NW
Stop # 29214 - E bound
route
destination
minutes
44
Downtown via University District
10:33 - 2 min delay
NOW
44
Downtown via University District
10:46 - on time
15
44
Downtown via University District
11:00 - on time
29
Last Update: 10:31 PM
Nearby stops:
NW Market St & 17th Ave NW - W bound
See the full schedule for this stop (# 29214)
Search for another stop
Carrier
1:20 PM
Home
Filter
Stevens Way & Benton Ln
Stop # 75414
372E
Woodinville
1:18 PM - on time
NOW
75
Ballard, Adams
1:22 PM - 2 min delay
2
68
Northgate, Maple Leaf
1:37 PM - 2 min early
17
65
Lake City, Olympic Hills
1:38 PM - 5 min delay
18
372E
Woodinville
1:47 PM - on time
27
75
Ballard, Adams
1:48 PM - on time
28

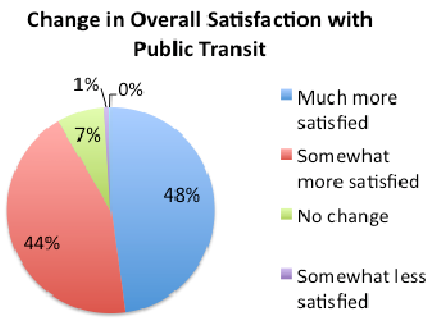
Impacts of OneBusAway

How is OneBusAway changing user perceptions and behavior with respect to public transit?

Assessing Behavior Change

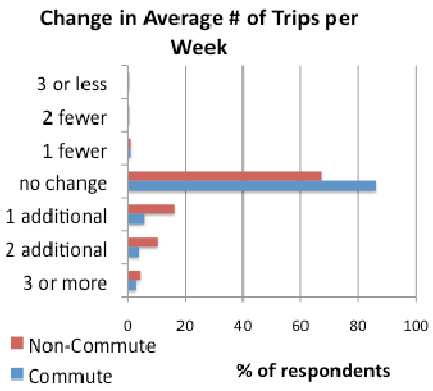
- August 2009 survey of OneBusAway users
  - 488 responses
- Specific questions about OneBusAway:
  - "Now that you've been using OneBusAway, how has _____ changed?"
  - Satisfaction with transit, Usage of transit, Wait time, Perceptions of Safety, Walking
- Caveats: self-report, no control group

Change in Satisfaction



"I no longer sit with pitted stomach wondering where is the bus. It's less stressful simply knowing it's nine minutes away, or whatever the case."

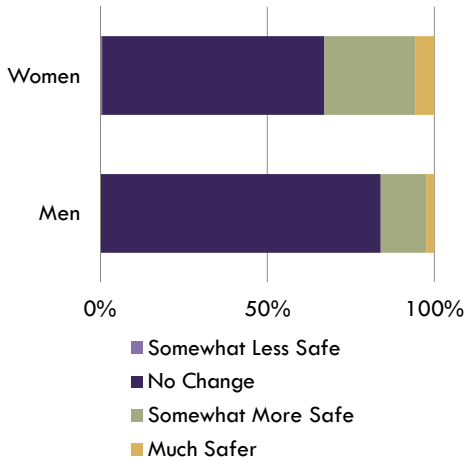
Change in Usage



"While my work usage was pretty much on a fixed schedule, OneBusAway has made impromptu trips much more convenient."

OneBusAway Evaluation

- Perception of Safety
  - 79% no change
  - 18% somewhat safer
  - 3% much safer
- Safety correlated with gender
  - χ^2=19.458
  - p-value=0.001



The Catch

- Self-report, no control
- Tricky for quantitative results like # of trips, wait times, walking

- **Can we more accurately measure how OneBusAway is changing behavior?**

Where IS my bus?

