System Specification

for

AGORA

Version 2.0

A Versatile Environment for the Development of IntelliDrive Applications

(Visual …Extensible …Rule-Based)

Department of Computer Science, Western Michigan University

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Revision History

Name	Date	Reason For Changes	Version
Vinay B Gavirangaswamy	01/24/2010	Initial Draft	1.0
Vinay B Gavirangaswamy	02/11/2010	Added following section to the document 2.2,2.3,2.5,2.6,3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12,4.1,4.2	1.1
Vinay B Gavirangaswamy	02/16/2010	Changed project name from VII to AGORA, changed paragraph formatting, and reformatted cover page.	1.2
Vinay B Gavirangaswamy	07/06/2010	New version release	2.0

1. Introduction

1.1 Purpose

AGORA refers to a set of application and infrastructure which constitutes intellidrive environment that is being developed at Computer Science Department, Western Michigan University. This infrastructure consists of On-Board Equipment (OBE), Road Side Equipment (RSE), and Traffic Management Centers (TMC), which work together to increase the safety and efficiency of the transportation network. Current system that is deployed across the university consists of initial versions of RSE's, OBE's and VIS. And Current scope of work involves enhancement of VIS to include more features and functionality through incorporating different capability/applications. And it will also include development of TMC (Traffic Management Center). However the goal of this program is to facilitate MDOT in enforcing a safe and an efficient transportation system.

1.2 Intended Audience and Reading Suggestions

Document is primarily intended for members of MDOT team which consists of graduate students working under the guidance of Dr. Ala Al-Fuqaha and Dr. Dionysios Kountanis.

1.3 References

- Project Proposal Document

2. Overall Description

2.1 Product Perspective

AGORA is a futuristic technology that is engineered to increase the safety and efficiency of the transportation network. This is achieved through integration of number of platforms such as OBE, RSE, and TMC.

2.2 Guiding principles

System developed in this project follows few guiding principles which have wide impact on all aspects; including the thought process among the team and which in turn results in development of processes and sub systems.

2.2.1 Increased safety and efficiency of transportation network

Statement	Transportation system should be intelligent and be aware to increase over all life safety and efficiency of transportation network.
Rationale	By making transportation system self aware and intelligent; it will be able to operate efficiently to increase life safety, usage, ease of maintenance, operation efficiency and

	potentially reduce maintenance cost for government.
Implications	There are significant implications to increase safety and efficiency of transportation network such as need of OBE, RSE and TMC's. And also need of additional man power to operate/maintain these systems.

2.2.2 State of the art technologies and engineering techniques

Statement	Product developed will be futuristically engineered and solutions will be implemented with best of breed technologies.
Rationale	By engineering solutions for the future; architecture needs to be very flexible. It should be able to solve contemporary problems and also solve/accommodate solutions that might arise or not anticipated. Using best of breed, latest technologies also allows life time of the components.
Implications	Solution implementation need to be highly dynamic with ability to implement or extend functionality though configuration changes in the product that is developed. Problem identification and solutions that are engineered needs to be done by highly skilled labor.

2.2.3 Serve as Communication Platform

Statement	Serve as communication platform for intra AGORA and also for non AGORA systems integrating which are disjoint and would integrate though AGORA.
Rationale	AGORA's behavior as common communication platform we are improving ease of use and integration efforts and also EA governance.
Implications	Systems and technologies used should be platform independent. And confirm to open standards. It also tries to use open source technologies as compared to closed or proprietary counter parts. Custom solutions will also be engineered used ongoing research as and when required.

2.2.4 Increased people governance

Statement	General population should be able to increase self awareness of the transportation network.
Rationale	By allowing general population interacting with AGORA; people's responsibility towards society in general is increased. By allowing real time feedback and potentially increasing overall efficiency.

Implications	There is huge implication on how to enable's interaction with AGORA. Application or interfaces needs to be built/extended to all related systems/technologies that exists.

2.2.5 Green Transportation ecosystem

Statement	Reduce harm index and increase eco friendliness of overall transportation system.
Rationale	By making transportation network go green; one can help reduce environmental pollution such as air pollutants (CO2), noise pollution and also potentially increase fuel efficiency.
Implications	To achieve above set goals one should develop and integrate components, practices that will measure, improve efficiency and also improve awareness of the populous through customer applications.

