Connected Vehicle Enabled Freeway Merge Management - Field Test

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Introduction

The act of merging (on freeways, roundabouts, etc.) creates vehicular conflicts that frequently result in congestion and crashes. Connected vehicles present a unique opportunity to develop a dynamic assistance system by utilizing the newly available vehicle trajectory data and capability of relaying advisory messages to vehicles in the system. With this background, the research team has previously developed three freeway merge assistance algorithms (lane-level variable speed limit, lane changing advisory, and merge control) for FHWA. This project will build upon the prior work and conduct a field test of these algorithms at the Smart Road of the Connected Vehicle UTC testbeds. Results from this field testing will provide real understanding on how these types of merge assistance algorithms can be tested and/or implemented in a real situation.

Research Objective

The purpose of this proposed project is to move a set of the algorithms developed in the FHWA sponsored work from a simulation environment to the Smart Road facility of the Virginia Connected Vehicle UTC testbed. This is an important step needed to refine the algorithms for real-world use, and to help demonstrate connected vehicle benefits to transportation agencies. The Smart Road component of the UTC Virginia test bed presents an excellent opportunity to follow-up on the work sponsored by the EARP program to validate the benefits of the developed algorithms. This will provide the benefits of accelerating implementation of this mobility application, and also helping to refine UVA CTS's connected vehicle simulation environment for use on other algorithm development efforts.

Project Goals

The goal of this project is to field test three freeway merge management algorithms on the Virginia Connected Vehicle UTC Test Bed. Initially the research team will focus on implementing and evaluating dynamic lane control in the Test Bed. Based on the success and evaluation results, the team will pursue further by introducing partial control in the Test Bed.

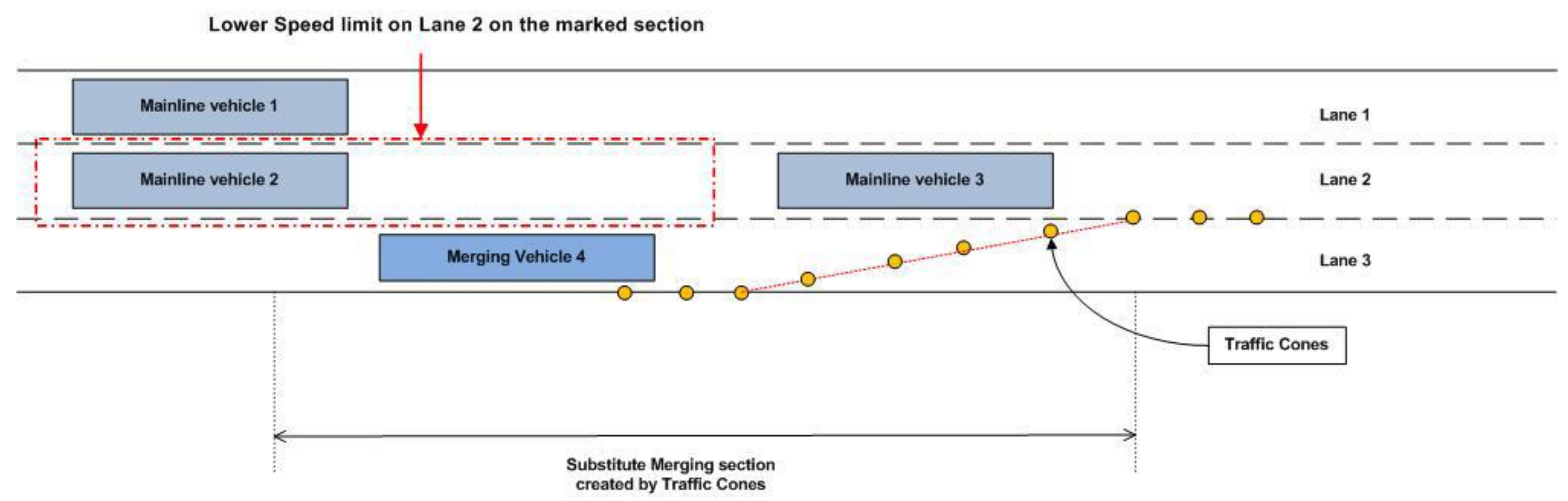
Specific objectives of this study can be summarized as follows:

1. To implement Variable Speed Limit (VSL), Lane Changing Advisory (LCA), and Merge Control Algorithms (MCA) in the Connected Vehicle UTC Test Bed,
2. To evaluate the impact of the VSL, LCA, and MCA in real-world scenarios in improving freeway merging operation,
3. To collect extensive field-level data to improve the connected vehicle simulation environment,
4. To investigate the impacts of communication performance in successfully implementing the different algorithms in the merge assistance system, and
5. To investigate the potential of partial control implementation through merging control algorithm in the merge assistance system.