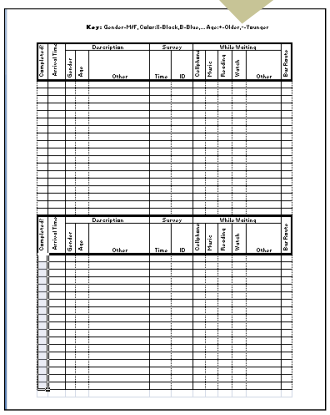
OneBusAway and wait time

Wait Time Study

- Overcome limitations of self-report study
- Little work on mobile real time info
- 14 stops near UW
- 8 surveyors working in pairs
  - Observer records all riders
  - Questioner surveys subjects

Observer Noted

- Arrival time
- Gender
- Age group
- Distinguishing Features
- Survey time
- Survey ID
- "While Watching"
- Bus Route & Bus Arrival



Key: Gender-M/F, Color:B=Black,B=Blue,...Age:Y=Older,y=Younger

Questionnaire	Arrival Time	Description			Survey			While Waiting			
		Gender	Age	Other	Time	ID	Cell Phone	Tracker	Reading	Watch	Other	Bus Route

Difference of means tests

Variable	N	Mean Perceived Wait	Mean Measured Wait	Mean Difference	95% CI
Real Time	111	4.98	4.66	0.32	-0.1 – 0.7
Schedule	544	6.19	5.36	0.83	0.6– 1.1

$$H_0 : (\mu_{\text{Real time measured}} - \mu_{\text{Real time perceived}}) - (\mu_{\text{Schedule measured}} - \mu_{\text{Schedule perceived}}) = 0$$

$t = -2.1305$

$Pr(T > t) = 0.0344$

Model of perceived wait time

$$PW_i = \beta_o + \beta_1 MW_i + \beta_2 RT_i + \beta_3 PM_i + \beta_4 BF_i + \beta_5 AL_i + \varepsilon_i$$

$R^2 = 0.43$

Variable	Coefficient	Robust Standard Error	T-statistic (p-value)
Constant	1.9	0.40	4.82 (0.000)
Measured Wait (MW)	0.72	0.05	14.63 (0.000)
Real Time Info (RT)	-0.73	0.24	-3.08 (0.002)
PM	0.59	0.22	2.73 (0.006)
Buses per Hour (BF)	-0.14	0.06	-2.24 (0.025)
Aggravation Level (AL)	0.19	0.05	3.53 (0.000)

Other Measures

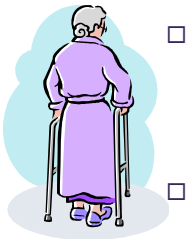
- How long do you typically wait for this bus?
- On a scale of 1 to 10,
  how do you feel about waiting for the bus?

Group	Real Time	Schedule	Difference	T-stat (p-value)
Mean Typical Wait	7.54	9.86	2.32	5.50 (0.00)
Aggravation Level	3.35	3.29	-0.05	-0.24 (0.81)
Actual Wait Time	9.23	11.21	1.98	2.17 (0.03)

Explore

Trip planning with destination unknown

Transit-use with destination unknown



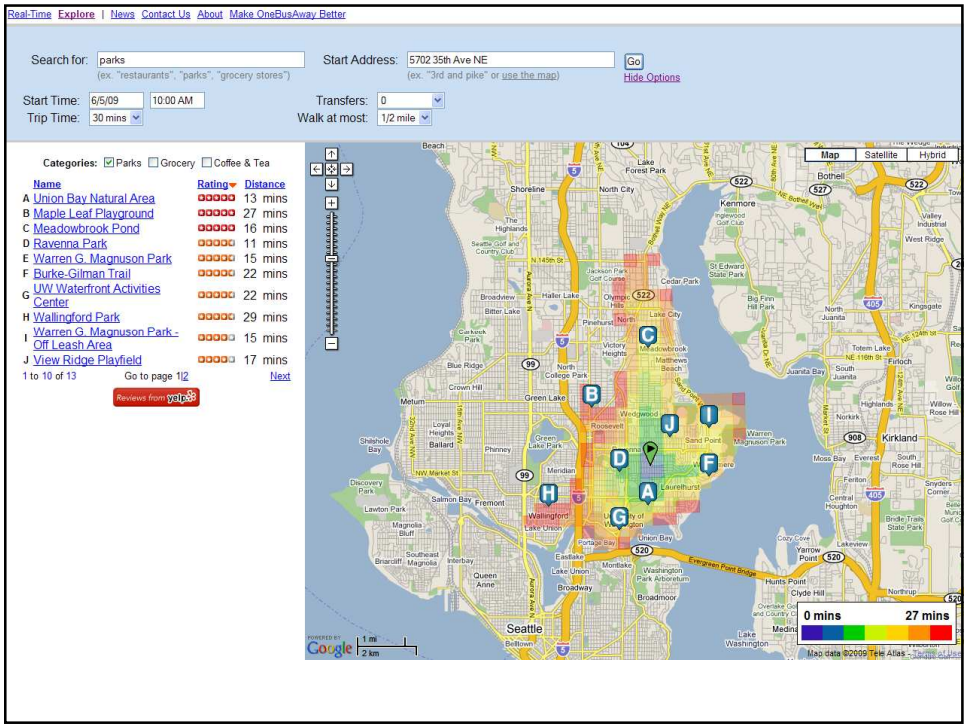
- Transit-dependent elderly woman looking for a new doctor

