Implementation of V&V Techniques and Tool for Testing a Queue Warning System Deployed for Clemson's Game Day

Introduction

The principle of operation of a Queue Warning System is to inform road users or travelers of the presence of downstream traffic based on real-time traffic detection, using warning signs, flashing lights and other means of communication. This helps drivers anticipate an impending situation of emergency braking, reduce queue related collisions and avoid erratic behavior. The rationale behind this project implementation is based off of the huge traffic situation experienced on Clemson's game day. The system features a dynamic message signs which show a symbol or word when stop-and-go traffic is near. Speed harmonization and lane control signals that provide incident management capabilities is also included in the system.

The Queue Warning application utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to infrastructure-based central entities (such as the Traffic Message Channel). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions[1]. The Q-WARN application performs two essential tasks: queue determination i.e. detection and/or prediction and queue information dissemination. In order to perform these tasks, the Q-WARN solutions can be vehicle-based or infrastructure-based or utilize a combination of both. The objective of this endeavour is to appropriate V&V techniques in creating the required work products, product components and the final product. This product will help in suggesting responsive courses of action that can help avoid queues that have been detected or even forecasted. Hence, making a strong case for a Connected Vehicle Reference Implementation Architecture based application to enable Cooperative Intelligent Transportation Systems.

Stakeholders of the System:

Users are stakeholders identified based on their categorization as Mobile, Field or Center user.

Mobile Users: Those who operate a device such as a smartphone, etc. that gathers and uses information that is part of the Q-warn application. This also includes users that operate a vehicle that is part of the Connected vehicle system. Note that pedestrians and cyclists also fall under this category.

Field Users: Those who are involved in the infrastructure that is on the transportation network performing intelligent surveillance, control functions, etc.

Center User: Those who own, operate and maintain back office systems that provide services in the Q-Warn. This includes managers, administrators, etc.

Developers: The developers are further sub categorized into Application developers (responsible for the creation of application) and the Device developers (responsible for the creation of devices that will interact with users).
Tester: They are responsible for the testing of the Q-Warn application to verify and validate the application.
Project Manager: The project manager is responsible for monitoring the project from inception to deployment of the entire application and also works with the testers and developers in order to ensure seamless development. The manager does not interact directly with the system.
Supply Manager: The supply manager is responsible for supplying the devices that support the Q-Warn Application
Enforcing Entities: They check for violations of regulations and they are entities that enforce road usage and traffic regulations be adhered to specific standards.
System Analyst: The system analyst is responsible for the increase in productivity and solves hardware and software problems.

User Specifications:

1. The Q-Warn System should predict potential queues on and off game days.
2. The Q-Warn system must project the delay that will be caused by a queue.
3. The Q-Warn System must inform a driver coming towards Clemson that a queue has built up in the area.
4. The Q-Warn System must transmit information to other vehicles and infrastructure systems.
5. The Q-Warning System must receive information from other vehicles and infrastructure systems.
6. The Q-Warn System should detect the formation of a queue around Clemson Downtown and environs.
7. The Q-Warn System must suggest to the driver some responsive courses of action to take including lane changing, speed reduction or diversions in order to avoid queues that have been detected.
8. The Q-WARN System needs to disseminate Q-WARN information to other dynamic mobility applications.
9. The Q-Warn System must communicate with other systems and gather information on road, traffic and weather conditions in order to provide a good picture of the factors contributing to queue formation and also suggest response strategies or generate warnings.
10. The Q-Warn System must analyze and evaluate itself in order to improve performance with time.