Experimental Algorithmic Scenarios

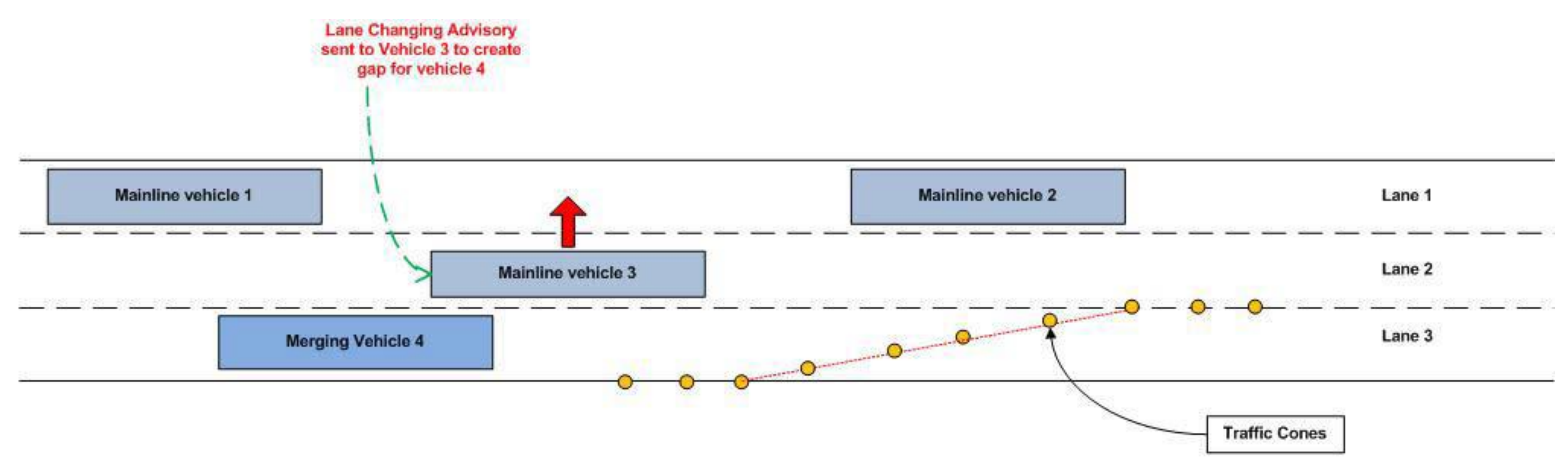
Lane-Level Variable Speed Limit (VSL)

This algorithm dynamically implements a lower speed limit to the right most lane of the freeway based on traffic densities of left and right lanes to encourage mainline traffic to move to the left lane and thus create better merging opportunities.



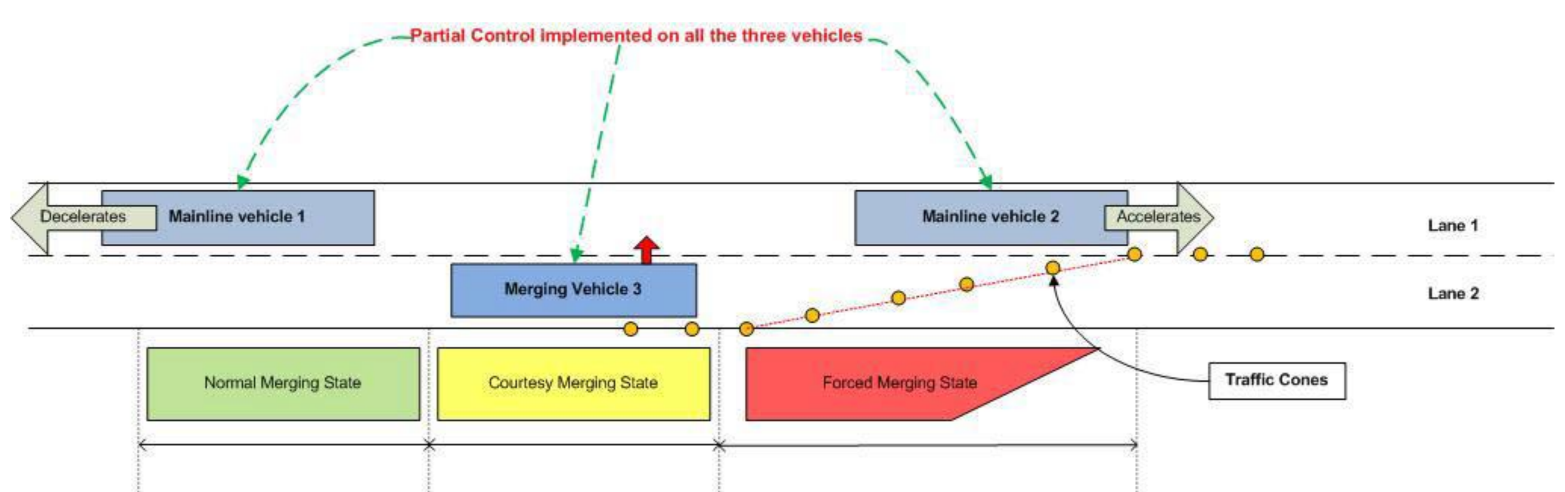
Lane Changing Advisory (LCA)

This algorithm provides advisories to selected mainline vehicles based on the expected gap availability for lane changes to encourage early mainline lane changes to enable smooth merging operation in freeway merging sections.



