Background

• Real-time transit information has many benefits
  – Shorter perceived wait time [1]
  – Shorter actual wait time [1]
  – Lowers learning curve for new riders [2]
  – Increased ridership (maybe?) [3]
  – Increased feeling of safety (e.g., at night) [5][6]

• Riders prefer accessing real-time transit info via mobile apps [1]

Challenge

- Custom mobile apps are expensive
  - Some estimates > $150,000k for a single platform [7]
  - Doesn’t include maintenance cost
- Implementing and maintaining custom apps on all popular smartphone platforms is cost-prohibitive
- Open data is good, but doesn’t always result in apps by 3rd party developers
- How can we cost-effectively launch mobile transit apps in new cities?


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OneBusAway

- Open-source real-time transit information system
- Originally developed at University of Washington
  - Ph.D. work of Brian Ferris and Kari Watkins
  - Used in multiple research studies to understand how real-time info affects transit riders
- Includes server-side software
  - Process bulk real-time transit info
  - Provides Application Programming Interface (API) for apps
- Includes mobile apps for:
  - iPhone
  - Android
  - Windows Phone
  - Windows 8

http://onebusaway.org
OneBusAway – Mobile Apps

Support user location, route, stop contextual/personalized information
All OPEN-SOURCE!

OneBusAway

- 2012 – Mobile apps only available in Puget Sound
- How do we expand them to new cities?

Where is your bus?

http://onebusaway.org
Original OneBusAway mobile app design

Each app points to the same server by default

University of Washington OneBusAway Server

Original OneBusAway mobile app design

Why don’t we duplicate the mobile apps for each city?

• Creates app maintenance work for each city, per platform
• Clutters app stores
• Fragments source code
OneBusAway “multi-region” design

- Each region maintains its own OneBusAway server software, but uses the same mobile apps
  - Reduces burden on regions to maintain apps
  - Eliminates burden on a centralized entity to maintain data quality control, servers, and customer support for each new region
  - Doesn’t clutter app stores – all users download the same “OneBusAway” app for all regions
- “You bring the server, we bring the apps”

Multi-region architecture

- Region information is stored in centralized server directory (i.e., Regions API)
- Apps now find nearby regions using Regions API
OneBusAway Server Directory

OBA – Android app
New OneBusAway Region Checklist

- Transit Data in GTFS format
  - AVL system that provides arrival estimates
  - Implement a GTFS-realtime (or SIRI) feed
  - Set up a OneBusAway Server
  - Do some quality-control testing
  - Launch OneBusAway apps in new city!
    - Via request to onebusway-developers group!

Adding OneBusAway regions to apps

- Following the request to the onebusaway_developer group, the new region can be added
- Two stages for a new region:
  1. Experimental:
     - Regions in development
     - Users can enable in iPhone and Android apps via “Settings->Enable Experimental Regions”
  2. Production:
     - Meets a certain standard in terms of quality and quantity of real-time data
     - Region is available in all apps by default
     - See http://goo.gl/ydbcoC for details
Setting up a new OneBusAway region – a case study

ONEBUSAWAY TAMPA

New OneBusAway Region Checklist

- Transit Data in GTFS format
- AVL system that provides arrival estimates
  - Implement a GTFS-realtime (or SIRI) feed
  - Set up a OneBusAway Server
  - Do some quality-control testing
  - Launch OneBusAway apps in new city!

- Here’s where we started in Tampa...
Creating a new region - Tampa

1. Establish a GTFS-realtime feed

GTFS-realtime software is open-source:
https://github.com/CUTR-at-USF/HART-GTFS-realtimeGenerator/wiki

2. Configure OneBusAway software

GTFS-realtime software is open-source:
https://github.com/CUTR-at-USF/HART-GTFS-realtimeGenerator/wiki
GTFS-realtime format (in plain text)

Estimated Arrival Times (TripUpdate)

```
trip_update {
  trip {
    trip_id: "974372"
  }
  stop_time_update {
    stop_sequence: 17
    arrival {
      delay: -180
      uncertainty: 30
    }
    stop_id: "571"
  }
  vehicle {
    id: "1301"
    Data displayed in mobile apps
  }
}
```

GTFS-realtime format (in plain text)