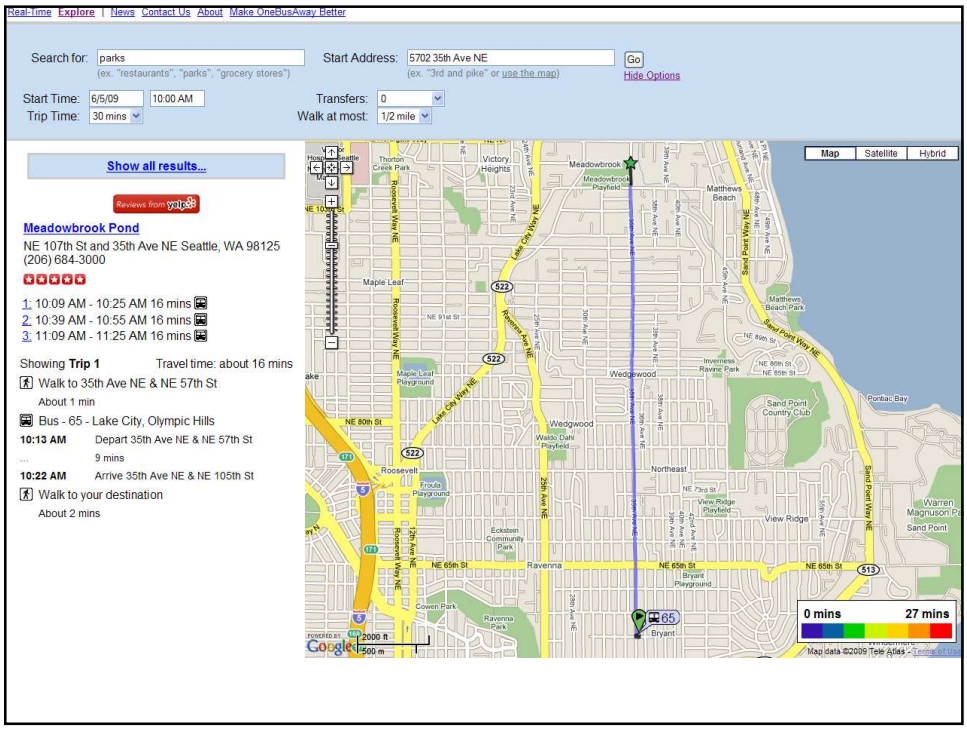
- Environmentally-conscious mom

- Group of college roommates going out for the night

Search Steps

1. Finding the area reachable by transit
   - Search for set of all transit stops reachable
   - Simulate all potential trips taken from start
   - Advance each trip in parallel through time
   - Stop searching when the longest trips reach user-specified time window
2. Finding amenities within reachable area
   - Discretize reachable area into half-mile grid
   - Grid cell included if it contains a reachable stop
   - Search for local businesses and amenities specified
   - Check results against street/sidewalk network to ensure path exists