2.2.6 Life Safety

Statement	Reduce number of life's lost because of accidents on the roads (transportation network)
Rationale	By trying to improve life safety one can improve road usage and encourage non-traditional means of transportation.
Implications	To achieve life safety we have huge implication in terms of transportation systems intelligence. This also includes different components of transportation system, vehicles etc.

2.2.7 Enforcement of Government Regulations

Statement	Improve enforcement of government regulations.
Rationale	By improving the way government regulations are enforced; improvement can be in terms of ease of use or the ease of enforcement. This can also potentially increase revenue.
Implications	To achieve this there needs to be increased collaboration among government, engineers and also people. Which will include different mode of enforcement, communication channels used inform populous about low and order etc.

2.3 Vision

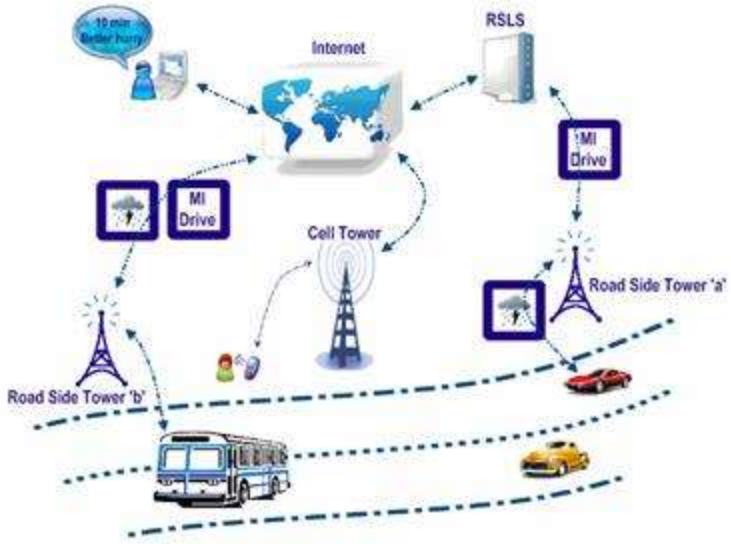

Figure 1 Birds eye view of VII and comprising systems

AGORA is a nascent concept intended to increase safety and efficiency of the transportation network. Solutions that are developed as part of this effort will be made open source. Primary characteristics of AGORA will include rapid development and deployment which comprises of following two features

2.3.1 AGORA Agent Messaging Protocol

The core of proposed system is the AGORA agent messaging protocol. This will facilitate efficient data exchange between different systems in AGORA including VIS, RSE, and TMC. Protocol would allow the software agents to proactively retrieve data from other agents or subscribe to receive asynchronous alerts from other agents. Furthermore, the protocol would be fully documented to enable the implementation of software agents in a variety of programming languages and interfaces.

2.3.2 AGORA Framework

Application Framework developed for AGORA will incorporate few best practices which will expose versatile application programming interface (API's) that will enable rapid development of AGORA capabilities. AGORA framework design will grow (scale) along with its usage and this is considered throughout its design. Few features of AGORA framework

- Rapid AGORA Application Development: framework that provides a north-bound interface to a variety of programming languages; thus, enabling rapid AGORA application development.
- Embeddable AGORA Framework: framework will be ease to port to a variety of Operation Systems (OS). This can be achieved by building an Operating System Isolation Layer (OSIL) that is OS dependent while keeping the rest of the system independent of the underlying OS.
- Rich AGORA API's: The proposed framework would provide rich API's that can be utilized for building applications that can potentially run on different platforms (Vehicle, road-side, TMC). The process of message exchange between vehicles and between vehicles and the road-side equipment would be hidden from the application developer. This enables AGORA

application developers to focus on the use of the collected data to build more sophisticated applications.
- Communication Abstraction Layer: The framework would provide a rich communication abstraction layer (CAL) that hides the details of the underlying communication technology from the application developer. This enables the team to change the underlying communication technology (e.g. MOTOMESH, WiMAX, DSRC, IEEE 802.11p, etc.) while maintaining the applications running correctly.
- Easily Configurable: The proposed system will be highly configurable without the need to recompilation.

2.4 Product Functions

AGORA consists of number of system components and subcomponents, whose function is briefly described below

- OBE
  OBE's primary function includes (i) in vehicle user interface, gather intelligence from the vehicles, inter-vehicular communication, etc.
- RSE
  Road-Side Equipment helps OBE's in communication.
- TMC
  Traffic Management Centers will act as central control stations used for communication and monitoring purposes.
- Gov 2.0
  Gov 2.0 is used to report location specific hazardous driving conditions to the transportation authority. This authority can take preventive measures accordingly.
- A3
  Advisory Alert Application informs location specific hazards reported to transportation authority by Gov 2.0.
- LSA
  Life Safety Application is used to make vehicles aware of surrounding life signs.

