

# Design and Evaluation of an Arterial-Friendly Local Ramp Metering System-Phase I: System Enhancements for Real-time Operations

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SMARTER Center  
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## Project Overview

This research developed and evaluated an Arterial-Friendly Ramp (AF-Ramp) metering system to optimize freeway and arterial traffic flow near freeway on-ramps. The system integrates real-time data to coordinate ramp metering and intersection signal plans within the ramp impact area, aiming to mitigate common traffic issues such as on-ramp queue spillbacks and freeway congestion.

## Methodology

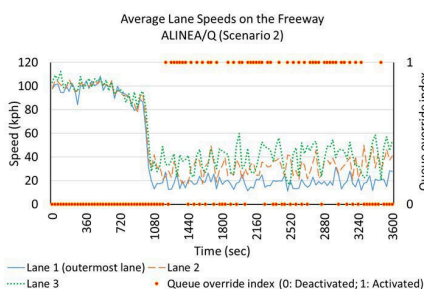
The Real-time AF-Ramp system enhances existing models by incorporating lane-group-based traffic prediction for real-time operations at freeway interchanges. The system utilizes traffic surveillance data including detector information and probe vehicle speeds. It employs a three-stage control process covering system initialization, traffic pattern projection, and dynamic execution of integrated controls. Performance evaluation utilized VISSIM simulation experiments across various traffic scenarios.

## Key Findings

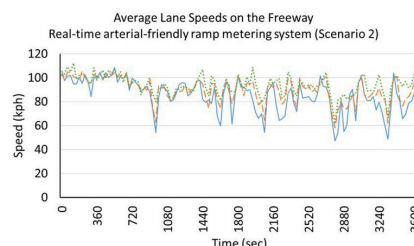
- Freeway Speed Performance:** RAF-ramp system maintained freeway speeds above 40 kph in medium-volume scenarios and prevented on-ramp and arterial link queue spillback, outperforming ALINEA/Q which frequently dropped below this threshold
- Throughput Enhancement:** Under high-volume conditions, total throughput increased 5.34% compared to ALINEA/Q, achieving 6031 vehicles versus 5725 vehicles
- Network Delay Reduction:** Total network delays improved up to 63.27% compared to ALINEA/Q and 67% compared to AF-ramp in high-volume scenarios
- Mainline Delay Optimization:** Freeway mainline delay reduced to 8.1 vehicle-hours under RAF-ramp versus 115.4 vehicle-hours with ALINEA/Q control

## Key Figures

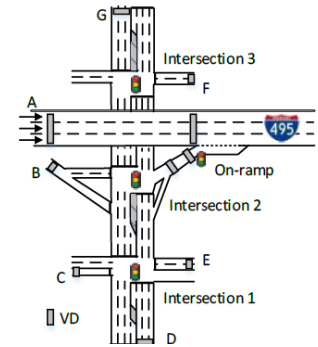
Simulation analysis depicts freeway vehicle speeds and queue spillbacks before and after AF-Ramp system implementation.



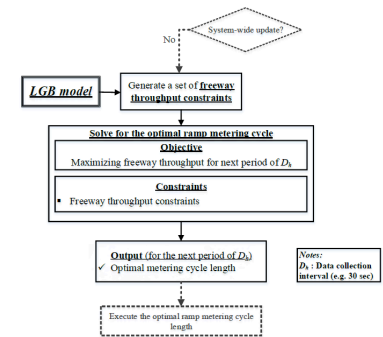
Without AF-Ramp System



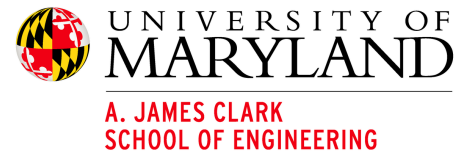
With AF-Ramp System



## Test site geometry and detectors



## Ramp metering optimization module



This research was led by faculty from the University of Maryland

## Notes for Policymakers

The AF-Ramp metering system provides practical strategies for enhancing traffic flow:

- Implement real-time ramp metering systems** that coordinate with local intersection signals
- Prioritize integration** of ramp controls with arterial signal systems
- Establish comprehensive field testing protocols** to validate system parameters