UTC Project Information	
Project Title	Connected Vehicle Applications for Adaptive Overhead Lighting
University	Virginia Tech
Principal Investigator	Ronald Gibbons
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Funding Agencies	CVI-UTC (Tier 1 UTC)
Agency ID or Contract Number	451180
Project Cost	$150,000.00
Start and End Dates	September 1, 2012 – August 30, 2013
Project Duration	1 year
Brief Description of Research Project	Adaptive Lighting refers to an emerging technology where lighting systems are tailored to the needs of the environment. For the roadway environment, there are two primary systems that can be adapted. The first is the vehicle headlamps where swiveling or turning lamps are capable of being move in accordance with the vehicle steering. These headlamps can also be turned away in the case of approaching vehicles to limit deleterious effects such as glare. Significant research efforts have been undertaken to implement adaptive headlamps systems. This project is concerned with the other lighting system that can be adapted, which is the overhead lighting installed along the roadway. In this case, this would imply dimming or shutting off lighting when it is not required. There is the possibility of providing "Lighting on Demand", where the lighting is on-turned on when needed, using new technologies as well as connected vehicle methods. The Center for Infrastructure Based Systems at the Virginia Tech Transportation Institute is leading the research effort that establishes the adaptive lighting design standards and methodologies for overhead roadway lighting. This project is an extension of these efforts as an initial investigation of the possibilities for Lighting on Demand. Overhead lighting adaptive technology is enabled through the utilization of recently developed electronic ballasts and controllers that can provide dimming capability. These systems work for traditional as well as new lighting technologies such as solid state and induction sources. These new technologies

	however provide an additional benefit in that in addition to dimming, instant on and off capability can be achieved as these lamps do not require a warm up period as required by traditional lighting systems. This instant on and off leads to the ultimate extension of adaptive lighting which is Lighting on Demand where a series luminaires are triggered by the presence of a vehicle and shut off after the vehicle departs.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	There are a multitude of benefits which result from the implementation of adaptive lighting including a reduction in light pollution and maintenance. The most significant result of adaptive lighting technology is energy savings. It is estimated that a lighting system can be dimmed to a 50 percent level for at least 50 percent of the system burn time. This represents a 25% energy savings in the lighting system cost. In 2001 it was estimated that outdoor lighting in the United States used 57.35 Terawatt-hours of electricity costing 5.9 billion dollars. With a 25% savings this represents a $1.49 billion dollar savings. A communication and control protocol has been established for Adaptive Lighting. NTCIP 1213 "Electrical Lighting and Management Systems" is an ITS standards which describes the control and monitoring of roadway lighting, energy metering and requirements for grounding. This standard has been revised three times each improving the integration of adaptive lighting and controls into both Smart Grid and Traffic Management Protocols. Currently, most Adaptive Lighting Systems (including the system installed at the Virginia Smart Road) are managed from a central cloud location where the lighting control is instigated. The options available for integrating connected vehicle technologies would be either using Dedicated Short Range Communication (DSRC) from the vehicle to Roadside Equipment (RSE) which are then in communication with Traffic Management Centers (TMC) or have direct cellular connection to the TMC from the vehicle. The TMC would then communicate with the lighting control system. The cellular connection would have the additional benefit of future integration with pedestrian traffic monitoring. Latency in the communication may be an issue, particularly for Lighting on Demand concept. The delay in these communication jumps between the vehicle, RSE, TMC and the Lighting Control Cloud can cause significant delays in reaction time of the lighting system in response to the needs of the roadway. If the latency of the system is too significant, the possibility of having the vehicles communicate with the RSEs which communicate directly to the lighting system may be a

	possible solution.
Impacts/Benefits of Implementation (actual, not anticipated)	This study is still in progress, actual impacts and benefits of implementation will be determined in Summer 2013 when the study is completed. This page will be resubmitted in the next round of reporting to state these actual impacts and benefits.
Web Links • Reports • Project Website	http://www.connectedvehicleinfrastructure-utc.org/?q=node/63 http://rip.trb.org/browse/dproject.asp?n=32358