Prototyping of 5G for Smart Ag, Smart UAV, Smart Cars

PROJECT PLAN

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Revised: 20180924 V1

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OAI (Open Air Interface)

SUMO (Suburban Mobility)

CPS (Cyber Physical Scheduling)

USRP (Universal Software Radio Peripheral)

1 Introductory Material

1.1 Acknowledgement

Professor Zhang Hongwei, Anthony Benson, Jared Gorton, Hye-Sung Moon, Khanh Luu, Ted Miller, Jaime Zetina.

1.2 Problem Statement

Today's current network speeds that are available through 4G LTE are essential for the demand of data and communication the world has. The new development of smart IoT's has begun to demand more from 4G LTE and 4G LTE is quickly reaching it limit in its' ability to support the new wave of IoT's.

The development of 5G will allow the new world of smart IoT's to send receive and access the data it need at the time it needs it to operate at its full capacity. We are prototyping a 5G network to be able to deliver on this demand.

1.3 Operating Environment

The operating environment is ideally every single location reachable by man. The network would support a smart car that needs to receive, process, and send road conditions to drive autonomously and safely.

1.4 Intended Users and Intended Uses (two paragraph +)

The intended users are anyone seeking to use a 5G network in various applications.

The intended use is as a high reliability, low latency 5G wireless network.

1.5 Assumptions and Limitations

We assume autonomous vehicle and IoT industry growing exponentially, the importance of high speed, low latency, and reliable network systems is highlighted. One of the most promising option is 5G network. 5G network provides the 20 times faster data rate than 4G network, and the error rate and latency is near to zero. We are expecting to wirelessly commands the AV with 99% reliability.

Given the fact that we are designing a 5G network prototype, there is a practical limitation to fulfill the latency requirement which is less than 1ms. We decided to leave the latency level as 4G network (100ms) and more focus on reliability.

1.6 Expected End Product and Other Deliverables

The expected end product is a prototype 5G network implementation with high reliability and low latency. With this systems, we are expecting to implement the Autonomous Vehicles, IoT and other related devices.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

The main objective of this project is to create a prototype 5G network that is both low latency and highly reliable. We will then use this network to control a remote controlled vehicle.

2.2 Functional Requirements

The main functional requirements of our prototype 5G network are as follows

1. The network should be able to send and receive data without data loss.
2. The network should be able to send and receive data to and from many connected devices.

2.3 Constraints Considerations

The main non-functional requirements of our prototype 5G network are as follows

1. The network should be able to send and receive data with a reliability of at least 90%.
2. The network should have latency low enough for the real time control of a remote control vehicle.

Coding standards have yet to be decided. All of our practices will follow the ethical standards of IEEE.

2.4 Previous Work And Literature

Our advisor, Prof. Zhang, has already done some research into cyber-physical scheduling which we will use as a basis for our implementation.

2.5 Proposed Design

Our proposed prototype 5G network will use OAI in the implementation of our own version of CPS.

2.6 Technology Considerations

Current wireless technology lacks the reliability needed for many applications such as autonomous vehicles and other safety critical applications. Our implementation of CPS will hopefully address these issues.

2.7 Safety Considerations

Most of the project is software applications so there are little to no safety considerations needed for most of the project. The only thing would be that if we get far enough to setup the remote control car. In which case there is a minor chance of being shocked. All that would be needed for that would be to wear rubber gloves or to ground ourselves.

2.8 Task Approach

The first part of the project will mainly be focused on research. The research will be broken into two different categories in-order to save time. One category will by CPS and the other will be OAI. CPS will involve more research and will focus on developing a CPS algorithm. OAI will have less of a focus on research and will mainly be getting the software up and running.

2.9 Possible Risks And Risk Management

The main hindrance to the project will be the knowledge that is needed for the project. To solve this issue the group has jumped into research on the matter. Another risk will be equipment, the program OAI requires a powerful computer with other exact specifications.

2.10 Project Proposed Milestones and Evaluation Criteria

The first main milestone of the project is finishing our CPS research materials. Also in the first milestone will be getting OAI up and running. The second milestone will be developing a CPS algorithm. Our groups CPS algorithm will be put into OAI for our third milestone. This milestone will be tested by using a program called SUMO. This will also act as testing for the second milestone as well. After that testing is done the group hopes to get a physical prototype going. This is a hopeful Fourth and final milestone.

