



Department of Civil and Environmental Engineering
CE454 Urban Transportation Systems

Final Report

Streetcar Arrival Validation

PROJECT TEAM

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DISCLAIMER

“This report is the result of an academic exercise. The results and recommendations are the opinions of the student authors only.”

INTRODUCTION

The Portland Streetcar system began service in July 2001 and is now a 7.2 mile continuous loop serving Northwest Portland, Portland State University and the emerging South Waterfront District. One of the planning goals of the streetcar was to link neighborhoods with a convenient transportation alternative with service provided approximately every 13 minutes. As a service, reader boards are provided indicating streetcar arrival times at each stop. Anecdotal accounts indicate that this system misrepresents the actual time of arrival. This report addresses the question of the accuracy of streetcar arrival time updates.

NextBus, Inc. provides real time information updates for the Portland Streetcar System. This system uses GPS locators on each vehicle to track its location along the route. Computer models then predict the arrival time taking into account both the actual location of the vehicle and the typical traffic it will encounter on the way to the stop. The results of the time prediction are sent to station reader boards and updated as the streetcar progresses towards the stop.

For a streetcar patron this information is only valuable if the predicted arrival time closely approximates the actual arrival time of the streetcar. If the predicated arrival time is too inaccurate, patrons may lose trust in the system and select a more reliable mode of transportation. To model this system from the point of view of a streetcar patron, data was collected at the actual streetcar stops. By comparing this data to the actual arrival time of the streetcar the accuracy of the arrival time prediction can be tested.

METHODOLOGY

Data on the arrival times of the streetcar is produced in many forms. The streetcar website (<http://www.portlandstreetcar.org>) displays real-time position and arrival information. However, the real-time arrival estimations reported on the website were found to vary by as much as two minutes from the arrival times displayed at the stops. The NextBus system uses GPS technology to relay information to create the time prediction, and a similar method of using GPS was to collect data was explored. Unfortunately, the Garmin iQue 3200 GPS units available for this

study could not accurately determine the streetcar's position in the urban canyon. So the estimated arrival times were recorded from the reader board displays. The data produced in this report was collected at several different stations directly from the reader board displays.

The data collection method was chosen to resemble the perspective of a normal streetcar patron. Although patrons may use the online system to check an approximate time of the streetcar arrival – the real opportunity for the system is to predicate arrivals for patron's waiting at the stop. Other data collection methods may provide more data in a more timely fashion, but none represent the reality streetcar riders face as closely as collecting data at the stop itself.

Data was collected from the reader board using a data collection worksheet (see appendix). At one minute intervals the reader board estimated arrival time and time of day was recorded. This continued until the streetcar arrived. The interval during which the streetcar departs is also recorded. This time is taken as the 'time of arrival' and was used in the data reduction.

To determine the accuracy of the predicted arrival times these were compared directly to the time to the actual streetcar arrival at each stop. The time the streetcar arrived was subtracted for the time of day, resulting in the real time to arrival. This actual time of arrival was then directly compared to the predicted time to arrival for each streetcar.

ANALYSIS

Over the course of the investigation data was collected on 13 separate occasions. This resulted in over 500 minutes of usable data with times for both the streetcar arrival and the reader board display. Data was collected at seven different stops and on weekdays and weekends. Included in the data set are 45 streetcar arrivals, 31 of which have data to 10 minutes prior to arrival and 17 have a full record to 12 minutes prior to the streetcar arrival. 12 minutes is considered a full run for the purposes of this report as the streetcars are expected every 13 minutes. The amount of data collected has resulted in several analyses performed with consistent agreement to the observed data.

All of the streetcar runs were plotted with regard to arrival time and predicted arrival time. The graph is shown in Figure 1. If the prediction matched the true arrival time the slope of the fitted line would be at a 45 degree angle with a slope equal to 1. The equation for the fitted line has a slope of 0.849. This means that taking the prediction and dividing it by the slope will give the actual arrival time. Therefore the reader board arrival time is, on average, under predicting the arrival time and the streetcar is about 15% late. The agreement between the data and the fitted line is very good with an r-squared value of 0.998.

