# Visualization for On and Off the Rails: Train Commuting Dashboards for DC

Jacob Rosen*
American University

Jeff Zhang†
Georgetown University

Alex Godwin‡
American University

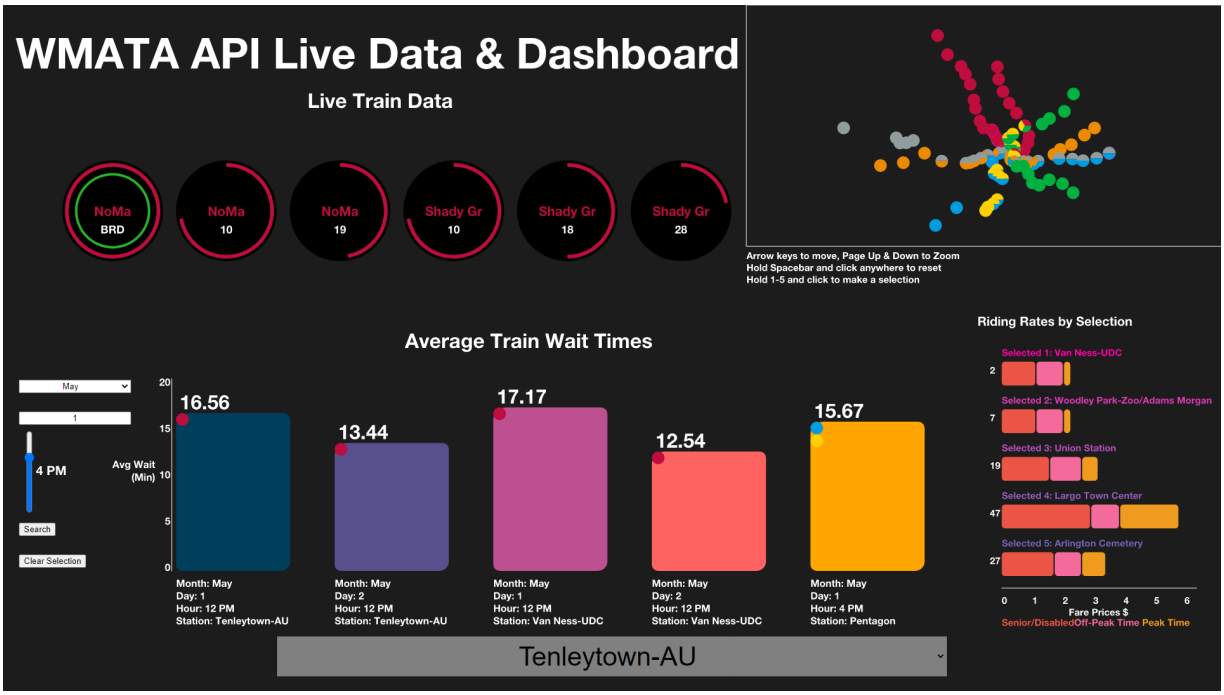


Figure 1: The MetroVis dashboard. Estimated arrival time queried from live data for a location is displayed using circular gauges (top left) and a route map (top right). Below, an interactive portion allows a commuter to query historic data for a specific time (bottom left and center) and review riding rates for the selection (bottom right).

## Abstract

The Metro API Data Visualization project (MetroVis) balances passive display capabilities for commuters with interactive queries to visualize Washington Metropolitan Area Transit Authority's (WMATA) live and historic transportation data. MetroVis is designed for commuters of two types: those that have to rapidly make decisions and catch a train, and those that have a moment to wait. For commuters that have to rapidly determine which train is arriving and how much time they have to catch it, MetroVis displays relevant information about a location that can be discerned at a glance. For commuters that have a moment to interact with the display while waiting for a train, MetroVis presents several dynamic and interactive features that allow commuters to quickly find information.

**Index Terms:** API—Visualization—Visualization techniques—Visualization design and evaluation methods

## 1 Introduction

Public transit requires reliable and efficient information systems to support its ridership. Accessibility for both locals and tourists alike is key to providing travellers with information to help them along their trip. The MetroVis application can accurately show you information about your train, where the train is headed, the train line color, your estimated arrival time to wherever you are travelling to, and how long your trip will take once you're on-board. To address these common problems, MetroVis contributes the following:

1. **Real-Time Data Discernible at a Glance**. MetroVis retrieves data from numerous WMATA APIs to show commuters train information. With this data, we create a dynamic, multi-faceted dashboard, with each visualization displaying something unique. All relevant information regarding a train is available for viewing quickly and with no prior training. From train line colors, arrival time, and even riding rates, our approach with MetroVis focuses on users having everything they need all in one place.

2. **Interactivity**. MetroVis gives commuters with available time the power to interact with every visualization element without filtering or skewing the primary at-a-glance view. For example, users can select their current station from a drop-down menu, and the entire dashboard will update to their selection. While interacting with the historic data portions of the dashboard, however, the live train data will continue to display the data for the selected station.

The dashboard user interface (UI) shows four main elements, and they concurrently display different visuals. In doing so, our UI is efficient and makes for easy comparison between different

*E-mail: jr5496a@american.edu
†E-mail: jz838@georgetown.edu
‡E-mail: godwin@american.edu

information visualizations. Our project follows WMATA's design philosophy, where we base our project's design on their Brand and Style Guidelines [5]. These guidelines outline the exact color values used in their color palette, and the exact fonts used in their corporate typeface. Both these colors and text fonts are used in our visualization to keep it consistent with other WMATA services.