2.11 Project Tracking Procedures

We will use our schedule to track the progress of the project. The schedule itself covers the entire project and has different goals for the end of each one. For example the first deadline is for the group to be done with the research into 5G LTE. This schedule spans both semesters.

2.12 Expected Results and Validation

The desired outcome for the project is a workable efficient CPS algorithm working in OAI. This will be tested by seeing in the algorithm works in the simulation program SUMO.

2.13 Test Plan

The plan to test the project is to begin with basic tests while its running in OAI to make sure it outputs and runs correctly. This will include making sure the response time is within an acceptable range, as well as making sure the program outputs the right information. The second stage of testing will be done in SUMO which will test if our program enables efficient communication between different autonomous vehicles.

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

Assignment	Sept 3rd - Oct 12th	Oct 13th - Oct 26th	Oct 27th - Dec 14th	Jan 12th - Feb 28th	March 1st - May 5th
Read 4G LTE Advance Pro and The Road to 5G					
Research unified Cellular Scheduling					
Research Cyber Physical Scheduling					
Research effects Latency on Reliability					
Research efforts towards Network Reliability					
Research Open Air Interface software					
Research SUMO software					
Research Graph Theory					
Determine Specific application to simulate					
Research and design Algorithm for simulation					
Design Code to create Simulations					
Validate Simulation					
Hardware Prototype based on Simulation					

Table 1: Timeline of proposed work schedules

Due to our particular situation for our project, we spend most of time researching about the 5G network and regarding materials that we required.

First half of the Fall 2018 semester will be assigned for the researching about LTE and conceptual 5G and regarding materials.

Second half of the Fall 2018 semester, we are going to make algorithms and codeworks for simulation.

First half of the Spring 2019 semester, we will test the compatibility with simulation and hardware(vehicle).

Second half of the Spring 2019 semester, we will test the overall systems performance with the autonomous vehicle.

3.2 Feasibility Assessment

The hardest part will be the making an algorithm over OAI. We are making a 5G prototype, this algorithm and codework will be the most crucial and essential part of our project. That algorithm also have to maintain the high level of reliability of the systems and low latency over simulation and implementation.

3.3 Personnel Effort Requirements

We divide into two teams, OAI research team and LTE-5G team to use our time efficiently. In order to minimize the gap between two teams, we make a summary of each team's research and share weekly.

Topic	Time (hours)
Researching LTE-5G	20
Researching Cyber-Physical Scheduling	20
Research OAI	20
Research SUMO	10
Design algorithm over OAI	40
Validate Simulation	10
Hardware Implementation	15
Overall System Check	15
Total Hour	150

Table 2: Task-by-task basis timeline

All individuals in the team are required to research the listed topics and regarding material to perform the project.

3.4 Other Resource Requirements

We are expecting to need a RC(Remote Control) car just in case. Our primary HW will be provided by the Prof. Zhang. It is an actual vehicle with USRP SDRs. Since RF devices are extremely expensive, we are expected to use his hardware. If not, we are going to design a RC car with microprocessor and implement the hardware performance.

3.5 Financial Requirements

Item	Description	Budget ($)
OAI	Basic program to build code work and algorithm. It is open source SW	0
USRP SDR	RF device to communicate from device to device. It will be provided by Prof. Zhang	0
Vehicle	Prof. Zhang already has a vehicle, and we are going to use it.	0
Computer	We are going to use our own laptop to make a simulation or will be provided by the professor's student.	0
	TOTAL	0

Table 3: Budget

4 Closure Materials

4.1 Conclusion

As a group we have been working hard towards finishing our project. We have researched the basic necessary information for the project. This includes reading several research papers and books. Also we have worked on getting the software OAI running. OAI has proved to be difficult because of how specific its requirements are. Getting OAI up and running with our CPS algorithm is one of the big goals for the project. Another goal is to get it running in the simulation environment SUMO. To succeed in these goals we have broken into two groups and are working on the CPS algorithm and OAI separately to begin with. We will then come back together and get both working together to test in SUMO.

4.2 References

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OpenAirInterface 5G software alliance for democratising wireless innovation http://www.openairinterface.org/

4.3 Appendices