Estimated Arrival Times (TripUpdate)  Vehicle Locations (VehiclePositions)

```
trip_update {
  trip {
    trip_id: "974372"
  }
  stop_time_update {
    stop_sequence: 17
    arrival {
      delay: -180
      uncertainty: 30
    }
    stop_id: "571"
  }
  vehicle {
    id: "1301"
    Data displayed in mobile apps
  }
}
```

```
vehicle {
  trip {
    trip_id: "974372"
  }
  position {
    latitude: 28.02931
    longitude: -82.456566
    bearing: 360.0
    speed: 0.0
  }
  vehicle {
    id: "1301"
  }
  Not currently used by mobile apps
}
```
OneBusAway Tampa
Challenges – Technology / Process

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution / Lesson Learned</th>
</tr>
</thead>
</table>
| Old documentation for OneBusAway at the start of the project | Create new documentation!  
   Painful at first, but helps others          |
| Unknown accuracy of arrival times from vendor AVL | On-the-ground testing and validation necessary  
   After several iterations, got good results! |
| Communication with various parties            | Get upper-management buy-in for Agency, have in-person meetings. Identify champion within agency.  
   • Agency ITS staff  
   • Agency IT staff  
   • Agency Marketing staff  
   • Vendor |

Arrival estimate, based on real-time delay

Delay value
### OneBusAway Tampa

#### Challenges – Data

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution / Lesson Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTFS - arrival time for Stop A is after arrival time for Stop B during trip</td>
<td>Work with agency to resolve problem. Show the agency error in software, create documentation to explain the current data issues with examples</td>
</tr>
<tr>
<td>GTFS - Seconds resolution (&quot;HH:MM:SS&quot;) for time not included</td>
<td>&quot;</td>
</tr>
<tr>
<td>GTFS - Incorrect route URLs prevented app users from seeing schedules</td>
<td>&quot;</td>
</tr>
<tr>
<td>AVL - triplDs not matching GTFS tripIDs</td>
<td>Examine data dictionary for AVL system, talk directly to vendor. Conference call helped resolve issue</td>
</tr>
<tr>
<td>AVL - Flipped +/- for delay value</td>
<td>Extensive troubleshooting and isolation of issue, talk directly to vendor. Finally resulted in on-site meeting, where we resolved the problem</td>
</tr>
<tr>
<td>AVL – Agency database replication issues</td>
<td>&quot;</td>
</tr>
<tr>
<td>AVL - Use “deviation” or “predicted_deviation” value?</td>
<td>On-the-ground testing and validation necessary. After several iterations, got good results!</td>
</tr>
</tbody>
</table>

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### Tampa - From pilot to production

- USF launched a pilot of OneBusAway in Tampa with approximately 200 users in February 2013.
  - Partnered with Georgia Tech to do controlled study of impact of real-time info on riders
  - USF maintained OneBusAway for the pilot
- Public launch – August 2013
  - HART adopted OneBusAway Tampa, now runs on their servers ([tampa.onebusaway.org](http://tampa.onebusaway.org))
  - USF assisted HART in preparing RFP for long-term vendor support (began February 2014)
**LESSONS LEARNED & CONCLUSIONS**

The “take-away”

**LESSONS LEARNED & CONCLUSIONS**

**Lessons Learned**

- Open-source software enabled this project – many contributors
  - Git and Github are huge enablers
- Volunteer developers are great for general advancement of the project, but for time-sensitive, or specific, tasks paid developers may be required
- Identifying an on-going funding source is important for limited centralized operations (e.g., review and merging of software contributions from community)
- Pattern of “tech demo -> production” region deployments seems to be emerging
Conclusions

• OneBusAway mobile apps in new cities:
  – Tampa (tampa.onebusaway.org – Hillsborough Area Regional Transit)
  – Atlanta (atlanta.onebusaway.org – Georgia Tech, w/ data from MARTA)
  – York Region, Canada (tech demo – York Region Transit)
  – (More soon)!

• OneBusAway multi-region -> easy to add new cities in the future
  – Sustainable, scalable, low-cost, and low-maintenance model
**Future work**

- Ongoing research to understand impact of real-time info on riders
  - Helps us understand what users want, how to encourage use of non-single occupancy vehicle modes
  - Justifies investments in the technology
- New features
  - Improved issue reporting
  - Contributions from deployments
  - OneBusAway for Google Glass
  - Others...

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