Real-Time Explore | News Contact Us About Make OneBusAway Better
Search for: parks
(ex. "restaurants", "parks", "grocery stores")
Start Address: 5702 35th Ave NE
(ex. "3rd and pike" or use the map)
Go
Hide Options
Start Time: 6/5/09 10:00 AM
Trip Time: 30 mins
Transfers: 0
Walk at most: 1/2 mile
Categories: Parks Grocery Coffee & Tea
Name Rating Distance
A Union Bay Natural Area 13 mins
B Maple Leaf Playground 27 mins
C Meadowbrook Pond 16 mins
D Ravenna Park 11 mins
E Warren G. Magnuson Park 15 mins
F Burke-Gilman Trail 22 mins
G UW Waterfront Activities Center 22 mins
H Wallingford Park 29 mins
I Warren G. Magnuson Park - Off Leash Area 15 mins
J View Ridge Playfield 17 mins
1 to 10 of 13 Go to page 1 2 Next
Reviews from yelp
Map Satellite Hybrid
0 mins 27 mins
Map data ©2009 Tele Atlas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Start Address: 5702 35th Ave NE
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Go
Hide Options
Start Time: 6/5/09 10:00 AM
Trip Time: 30 mins
Transfers: 0
Walk at most: 1/2 mile
Show all results...
Reviews from yelp
Meadowbrook Pond
NE 107th St and 35th Ave NE Seattle, WA 98125
(206) 684-3000
1: 10:09 AM - 10:25 AM 16 mins
2: 10:39 AM - 10:55 AM 16 mins
3: 11:09 AM - 11:25 AM 16 mins
Showing Trip 1 Travel time: about 16 mins
Walk to 35th Ave NE & NE 57th St
About 1 min
Bus - 65 - Lake City, Olympic Hills
10:13 AM Depart 35th Ave NE & NE 57th St
9 mins
10:22 AM Arrive 35th Ave NE & NE 105th St
Walk to your destination
About 2 mins
Map Satellite Hybrid
0 mins 27 mins
Map data ©2009 Tele Atlas

Value Sensitive Design

What should the next transit info tools be?

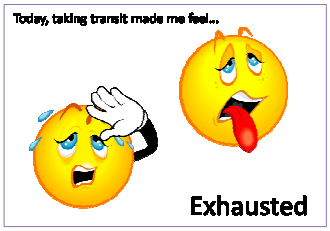
Value Sensitive Design

- Process of looking at the values implicated by technology
- Identify and examine values of direct and indirect stakeholders

- What should the next transit info tools be?
  - What's useful to riders?
  - What's useful to future riders?
  - Impact on bus drivers?

Cultural Probes

- What do you like about transit?
- What do you hate about transit?
- What is unique about how you use transit?
- What are your tips and tricks for using transit?
- What information do you need to ride the bus?
- What frustrations do you have finding that information?



Potential Transit Tools

- Social Engagement
- Transit-use Incentives
- Trip Planning Tools
- General Planning Tools
- Maps and Information Tools
- Notifications
- Accessibility

Bus Driver Impact

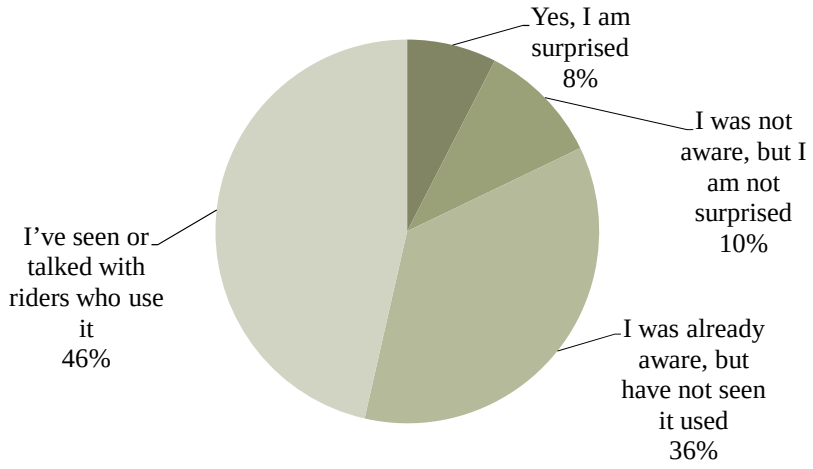
Bus Driver Study

- Little work to date with bus drivers about impact of real time information
- Semi-structured interviews of 6 bus drivers
- Leading to survey of 250 bus drivers

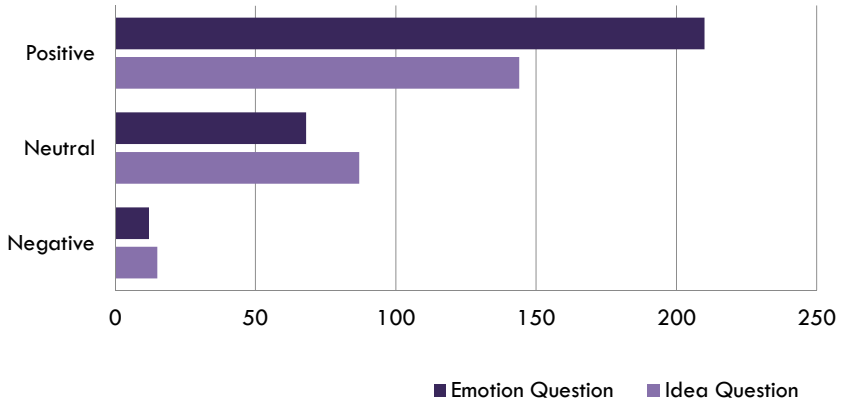
Bus Driver Survey

- Randomly selected 500 drivers from 2769
- 253 responses (50% response rate)
- Representative sample
- Asked feelings about:
  - Existing real time information
  - Potential future tools

