Protocol Pros

Autonomous Intersection Management System
Project Plan

Version 2.0

Document Preparation

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Revision History

Date	Version	Description	Author
11/04/2022	2.0	Updated the Project Plan Template to new version	Julian Villarreal

Table of Contents

Project Plan

1. Introduction

1.1 Purpose of the Document

The purpose of this document is to describe the plan for Protocol Pros to implement the software development effort. This project plan provides the acquirer insight and a tool for monitoring the processes to be followed for software development. It also briefly describes methods to be used and the approach to be followed for the specified tasks.

This plan will communicate to all team members of Protocol Pros and stakeholders the approach to be taken when developing protocols and the AIM(s) system and how the Project Manager will utilize available resources.

1.2 Scope of the Document

This Project Vision document applies to the development of an efficient protocol for Autonomous Intersection Management System (AIMS), which will be implemented by 'Protocol Pros' using Omnet++, and derived from other standard protocols like MAC, HMAC, SHA2, TCP/IP, UDP, etc. The AIMS protocol will depict the entire flow of data transmission between the traffic intersection entities. However, few things like early setup of the system, pre-allocation of secretkeys for MAC authentication, deciding the number of rounds in SHA-2, maintaining consistent bandwidth and throughput for communication is beyond the scope of this document.

1.3 References

1. Sequential Online Chore Division for Autonomous Vehicle Convoy Formation. Harel Yedidsion, Shani Alkoby, and Peter Stone pdf

2. Scalable Multiagent Driving Policies For Reducing Traffic Congestion Jiaxun Cui, William Macke, Harel Yedidsion, Aastha Goyal, Daniel Urieli, and Peter Stone In *Proceedings of the International Conference on Autonomous Agents and Multi Agent Systems* (AAMAS), 2021
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3. A Protocol for Mixed Autonomous and Human-Operated Vehicles at Intersections. Guni Sharon and Peter Stone In *Autonomous Agents and Multiagent Systems - AAMAS 2017 Workshops, Best Papers*, 2017 pdf

4. Traffic Optimization For a Mixture of Self-interested and Compliant Agents. Guni Sharon, Michael Albert, Tarun Rambha, Stephen Boyles and Peter Stone
In *Proceedings of the 32nd AAAI Conference on Artificial Intelligence* (AAAI-18),
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5. Multiagent Traffic Management: A Reservation-Based Intersection Control Mechanism.
Mechanism. In *The Third International Joint Conference On Autonomous Agents and Multiagent Systems* (AAMAS 04), July 2004. pdf

6. Human-Usable and Emergency Vehicle–Aware Control Policies for Autonomous Intersection Management. Kurt Dresner and Peter Stone. In *The Fourth Workshop on Agents in Traffic and Transportation* (ATT 06), May 2006. pdf

7. Marginal Cost Pricing with a Fixed Error Factor in Traffic Networks. Guni Sharon, Stephen D. Boyles, Shani Alkoby, and Peter Stone In *The Proceedings of the 18th International Conference on Autonomous Agents and Multiagent Systems* (AAMAS 2019), 2019 pdf

1.4 Definitions, Acronyms, and Abbreviations

See Appendix A.

2. Project Goals

2.1 Business Goals

With the lack of any sort of traffic intersection breakthrough in recent years, traffic time as well as accidents seemingly increase with time. With our development of an Autonomous Intersection Management System, we'll provide a safer and more time effective future for our world.

2.2 Product Goals

Goal Number	Product Goal
1	Instantiate application for a particular intersection
2	Integrate the instance to a 'City' (Smart City System)
3	Setup perceptive nodes for that instance
4	Setup status stream from AIMS to 'City'
5	Pause Application
6	Exit Application
7	Change vehicle priority
8	SHA-2 based hashed information exchange
9	Provide instructions to agents through TCP using HMAC authentication
10	Embedded ambient Intelligence through image processing
11	OCR (Optical Character Recognition) for identifying every individual vehicle/agent
12	Image Recognition (Agents without IoT capabilities)
13	Place emergency vehicle condition
14	Change vehicle priority in system, based on intersection instance
15	Send emergency condition alert to higher authorities (Smart City System)

2.3 Quality Goals

The product of the implementation of this system will lead to many benefits. These benefits will make the intersection much safer and much more efficient that today's interpretation. The quality goals to be reached are as follows:

Benefits	Supporting Features
Safe communication between agents and application	There is minimal vulnerability in the communication between the application and agents involved, thereby ensuring data-safety and road-safety simultaneously
Priority based allowance to agents	Emergency vehicles are always given the highest priority in the intersection. The priority of vehicles is preset in the application, and it responds to requests accordingly.
Saves traffic time	Due to the proper implementation of autonomous intersection management application, a lot of traffic time is saved, as compared to conventional traffic-signal based systems.
Efficient intersection status reports provided to Smart City Systems	AIMS enables the provision of a timely report to the higher levels of the metropolitan such as Smart City Management Systems, subsequently helping the cities to get the status of roads.