## 2 Related Work

MetroVis aims to further contribute to the variety of public transit system visualizations which use real-time data. Previous works in the field of ambient visualizations outline the importance of achieving an aesthetic balance, but also in some instances, conveying information through text [1]. Rodgers and Bartram found that despite their aesthetic and effective pattern designs, participants indicated they "wanted to 'see the numbers' in certain situations" [1]. Skog, Ljungblad, and Holmquist [2] found similar issues with displaying absolutely no text on their visualization. Feedback on their Mondrian-inspired bus visualization had interviewees asking for some manner of direction and indication of which specific bus they needed to catch [2]. Similarly, we have incorporated circular representations of the remaining arrival times so that they can be compared quickly, but we have retained the more familiar text-based representation of the number of minutes for fast lookup at a glance.

Vogel and Balakrishnan [4] created a user-friendly public transit visualization system, which displays public transit information on interactive ambient displays. The system also explores methods to efficiently present as much useful information to users as possible, to respect user privacy in public spaces, and to find ways to communicate with users in a minimally intrusive manner [4]. We have also attempted to balance the public display of the station data at the top of the view for all users while still allowing a commuter to interact with the lower portion of the display for specific queries. Sun, Shi, and Schonfeld [3] demonstrate emerging applications of automatically collected data through analysis of aggregate patterns of transit passenger flow characteristics and monitoring transit travel time reliability from the passengers' perspective. By providing a running database of average train wait times, we can more accurately convey the expected accuracy of the live data to commuters in the context of what has historically occurred.

## 3 Features

Each of our four visual elements are designed to present the user with relevant information supporting different types of commuter questions. Our project's visual elements are the following:

### 3.1 Geolocation

To help users make more time-sensitive decisions, the dashboard will automatically select the geographically-closest station. By automatically detecting location, the dashboard provides fast access to the live data from the WMATA API that is most likely to be relevant to the commuter immediately. The user is also free to click the menu at the bottom to select other stations for planning. Selecting a different station will update other visual elements to display relative information.

### 3.2 The Estimated Arrival Time Gauges

The *Estimated Arrival Time Gauges* located on the top area will update. These circular gauges display a given train's line color, estimated arrival time, remaining stops, and terminal station. Each gauge represents a train that will soon arrive at the currently-selected station (maximum of 6 trains). The arc that goes along the edges of the circle is colored based on the train's WMATA line color. To provide a dynamic and updated view for commuters, a query is made for the selected station every 1.5 seconds.

### 3.3 Average Train Wait Times Selection

The *Average Train Wait Times Selection* section allows the user to see the average waiting time for a train at their currently selected station. It is located in the bottom-left of the dashboard. Users can select the date they would like information from: a drop-down menu to select the month of choice and an input-search bar to select the day of choice. Below the month and day selectors, users can drag a vertical slider bar to choose their time of choice. After these three options are chosen, the user can press the "Search" button to see the average wait time for any train at their currently selected station visualized as a bar with the time (in minutes) placed on top of the bar. The user can request up to five average train wait time bars for comparison. Changing the selected station name from the drop-down menu below allows the user to compare average waiting times at different stations.

During the development of MetroVis, we encountered one main setback that caused unforeseen problems. WMATA APIs do not offer historical data queries. This required us to cache the data ourselves. By designing a Node.js fetch script and requisitioning a cluster on MongoDB, data for all stations is cached every five minutes and available for commuters in the query dashboard.

### 3.4 Route Map and Riding Rates by Selection

In the upper right of the dashboard is the WMATA Train Route Map. This map plots all WMATA train stations as dots based on their geographical coordinates. Each station dot is colored based on the train lines available there. This conveys to users that station dots with multiple colors mean transfers are available at that station (ex. Metro Center). In this prototype, the user holds a hotkey 1-5 and clicks on a station node to add it to the accompanying visualization below. In future iterations, this can be replaced by a multi-touch interaction to remove the necessity of a keyboard.

The Riding Rates by Selection Chart visualizes how expensive each fare is from the currently-selected station via a stacked-bar chart. The estimated ride time is also displayed, allowing users to calculate their fare before reaching the station and estimate how long their trip to a target destination would take.

## 4 Conclusion

We believe our dashboard serves as a great foundation for visualizing the WMATA APIs. We are excited about what we have accomplished so far, and we hope it is as useful to commuters as what we envisioned in our design. MetroVis employs both at-a-glance and interactive visual elements to ensure a more informed ride to commuters with different use cases and information requests.

## References


[1] J. Rodgers and L. Bartram. Exploring ambient and artistic visualization for residential energy use feedback. *IEEE Transactions on Visualization and Computer Graphics*, 17(12):2489–2497, 2011. doi: 10.1109/TVCG.2011.196

[2] T. Skog, S. Ljungblad, and L. E. Holmquist. Between aesthetics and utility: designing ambient information visualizations. In *IEEE Symposium on Information Visualization 2003 (IEEE Cat. No. 03TH8714)*, pp. 233–240. IEEE, 2003.

[3] Y. Sun, J. Shi, and P. M. Schonfeld. Identifying passenger flow characteristics and evaluating travel time reliability by visualizing afc data: a case study of shanghai metro. *Public Transport*, 8(3):341–363, 2016.

[4] D. Vogel and R. Balakrishnan. Interactive public ambient displays: Transitioning from implicit to explicit, public to personal, interaction with multiple users. In *Proceedings of the 17th Annual ACM Symposium on User Interface Software and Technology*, UIST '04, p. 137–146. Association for Computing Machinery, New York, NY, USA, 2004. doi: 10.1145/1029632.1029656

[5] WMATA. *Washington Metropolitan Area Transit Authority Brand and Style Guidelines*, Mar 2018.