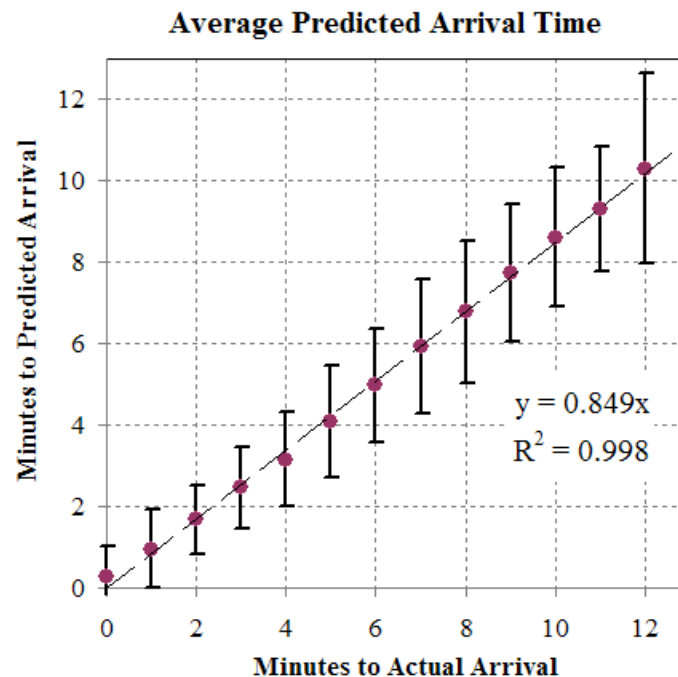


Figure 1: Actual Arrival Time vs. Predicted with Standard Deviation Bars.

RESULTS

Weekday Arrivals

During the week, 14 streetcar runs were recorded to 12 minutes. When only these runs were analyzed a similar pattern emerged. If only the weekdays were considered the arrival prediction is actually slightly worse. The slope of the fitted line is 0.816 and the streetcar is 15-20% greater than the predicted arrival time.

Weekend Arrivals

During the weekend 6 streetcar runs to 10 minutes were recorded. Analyzing only the weekend arrivals revealed that slope of the fitted line is 0.993. Therefore on weekends the predicted arrival almost exactly models the arrival time and the accuracy of the NextBus arrival system is quite good.

Accuracy Over Time

An interesting way of looking at the collected data is to graph the percentage error of streetcar predicted arrival. Figure 2 displays the graph. If the prediction was improving the closer the streetcar was to the station the percentage late would go down as the time to arrival goes to zero. However, from 7 to 2 minutes out the accuracy continues to be poor and does not significantly improve until the streetcar arrival is imminent.

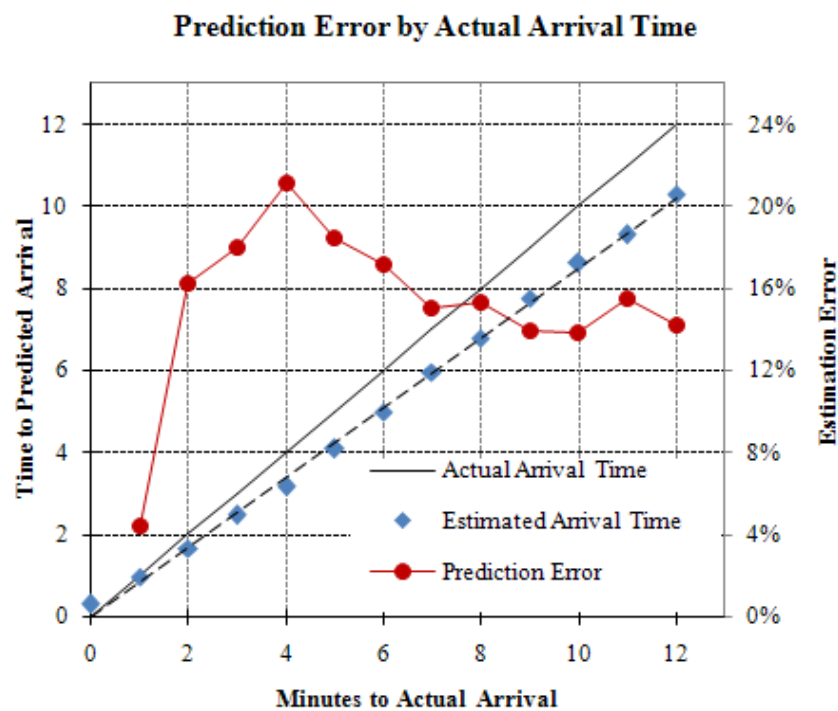


Figure 2: Percentage Late

Noteworthy Observations

Over the course of the data collection, several conditions were observed:

