Cyber-Physical Applications for Freight Transportation Systems
Management and Operations: Opportunities and Challenges
Mark Abkowitz, Hiba Baroud

Institution. Vanderbilt University, located in Nashville, TN, offers a full range of undergraduate, graduate and professional degrees. An emphasis on cutting edge research creates an invigorating atmosphere where students tailor their education to meet their goals and researchers collaborate to solve complex questions affecting our health, culture and society. Transportation research activities at Vanderbilt University are facilitated through the Vanderbilt Center for Transportation and Operational Resiliency (VECTOR). VECTOR’s mission is to improve the quality of life in our community, region, and nation through leadership and excellence in transportation research, education and outreach, using all of the resources of the university and strong partnerships with government and industry. Our work is governed by a commitment to objectivity, innovation, quality, timely delivery of cost effective results, and responsiveness to our stakeholders. Facilities resident at Vanderbilt and within VECTOR are ample to support the proposed research. This includes state-of-the-art computational resources as well as access to GIS data/software and other information technology tools. Of particular note is Vanderbilt’s relationship with ESRI, arguably the leading GIS platform developer worldwide. Through this agreement, VECTOR has access to the entire ESRI library of data and tools, as well as the availability of technical support, when needed.

Project Scope and expected results. Freight transportation systems have a direct impact on the productivity, environment and energy consumption in Tennessee, as well as beyond the state’s borders. To achieve more efficient, safe, secure and sustainable transportation, the freight transportation industry is relying heavily on the use of cyber-physical (CP) applications. This involves deploying computing software/hardware to control or monitor physical components in real-time (e.g., automation, sensors, mobile technologies, GPS). CP technologies present opportunities for freight management and operations in both the public (e.g., ports, traffic operations, incident management) and private (e.g., shippers, carriers, warehouse/distribution operators) sectors. Concerns have been expressed, however, as to potential limitations to CP adoption due to issues involving information fidelity, application scalability, and acquisition/operating costs. Moreover, excessive dependency on CP systems can introduce vulnerability to accidental and intentional security breaches, a growing concern as many freight operators are shying away from investing in backup systems.

The objective of this research is to perform a comprehensive review of existing and anticipated CP technologies and applications, with a critical eye on their role in improving freight transportation management and operations. These technologies will be evaluated according to their performance in achieving system efficiency, safety, security, and sustainability. Communication with CP providers and users (in both the public and private sectors) will be utilized as additional sources of information. The deliverable from this effort will be a synthesis report summarizing the opportunities and challenges of implementing cyber-physical applications for freight transportation systems management and operations, including recommendations for how TDOT and the freight transportation industry in Tennessee can make the most appropriate use of this growing technology trend.