Project # 5:  Ramp Metering Control in Freeway System

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**ABSTRACT**

*Project Context.* Traffic flow in a merging area of the mainline of a freeway and an on-ramp can become a big factor causing congestion on the freeway mainline if not controlled [1]. To mitigate this congestion, ramp metering, by deploying a traffic signal on the ramp, is used. This is a countermeasure to control the rate of vehicles entering the freeway from a local roadway or connector [2], as illustrated by Figure 1. By controlling the entering rate, the traffic flow in the mainline of the freeway will remain at a moderate level of service due to the reduction of interrupted traffic from the ramp. As a result, the existing freeway capacity increases. The overall impact due to congestion reduction in the ramp and fast movement of traffic in the mainline of the freeway is a reduction in travel time, vehicle pollution emission, and number of crashes.

![Figure 1. Illustration of Ramp Metering System.](image)
This greatly improves the quality of daily life of people using these facilities.

Ramp metering, a proven engineered control technique, was initiated in 1960s in Chicago, Detroit and Los Angeles, and is now widely deployed in Washington and California [1]. Further improvements in ramp metering are now being explored by integrating Intelligent Transportation Systems (ITS) into it, which includes interfaces with local street control system and other advanced ITS systems, such as advanced vehicle control systems and dynamic route guidance through traveler messaging systems [1-4]. However, ramp metering has been criticized for increased queue and delay of vehicles on the ramps. In Cincinnati, Ohio the increasing traffic volumes in freeways I-275, I-71 and I-74 have necessitated the use of ramp metering controls. Ohio Department of Transportation (ODOT), with support from FHWA, has funded research to develop management tools to better control the metering systems so as to enhance traffic flow service and reduce vehicular emission pollution.

**Project Description.** The goal of this project is to develop a simulation-based approach to evaluate the effectiveness of a simulated ramp metering system based on defined scenarios with different cycle lengths against heavy traffic conditions data in a mainline segment of I-275 and its connected arterial or street in the vicinity of Exit 46 in Cincinnati, Ohio. The microscopic traffic simulation tool, VISSIM will be used to stimulate movements and interactions of road users through a car-following model and considering physical and psychological aspects of the drivers to model lane-changing algorithms. The results from analysis of varied scenarios will be further used to estimate optimized ramp metering control scheme to ensure smooth vehicular flow along the selected mainline of I-275 while minimizing associated on-ramp delay.

**Facilities to be Used.** Simulation modeling will be conducted at the AC’s Advanced Research in Transportation. Systems and Engineering (ART-Engines) Lab, and field data will be collected using the floating car method [5-7], vehicles equipped with GPS traveler logger devices, and radar data counter. Other video-based traffic data is available at the ART-Engines lab through leveraging the efforts from an on-going ODOT research project. VISSIM will be used as the simulation tool.

**Research Content Training.** The following specific training activities will be conducted: 1) background on operational characteristics and mathematical models describing the ramp metering system; 2) data collection techniques; and 3) data analysis using VISSIM for select I-275 case study site. A field trip to the ODOT Traffic Management Center in Columbus, Ohio will show the actual deployment of a real-world traffic operation and management system at the state-level.

**References**