2.5 User Classes and Characteristics

AGORA will tentatively be used by following user classes

- General population driving small to mid size vehicles (including small, mid, and big cars, trucks etc): this class of users are the most in number. They are primary users of AGORA and all other infrastructure, user classes are developed to server and/or govern their activities.
- Traffic network maintenance vehicles: This class of users has slightly different features with additional privileges which help during maintenance.
- Public safety vehicles: This class includes ambulance, police cars and school bus etc. vehicles that will also have additional features.

2.6 Assumptions and Dependencies

- Technologies used or programming environments and solutions developed will be highly configurable; and follow data driven architecture.
- AGORA will integrate with existing infrastructure seamlessly or will enhance transportation network along with supporting technologies as required by the designs.
- Systems developed will be OS independent.

3. System Features

3.1 Cooperative Driving

3.1.1 Functionality

Enable the drivers to report traffic incidents (e.g., accidents, disabled vehicles, dead animals, presence of dangerous objects, hazardous road conditions, weaving-traffic due to DUI and sleep deprived drivers).

3.2 Automated Report

3.2.1 Functionality

This feature aims to automatically detect hazardous driving pattern and inform neighboring vehicles accordingly.

3.3 Life Safety

3.3.1 Functionality

A feature that notifies the drivers to the proximity of pedestrians, this feature will also be available on GPS-enabled cell phones and PDAs. The application will use the EDGE, GPRS or EV-DO (Internet) connection of the cell phone or PDA to send an alert to the closest road-side equipment. The road-side equipment will then notify vehicles in the area about the pedestrian traffic.

3.4 A3

3.4.1 Functionality

Enable the road-side equipment to get localized weather forecast and traffic congestion information from Internet Web Services (e.g., weather.com, webservicex.net, MI-DRIVE) and alert vehicles on the local roads accordingly.

3.5 Inter-Vehicle Alerts

3.5.1 Functionality

OBD data will be collected (e.g., ABS, traction control, etc.) and alerts will be generated accordingly. These alerts will be communicated to neighboring vehicles to warn drivers of potential dangers. In this phase, inter-vehicle communication will be achieved through the road-side equipment.

3.6 Carbon Footprint

3.6.1 Functionality

This application aims to make the drivers aware of the carbon footprint of their trips.

3.7 Fuel Efficiency

3.7.1 Functionality

This feature aims to make the drivers aware of the monetary cost of their trips.

3.8 Traffic Signal Status

3.8.1 Functionality

This feature aims to alert the drivers to the current status of the traffic light signal that they are approaching (e.g. seconds to turn to red or to green).

3.9 Proximity of Vehicles

3.9.1 Functionality

Enable the vehicles to exchange messages through the road-side equipment reporting their GPS locations.

3.10 School-Bus Safety

3.10.1 Functionality

Report the presence of a stopped school bus to neighboring vehicles.

3.11 Smart Traffic Barrels

3.11.1 Functionality

Develop components that can be embedded on road-side equipment to alert drivers to the speed limits and boundaries of road construction sites.

3.12 Rail-Road Crossings

3.12.1 Functionality

Develop components that alert the drivers as they approach a rail-road crossing.

4. Other Nonfunctional Requirements

4.1 Performance Requirements

4.1.1 Large-Scale Deployment

The performance of the framework and the proposed application would be evaluated on the live AGORA test beds. The framework and the applications would also be evaluated on a

simulation/emulation environment. This would enable us to quantify the performance of the framework in large-scale deployment scenarios.

4.2 Software Quality Attributes

4.2.1 OSIL – Operating System Isolation Layer

Proposed system will be operating system independent and this will be achieved through development of a software abstraction for each operating system.

4.2.2 Easily Configurable

The proposed system will utilize XML to be highly configurable without the need to recompile the code.

Appendix A: Glossary

MDOT – Michigan Department of Transportation
OBE – On-Board Equipment
RSE – Road-Side Equipment
TMC – Traffic Management Centers
A3– Advisory Alert Application
LSA – Life Safety Application
VIS – Vehicle Integrated Software
OSIL- Operating System Isolation Layer
OS- Operation System
CAL- Communication Abstraction Layer
DSRC- Dedicated short range communications