3. Project Stakeholders and Stakes

3.1 Stakeholder Summary

Name	Description	Responsibilities
Project Manager	This stakeholder works with the customers and translates the needs into requirements.	Specifies domain, requirements – both functional and non-functional, requirement refining as per need. Keeping a check into the whole project and maintain the progress
Technical Manager	This stakeholder analyzes the requirements and does a feasibility check of the same.	Checks if the requirements can be well implemented without any modifications. Design ways to implement requirements.
Researcher	Makes a check of available and conventional methods of implementing the requirement and figures out better ways of designing them.	Crawls through available systems which revolve around the specified requirements and cite improvements in the execution methodologies.
Designer	Based on the papers produced by the researchers, this stakeholder designs a systematic and technical methodology of implementing the requirement	Figure out the optimal way of implementing the suggested methodology of the researcher and produce the design of the same.
Developer	Substantiates the proposed design by implementing the same in the decided technology stack.	Decide the best way to implement and execute the design, in order to support scalability and encompassing all possible cases.
Tester	Identify all possible test cases of every module in	Figure out the possible test cases in every segment/module of the system and perform

	the system and cite out the test cases, thereby testing the system against each of them.	manual/automation testing of the developed system against the drawn-out test cases.

3.2 User Summary

Name	Description	Responsibilities	Stakeholder
Intersection	Primary end user of the system	Exploit an instance of the AIMS system and maintain the traffic based on business logic of the system. Provide a timely report to the upper level in the hierarchy	This stakeholder will be the medium in which all agents will travel through.
Smart City Systems	Beneficiary of the system	Receive the periodic reports from every instance of the system and analyze if everything is going well. Ensure safety across all the instances and notify instances in case of absurdity.	This stakeholder will ensure the safety and network for the proposed system.
Interacting agents with IoT capabilities	Primary End-user of the system	Stay within the vicinity of their closest interaction instance and communicate their intentions in the intersection. Receive and follow the instructions provided by the system.	This stakeholder encompasses all agents within the intersection radius that has IoT capabilities.
Interacting agents without IoT capabilities	Allied agent of the system	They cannot directly interact with the system. However, our system, inculcated with ambient intelligence, can identify these	This stakeholder encompasses all agents within the intersection radius that does not have IoT capabilities.

		agents, and have an estimate of their intentions in the intersection.	

3.3 Summary of Key Stakeholder or User Needs

Currently, traffic intersections do not have any autonomous, and time-efficient control system, and the entire intersection operation is almost dependent on traffic signals. Traffic signals are apparently safe, but are inefficient in terms of time, and do not dynamically respond to road conditions and requirements. They operate in a uniform pattern, unless intervened by human beings.

Need	Priority	Concerns	Proposed Solution
Accurate Instruction	High	An absolutely accurate set of instruction for agents for their further move in the intersection, because it may stake high values if provided inaccurately.	Implementation of instruction provision based on a TCP-like connectionbased communication protocol between the system and the agent so that instructions are received, and the system is notified about the reception.
Unaltered Instructions	High	Even though the instructions sent by the system may be accurate, there is a vulnerability that a third party can alter the instructions by taking over the network.	Use a Hash-based Message Authentication Code (HMAC, based on Fully Homomorphic Encryption) protocol for interaction between agents and our system, to ensure that the instructions are unaltered, and integrity

			is maintained.
Secured Transmission of Intersection Status	Moderate	The Smart City system and AIMS should have secured communication so that illstatus is not leaked that may turn out to be pugnacious.	Usage of Secure Hash Algorithm (SHA-2) to transmit instructions between AIMS and Smart City systems would ensure safety in this communication.
Efficient Conveyance of instant status of Intersection to System	Low	Every intersection, at every quantum of time, is expected to convey its status to the AIMS in order to get instructions and transmit to every agent there.	Exploitation of User Datagram Protocol (UDP) based connection-less protocol for maintaining communication from the agent to the AIMS, to maintain efficiency.

4. Project Budget

Assume 1 day = 2 hours of team effort

Project Task	Time (days)	Time (hours)
Feasibility Study	4	8
Requirement Analysis and Specifications	2	4
Design	5	10
Coding and Unit testing/Development	8	16
Integration and System Testing	4	8
Maintenance	2	4

Total: 25 days 50 hours

5. Project Milestones and Schedule

Project Start Date: August 24, 2022 (08/24/2022)

Project End Date: December 07, 2022 (12/07/2022)

Project Milestone	Date	Deliverable
Problem Analysis, Vision Creation, Project Planning	09/21/2022	Product Vision Document Project Plan
Requirements Analysis	09/28/2022	Software Requirements Specification (SRS)
Product Design	10/12/2022	Software Design Document (SDD)
Product Implementation	10/26/2022	Software Code
Product Test	11/02/2022	Software Test Document (STD)
Final Product Deliverable	11/23/2022	All Documentation and Code
Product Launch	11/30/2022	Project Presentation

6. Project Communications

Communication through our team will be handled in two different ways. These two forms of communication will be in person and on Discord. Discord will be used to keep track of documents and deliverables. This includes previous and upcoming versions of said documents. Also, Discord will include a text-channel for discussion among team members and another for project resources. Through-out the week our class meets two times a week and following the class our team will touch base for 5-10 minutes. This small meeting will cover any current problems that is going on with on going tasks as well as assigning new tasks for new deliverables. For longer meetings, our team will meet in the library as it is on campus and easily accessible by all members.

