Proposal for Scope of Work Change for SMART Mobility Program

Project Task 7A.3.1.b

New Task Title: CACC Development and Field Test - Passenger Cars with Different Powertrain Types

Project PI: Xiao-Yun Lu, LBNL

Overview:
This memo proposes a change of Scope of Work for sub-task *7.A.3.2.1:* Develop and test passenger car CACC enhancements to improve energy efficiency (LBNL, ANL, INL) that has key benefits: (i) increases involvement of DOE labs and researchers and (ii) creates better and lasting energy saving and emission reduction research platform for platooning/CACC development and testing with vehicles of different power trains. The new task number will be CAV 7A3.1.b

Scope of Work:
Considering those factors, we propose to change the Scope of Work as follows: to develop CACC capability on new platform by ourselves. This platform would include vehicles with different powertrain types including: IC engine, hybrid electric, electric, and hopefully, fuel cell electric as well.

The roles of LBNL team will include:
- Purchase and develop 4 Central Control Computer PC-104
- Install Real-time operating system QNX
- Develop lower level software including interfaces with commercially available remote sensors (such as radar, lidar and video camera, or their combination), DSRC units and CAN Bus
- Preliminarily implement CACC on the 4 vehicles in this phase
- Conduct initial test with ANL and INL on a test track; candidate test tracks include: (a) GoMentum Station in California (http://gomentumstation.net/); and (b) Navy Air Station in Alameda, in California; both test sites are in the proximity of LBNL

  Additional points:
  - Two options for the vehicle use will be discussed in Section 5
  - Each vehicle is to have a DSRC Unit (the cost will be added to the required budget)
  - Accessible to CAN bus for data reading and control

The roles ANL team (Eric Rask's Group) will include:
- Provide interface protocol with CAN Bus for real-time data reading and control
- Develop powertrain mapping for vehicles with different powertrain types in Phase I
- Refine the powertrain mapping in Phase II

- Develop lower level control for each vehicle with different powertrain types in Phase III
- Assist and coordinate with LBNL for CACC overall system development

Joint activities of LBNL, ANL and INL *(Matthew Shirk):*
- Experimental test planning
- Coordination of system development
- Collaborative execution of testing

Roadmap for the Proposed Approach:

Phase I (June 2018 – Sept 2019): preliminarily design and develop of CACC capability on 4-vehicle string with at least three powertrain types; the target is to run on a test track at high speeds; first vehicle has only CC (Cruise Control); test and demo on closed track will be conducted;

Phase II: (June 2019 – Sept 2020): develop ACC to the first vehicle in the CACC string; adding 5th vehicle to the CACC string with different vehicle types or powertrains (e.g. hydrogen fuel cell); performance improvement for the 5-vehicle CACC string will be conducted by fine tuning of the controller; the target is to run on test track and on a freeway in real-world traffic; and energy consumption tests and demo on a freeway with public traffic will be conducted;

Phase III: (June 2020 – Sept 2022): incorporate lower level power train and drivetrain characteristics and their active control in CACC/Platoon design for further energy consumption reduction; the target is to run on freeway with public traffic; and energy consumption test and demo on freeway with public traffic will be conducted;

Other relevant effort related to the two options:

- Since LBNL/PATH team will use QNX based Real-Time Operating System as we have been using for over 30 years, there is no significant development necessary in this respect. With this platform, modules for interfacing with remote sensors and DSRC communication systems are almost ready to use since they have been developed in other projects. However, the protocol for interfacing with the CAN Bus for data reading and controls will need to come from the ANL group.
- Remote sensors: A Bay Area company AEye has agreed to donate four units of their remote sensors (fused lidar and video camera), which will not incur any cost.
- DSRC units: the project funding will need to purchase five DSRC units; the make would be what LBNL team used before to avoid effort of redeveloping the control driver; in this way, there will be no conflict when ANL teams needs to use the DSRC units on their vehicles for other projects.
- LBNL team is still working on the application of external funding for purchasing 4~5 new vehicles with different powertrain types; i.e. the funding is not guaranteed yet. If this option is not feasible, the only choice will be Option A, at least for Phase I project.