

## **OneBusAway: A Ten Year Retrospective of an Open Source Real-time Information System**

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**Abstract** One inexpensive way to combat the perception of unreliability from the user perspective is real-time transit information. The provision of real-time passenger information has benefited substantially over the past two decades from the increased availability of automated vehicle location data on transit fleets, ubiquitous mobile devices in passengers' pockets, the third-party developer and open data culture, and substantial data standardization efforts. The growing body of research aimed at understanding riders' benefits of real-time information has measured decreases in actual and perceived wait times, increases in satisfaction with transit service, and in larger transit systems, increases in ridership.

**Keywords:** Public transport · Real-time Information · Open Source Software · Ridership

### **1 Introduction**

Our current transportation system is associated with numerous societal problems, including congestion, pollution, political instability over oil, safety impacts, and health impacts. It is widely believed that alternative modes of transportation could address many of the critical issues identified in transportation. Transit has been found to reduce congestion, gasoline consumption, and the nation's carbon footprint (Davis & Hale, 2007; Schrank, et al, 2012). Increasing the competitiveness of non-auto modes is one key to reducing environmental impact (Poudenx, 2008).

However, from a customer perspective, a transportation choice is only a feasible option if it is timely, comfortable, and reliable (Walker, 2012). Reliability can be improved in many ways, including providing dedicated right-of-way and signal priority, adding slack time to schedules and other service planning approaches, and implementing vehicle holds and other control strategies. While these strategies can

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be effective at improving reliability, they either provide only minor improvements or come at a substantial cost.

## **2 Real-time Information as a Solution**

One difficulty many riders have with transit is the unknown wait time they face. Riders stand at a corner scanning the horizon for the approaching bus or train, wondering when, or if, it will come. However, the inherent uncertainty is less of an issue if the rider knows in advance when the bus is coming, even if it is a few minutes late. Providing transit real-time information (RTI) helps passengers adapt when service is unreliable (Carrel et al, 2013) and can be provided to transit passengers in an increasingly cost-effective manner via web-enabled and mobile devices (Schweiger, 2011).

The past two decades have brought about multiple technology enhancements that have made the provision of RTI easier, less costly, and more impactful for transit agencies. First, the deactivation of selective GPS in 2000 (US Office for Space-Based Positioning, Navigation, and Timing, 2013) increased the usefulness of GPS devices and soon thereafter decreased the cost and availability. This increased the number of transit agencies able to equip their vehicles with automatic vehicle location systems. Then, in 2005, Google and Trimet began an effort to standardize transit schedule data in the form of the General Transit Feed Specification to make it easier for transit agencies to share their data (Roth, 2010) to populate Google's transit trip planner. This move eventually led to greater awareness and adoption of transit data standards, including GTFS-RealTime and the Service Interface for Real time Information (SIRI), that allow agencies to share their real-time data feeds with developers (Reed, 2013)

In a similar timeframe, the ubiquity of smartphones across the United States has made mobile access to data easy for the majority of transit riders (Windmiller et al, 2013). This has increased the interest on the part of third-party developers to create applications for transit riders who can now easily access the information provided. With more and more transit agencies releasing their data feeds as part of the push for open data, developers have easy access to a multitude of transit data feeds from across the nation, making their applications reach more potential riders (Wong et al, 2013).

## **3 OneBusAway as an Application**

OneBusAway is one mobile real-time arrival application, co-developed by Dr. Brian Ferris and myself and advised by Dr. Alan Borning while we were Ph.D. students at the University of Washington. We began the program in 2008 using a data feed from King County Metro in Seattle to provide information to riders via a website. With the advent of the iPhone that year, we created one of the first real-time transit

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information apps, and we soon followed it with an Android app as that platform was introduced. We also introduced a short-messaging service (SMS) and an Interactive Voice Recognition (IVR) system to address the needs of riders without smartphones. By 2011, OneBusAway served over 100,000 unique weekly users in the greater Seattle region.