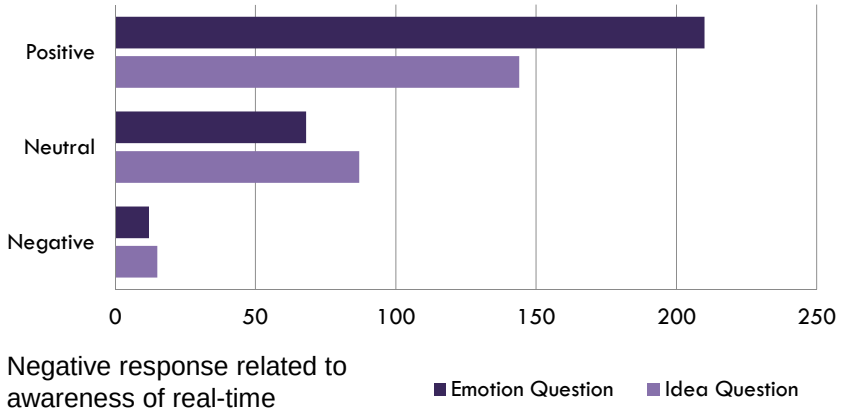
Awareness of real time information



Impression of real time information



Impression of real time information



Negative response related to awareness of real-time information (p=0.002, Fisher's exact test)

Should we create an app to?

	Identify physical issues at stops, shelters or on buses	Rate-my-route or stop
Open it to the PUBLIC	62%	61%
Agency ONLY	26%	16%
DON'T build	9%	20%
No answer	2%	3%
Total	100%	100%

Should we create an app to?

	Blind and deaf-blind rider tools	To be notified about the on-time status if >10 min late.	To see past performance and data (on-time, full)	To be notified about how full the bus is
Build it	89%	76%	66%	61%
DON'T build	6%	18%	29%	36%
No answer	5%	6%	5%	4%
Total	100%	100%	100%	100%

Future Work

How can we use this to revolutionize public transportation?

Next Steps

- More data (AVL, Alerts)
- Data standards must be refined and accepted
- Agencies must be willing and able to open up data

Apps Need Open Data

Largest transit agencies with no open data:

1. **Northeast Illinois Regional Commuter Railroad Corporation**
2. **Metropolitan Atlanta Rapid Transit Authority**
   Dr. Beverly Scott (General Manager/CEO)
3. **Port Authority Trans-Hudson Corporation**
   Mr. Michael DePallo (Director/General Manager)
4. **Pace - Suburban Bus Division**
   Mr. Thomas Ross (Executive Director)
5. **VIA Metropolitan Transit**
   Mr. Keith Parker (President/CEO)
6. **Santa Clara Valley Transportation Authority**
   Mr. Michael Burns (General Manager)
7. **Alameda-Contra Costa Transit District**
   Mr. Richard Fernandez (General Manager)
8. **City of Phoenix Public Transit Department dba Valley Metro**
   Ms. Debbie Cotton (Public Transit Director)
9. **City of Detroit Department of Transportation**
   Ms. Lovevett Williams (Interim Director)
10. **Washington State Ferries**
    Mr. David Moseley (Assistant Secretary, Ferry Division)

Transit agency? How to get off this list

Source: www.citygoround.org

Ongoing Work

- OneBusAway
  - Service Alerts
  - Transit Ambassador program – using crowd sourcing for identifying and handling data problems
  - Continue to help make sure all riders are served
- Frequent Transit Service Maps
- More tools to make transit use easier
- Quantification of impacts

Thanks!

This work was funded by the USDOT Eisenhower Program, Nokia Research Center, the National Science Foundation and TransNOW.

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In association with Dr. Alan Borning, University of Washington and Dr. Brian Ferris, now at Google