7. Project Members and Roles

Project Role	Name	Responsibilities
Project Manager	Ashutosh Mishra Amado Lazo	Specifies domain, requirements – both functional and non-functional, requirement refining as per need. Keeping a check into the whole project and maintain the progress
Project Technical Manager	Prakash Acharya Sarah Ryan	Checks if the requirements can be well implemented without any modifications. Design ways to implement requirements.
Project Design Manager	Brendan Edgerley Julian Villarreal	Figure out the optimal way of implementing the suggested methodology of the researcher and produce the design of the same.
Project Test Manager	Sarah Ryan Prakash Acharya	Figure out the possible test cases in every segment/module of the system and perform manual/automation testing of the developed system against the drawn-out test cases.
Project Engineer	Ashutosh Mishra Brendan Edgerley David Schelanko	Decide the best way to implement and execute the design, in order to support scalability and encompassing all possible cases

8. Project Work Breakdown Structure (WBS)

Work Package Number	Work Package Name	Responsible Team Member	Definition
WP-1	Research	Julian Villarreal, David Schelanko, Amazo Lazo	Makes a check of available and conventional methods of implementing the requirement and figures out better ways of designing them.
WP-2	Design Proposed Protocols	Julian Villarreal, Brendan Edgerley	Based on previous protocols and research, these package members design a technical and systematic outline for the proposed protocols.
WP-3	Design Simulation	Julian Villarreal, Brendan Edgerley	Based on the papers produced by the researchers, these package members design a systematic and technical methodology of implementing the requirement.
WP-4	Running Simulation Code	Ashutosh Mishra, Brendan Edgerley, David Schelanko	Decide the best way to implement and execute the design, in order to support scalability and encompassing all possible cases. This will be the first draft following the design from WP-2 and WP-3.
WP-5	Test Cases	Sarah Ryan, Prakash Acharya	Build different test cases to cover most if not all bases that will occur within the intersection
WP-6	Final Simulation Code	Ashutosh Mishra, Brendan Edgerley, David Schelanko	Based on previous simulation code and results of test cases, these package members will alter and build the technical simulation code.

9. Project Deliverables

Deliverable Number	Deliverable Name
D-1	Project Vision Document
D-2	Project Plan
D-3	Software Requirements Document
D-4	Software Design Document
D-5	Running Simulation Code
D-6	Software Test Document
D-7	RFC Draft

10. Project Risks

Risk Number	Risk	Risk Reduction Approach
R-1	Code Issues	Research and practice with Omnet++, Test code frequently, using best coding practices, resolving bugs and logical errors when they're found
R-2	Aggressive Deadlines	Create a thorough project plan
R-3	Error in Scope Definition	Collaborate effectively and receive frequent feedback from stakeholder

Risk Priority	Severity	Probability	Risk Level
R-1	High (3)	High (3)	9
R-3	Medium (2)	Medium (2)	4
R-2	High (3)	Low (1)	3

11. Appendix A – Definitions, Acronyms, and Abbreviations

Term	Abbreviation / Acronym	Definition
Autonomous Intersection Management System	AIM(S)	A system designed for the time when all (or most) vehicles are fully autonomous and connected.
Smart Intersection Management System	SIM(S)	An adaptive traffic control solution for an isolated intersection.
Message Authentication Code	MAC	A security code that is type in by a user to access accounts.
Hash-based Message Authentication Code	HMAC	Type of MAC that is acquired by executing a cryptographic hash function on the data.
Transmission Control Protocol	TCP	A transport layer protocol which is used by applications that required guaranteed delivery of data.
Internet Protocol	IP	A set of rules governing the format of data sent over the internet or other network.
User Datagram Protocol	UDP	A communication protocol that is used to establish a low latency connection between applications.
Secure Hash Algorithm	SHA	An algorithm that takes an input of any length and creates a hashed value.
Internet Of Things	IOT	The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data
Unified Modeling Language	UML	A general purpose, developmental modeling language to provide a standard way to visualize the design of the system

Intersection	I	A point where two lines or streets cross. Typically, there can be three types of intersections: Three-leg or T-intersection (with variations in the angle of approach), Four-leg intersection and multi-leg intersection.
Agent	A	As far as this document is concerned, an agent is any entity that is involved in the intersection, like vehicles, pedestrians, street-animals, pets, traffic management system, intersection management system, Smart City management system.
Internet of Things capacity/capability/ability	IOTC	The ability of an agent to directly interact, convey or respond to any other agent by means of digital medium.
Vehicle to Vehicle interaction	V2V	A connection between two vehicles within the designated intersection.
Vehicle to Agent interaction	V2X	A connection between a vehicle and an agent within the designated intersection.
Agent to Agent interaction	X2X	A connection between two agents within the designated intersection.