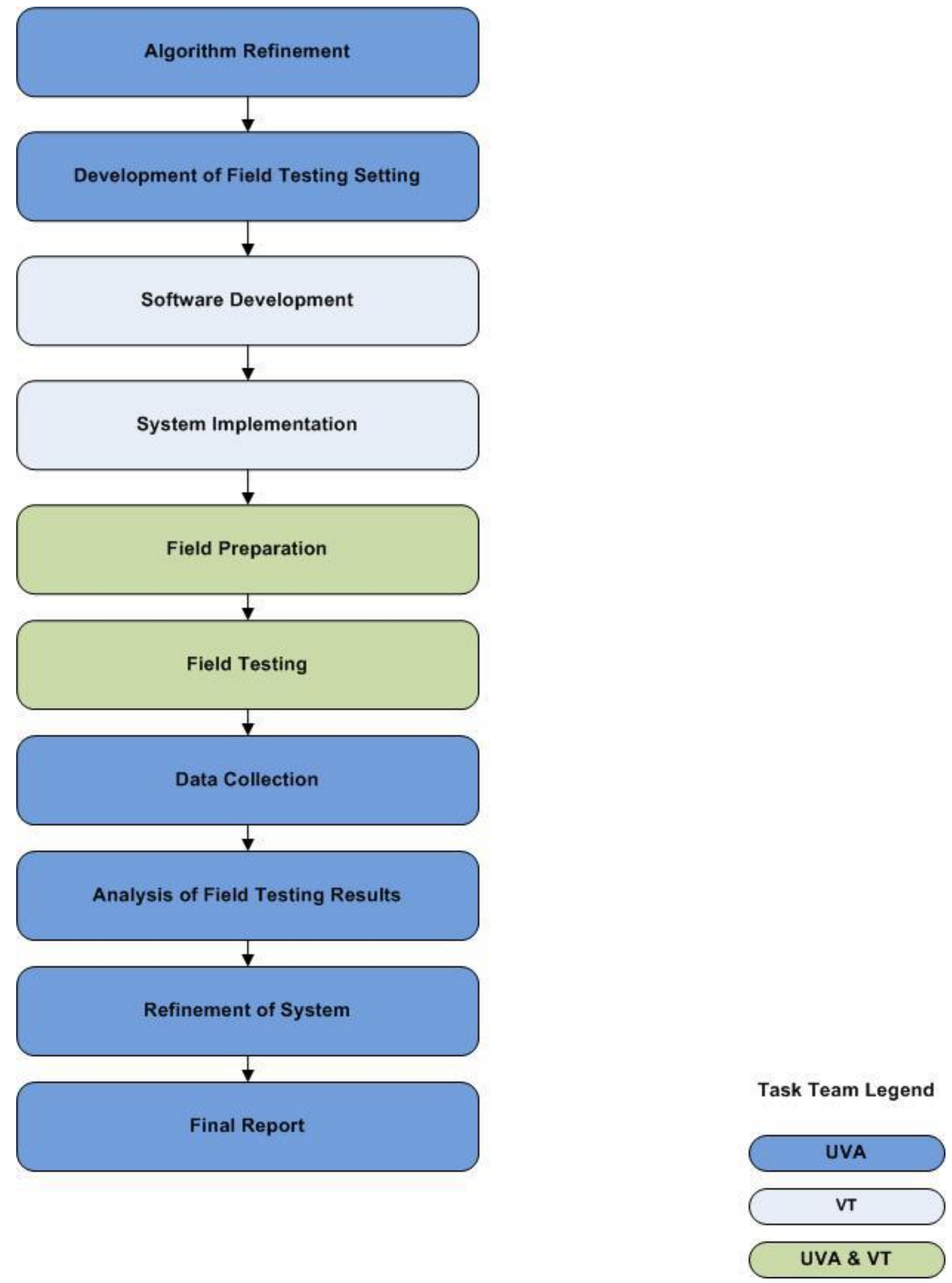
Merging Control Algorithm (MCA)

Among the four algorithms developed in the EARP Merge Assistance Project, this algorithm is the only one that implements partial control on both mainline and ramp vehicles to create adequate gaps for merging area. Based on the collected traffic data this algorithm calculates required gap for merging and then identifies appropriate control strategy and implements it.



Methodology

This section describes the methodology for conducting this field-test research project. The methodology consists of four sections as presented in the diagram below: (a) Preparation of Field Testing, (b) System Development and Implementation, (c) Field Testing, and (d) Data Collection and Analysis of Field Testing Results.



Task Flow Diagram

CVI UTC

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