- During one data collection a car was observed attempting to parallel park in front of the streetcar. Up until the time the car parallel parked the streetcar would have arrived on time. However as a direct result to the obstruction for the car the streetcar arrived two minutes late.
- The only time a streetcar was observed to arrive before the predicted time was on the weekend.
- At times the reader board will count down without apparent reference to the location of the streetcar. See the appendix for an example runs in Figures 3 and Figure 4.

CONCLUSION

The purpose of this investigation was to determine the accuracy of the streetcar arrival system provided on the Portland Streetcar line. By taking the perspective of a streetcar patron, a data collection method was developed and over eight hours of data was collected. The conclusions of this investigation are the following:

- On average, the streetcar takes 15% longer to arrive than the reader board indicates.
- On weekdays the arrival system consistently predicts that the streetcar will arrive before the actual arrival.
- On weekends the arrival system accurately predicts the actual arrival.
- There is evidence to suggest that conflict with other transportation modes on the shared right of way causes some of the delay.

The results of this report suggest that there is truth in the anecdotal reports regarding the performance of the streetcar arrival system. To maintain the confidence of streetcar patrons this discrepancy should be addressed, especially during peak-hour travel.

REFERENCES

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APPENDIX

Table 1: Data Reduction Summary

	Slope	R-Squared
All Runs	0.849	0.998
Weekday Only	0.816	0.996
Weekend Only	0.993	0.988

Run Examples

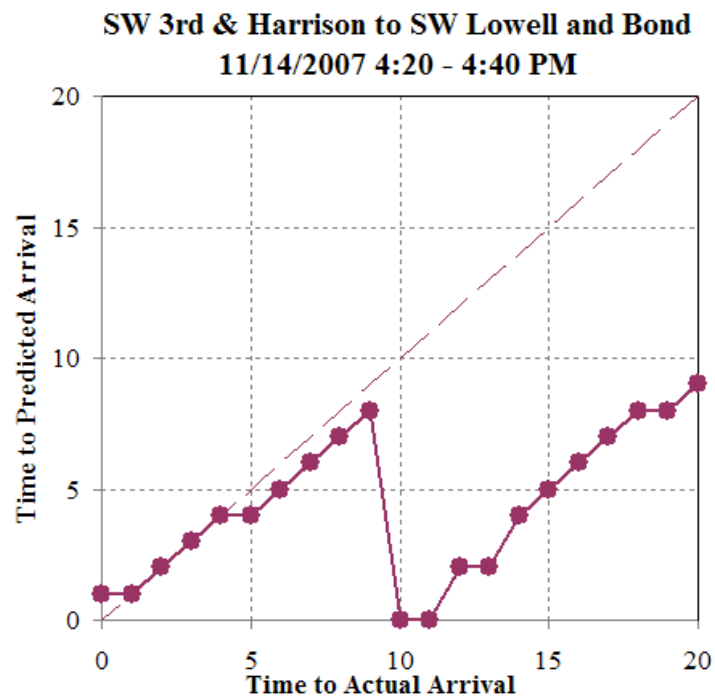


Figure 3: Run Example. Notice that the reader board counts down without any apparent relationship to the actual arrival. At 10 and 11 minutes away the reader board displays imminent arrival.

