Intelligent Transportation Systems-II
A Cyber-Physical System Approach and Research Strategy

Jyh-Charn (Steve) Liu
Department of Computer Science and Engineering
Texas A&M University, College Station, TX 77840
liu@cse.tamu.edu

Intelligent Transportation Systems (ITS), incepted around 1990 in a series of workshops, developed a roadmap about modernization of U.S. surface roads. Autonomous vehicles, fleeting of regular vehicles were among some most ambitious goals of ITS initiative. Although some research agendas were not materialized at time, many other cutting-edge technologies have been deployed to the roadside infrastructure and vehicles for sensing, traffic light timing, congestion control, traffic data management, etc. Twenty plus years later, we face a new technology era, in which much higher density of computing power, sensing ability, wired/wireless bandwidth, and computational logic can be operated per unit of power/size/weight of the photo-electronics. As the nation's opinion about presence of autonomous vehicles in the regular air and road ways, a model based, principle based design approach is essential for the new generation of ITS.

To harmonize physical and cyber worlds a CPS based transportation system, the first and most technical issue is creation of a regional level time-position model and its implementation. A region can range from a number of street blocks, a designated corridor (air, land or water). The reference cyber and physical models need to be at a resolution level high enough to suppcyber ort coordination of traffic relevant operations. On the basis of the time-position reference grid, layers of technologies perform their functions in vehicles and from the roadside infrastructure to achieve various system objectives. In addition to the ubiquitous GPS signals, other forms of signals can and should be considered in the CPS technical portfolio for design and standardization of such powerful technologies to support research of advanced transportation technologies.

Transportation research is a data driven, system environment driven discipline. It is world in which high tech (unmanned vehicles, cyber networked vehicles and fleets) and low tech vehicles (bicycles, mopeds, skateboards) need to coexist with each other. A clean slab approach, as well as a real-world driven approach are needed to drive the research process. How to minimize the impact, especially safety and service quality, of user groups is a critical issue that will need to be factored into research of future generation technologies. New forms of research outcome assessments are needed to translate basic research results into presentations and artifacts that are useful to researchers and practitioners in different transportation related sectors. Long term commitment is required for creation of interfacing standards to support safe and effective deployment of advanced vehicles. The following list represents a short summary of high priority research requirements.

- National scale infrastructure (with some form of live traffic) to support field research
- Assistive technologies for users at degraded performance levels (aging populations).
- High performance (unmanned or minimally manned) goods transport technologies.
- Sensing technologies for operations (traffic timing, incident detection, dynamic routing, etc.)
- GPS extension (or Pseudolite), repurposing of cellular and related RF signals for time-positioning references.