Techniques to Visualize and Monitor Transit Fleet Operations Performance in Urban Areas

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1 **Abstract.** A healthy and efficient public transit system is indispensable to reduce congestion, emissions,
2 energy consumption, and car dependency in urban areas. However, some bus routes chronically
3 underperform. Uncertain travel times and passenger demand preclude schedule adherence and headway
4 uniformity. In a stochastic environment, deviations from schedules are unavoidable leading to an overall
5 decrease on level of service and capacity. This study focuses on TriMet's Route 15 which experiences
6 difficulties in terms of schedule adherence and headway regularity. TriMet is the transit provider in the
7 Portland metropolitan region. TriMet's Bus Dispatch System (BDS) has been collecting and archiving
8 automated vehicle locator (AVL) and automatic passenger counter (APC) data since 1997; the availability
9 of this rich AVL/APC archived data allows for substantial performance measurement methods,
10 particularly data visualization techniques for route-level operations performance monitoring. Based on
11 the analysis of a half-year's worth of TriMet BDS data for Route 15, this paper offers two frameworks for
12 visualizing bus route operations performance measures: 1) A static visualization performance measure
13 framework based on color-coded time-space diagrams, which allows data analysis down to an hourly
14 level and for different segments, aggregate over time or space, or provide single stop analysis; and 2) A
15 dynamic interactive bus monitoring visualization framework based on Google Maps API, which
16 demonstrates bus operations performance along a route for any chosen bus. This research provides novel
17 ways to summarize and visualize vast amounts of transit data in an insightful and intuitive manner.
18 Visualizations proposed in this study will aid transit agency managers and operators to identify
19 operational problems, better understand how such problems propagate spatially and temporally across
20 routes.
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22 **Keywords**: transit performance, dynamic visualization, level of service, reliability
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