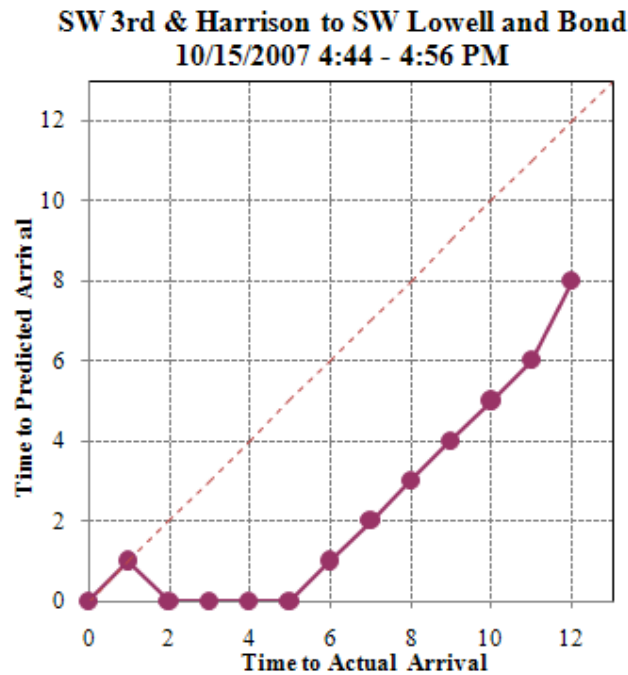


Figure 4: Run Example. Notice that the reader board is stuck on zero minutes when the streetcar is still five minutes away. This could be called the 'arrival syndrome' since the reader board only displays 'arriving' during these times.

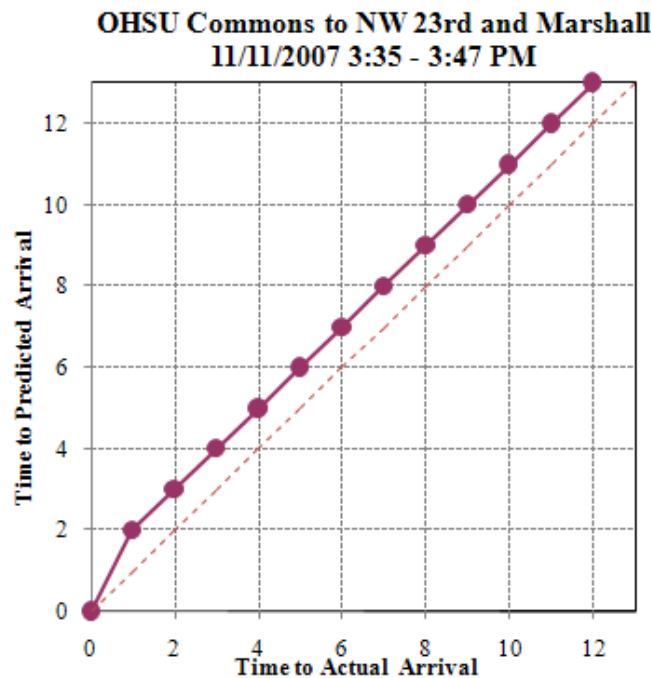


Figure 5: Run Example. In this example the reader board and the arrival time match fairly well.

Data Collection Example

**Street Car Arrival Validation
Data Worksheet**

Stop: OHSU COMMONS (WHITAKER AND BOND)

Direction (circle one): To NW 23rd and Marshall To SW Lowell and Bond

Date Nov 10, 2007 (SATURDAY)

Weather Sunny Cloudy Rain Snow Other:

Time	Rb Time 1	Rb Time 2	Arrival (Y/N)	Comments
3:51 PM	1	13		
3:52	ARRIVING	13	Y	3 ON, 0 OFF
3:53	11 11	23		
3:54	10	22 22		
3:55	9	21		4 ARRIVE ARRIVE @ STOP
3:56	8	20		
3:57	7	19		
3:58	6	18		
3:59	5	17		
4:00	4	16		
4:01	3	15		2 MORE ARRIVE AT STOP
4:02	2	14		
4:03	1	13		4 MORE ARRIVE
4:04	1	12		CAR DOOR OPENS IN FRONT OF STREET CAR
4:05	ARRIVING	11	Y	10 ON, 0 OFF TRAIN 002
4:06	10	22		
4:07	9	21		
4:08	8	20		TRAIN LETS OFF PIEDS
4:09	7	19		4 ARRIVE @ STOP
4:10	6	18		ARRIVE @ STOP?
4:11	5	17		
4:12	4	16		
4:13	3	15		
4:14	2	14		2 ARRIVE
4:15	1	13		WENT BACK UP TO 2

Collect By: BEN WILEY

Figure 6: Data Collection Worksheet