OneBusAway was developed under multiple federal grants as an open-source system allowing other researchers and transit agencies to adapt the code for their own systems and build on the initial implementation. In 2011, MTA in New York selected OneBusAway as the basis for their BusTime system to provide real-time information for the entire 6,000 bus fleet. Dr. Sean Barbeau, et al. (2014) created a new deployment of OneBusAway with Hillsborough Area Regional Transit (HART) in Tampa, Florida, and coordinated improvements to the OneBusAway mobile apps that enable them to provide service in multiple regions.

OneBusAway demonstrations are often created by independent transit advocates. Through a partnership with Code for America in 2012, the Detroit DOT launched a “TextMyBus” service and a corresponding developer API based on OneBusAway code. The transit agencies in York, Ontario, and San Diego, California, launched their own deployment of OneBusAway internal to their agencies based on the open-source code in 2014 and 2016, respectively. Additional deployments in Rouge Valley, Oregon, and Washington, DC, were launched under contract with transit technology consultants familiar with the code. Most deployments are initiated by the transit agency, but in some cases, local developers establish the deployment to fill the gap in available rider information with the intent to support it long term or to attract the interest of the local transit agency for eventual adoption. OneBusAway now serves over 500,000 unique weekly users.

**Fig. 1.** OneBusAway apps. The Android app on the left is showing information for Tampa, while the iPhone (center) and Windows (right) are for Seattle.



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#### 4 Benefits of Real-time Information

An integral part of OneBusAway is as a research project to evaluate the effect of providing such tools on ridership and rider perceptions. We have found multiple positive outcomes: 92% of riders reporting increased or greatly increased satisfaction with public transportation, along with an increased number of transit trips per week, increased feelings of safety (for example while waiting at night), and even additional walking, which has a public health benefit (Ferris et al, 2010). An additional study of perceived and actual wait times (Watkins et al, 2011) found that for riders without real-time information, *perceived* wait time is greater than *measured* wait time, but having real-time information brings perceived wait time in line with actual wait time. In addition, mobile real-time information users in the study were observed to actually wait almost 2 minutes less than those arriving using traditional schedule information.

In Tampa, we conducted a before-after control group research design in which the treatment was access to OneBusAway over a study period of approximately three months (Brakewood et al, 2014). Behavior change was assessed using before and after web-based surveys. The frequency of bus trips per week was evaluated before and after the availability of RTI, but the change in transit trips over the study period did not differ significantly between RTI users and non-users. This was not surprising since the majority of bus riders in Tampa are transit-dependent, meaning they lack other transportation alternatives. Analysis of “usual” wait times revealed a significantly larger decrease (nearly 2 minutes) for RTI users compared to the control group during the study period. Additionally, RTI users had significant decreases in levels of anxiety and frustration when waiting for the bus compared to the control group. These findings provide strong evidence that RTI significantly improves the passenger experience of waiting for the bus, which is notoriously one of the most disliked elements of transit trips.

Perhaps most critically, in some cases, real-time information has been shown to contribute to an increase in ridership (Tang and Thakuriah, 2012). Studies we originally conducted in Seattle showed that riders self-report an increase in trips, particularly in the off-peak, a beneficial result since the transit system will have additional capacity at that point (Ferris et al, 2010; Gooze et al, 2013). Studies we conducted in Tampa and Atlanta did not find a substantial change in transit travel associated with use of real-time information, but the methodologies used to study Tampa and Atlanta did not consider completely new transit riders.

Therefore, in New York City, we used an econometric approach to model bus ridership at an aggregate level over time (Brakewood et al, 2015). The gradual rollout of Bus Time in New York City allowed for a natural experiment in which routes with real-time information could be compared to those without real-time

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information. RTI as a single binary variable showed an average increase of approximately 118 rides per route per weekday (median increase of 1.7% of weekday route-level ridership) attributable to the availability of real-time information. This increase could equate to almost 100,000 new weekday trips systemwide. Additional results suggest that real-time information may have the greatest impact in areas with higher levels of service, such as frequent routes in larger transit-oriented cities.

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