Illinois Automated and Connected Track (I-ACT) Proving Grounds

Vehicle autonomy is an emerging technology spanning multiple disciplines. Multidisciplinary system design strategies can help address questions such as: How should vehicles and infrastructure be designed differently in the context of autonomous instead of human operation? What design features will help support a transition from the current transportation system to a future system? What is the interaction between policy design and technical system design? What policy aspects should be enacted to improve success of the transition to vehicle autonomy? How should autonomous vehicle systems and infrastructure be designed to account for human interaction and interface with non-autonomous entities? What strategies can achieve aggressive system-level safety objectives?

The Illinois Automated and Connected Track (I-ACT) Proving Ground facility is an effort supported by government (Illinois Department of Transportation [IDOT] and Village of Rantoul), academic partners (University of Illinois at Urbana-Champaign [UIUC], Northwestern University [NU], and the University of Illinois at Chicago [UIC]), and industry (e.g., FedEx and Traffic Technology Services). Designating I-ACT facility as a USDOT Automated Vehicle Proving Ground will enable collaboration between the aforementioned entities to leverage the current Illinois Center of Transportation (ICT) state-of-the-art facilities and world leading expertise in support of the innovations needed to make a safe and robust national automated vehicle/connected vehicle (AV/CV) Transportation System a reality.

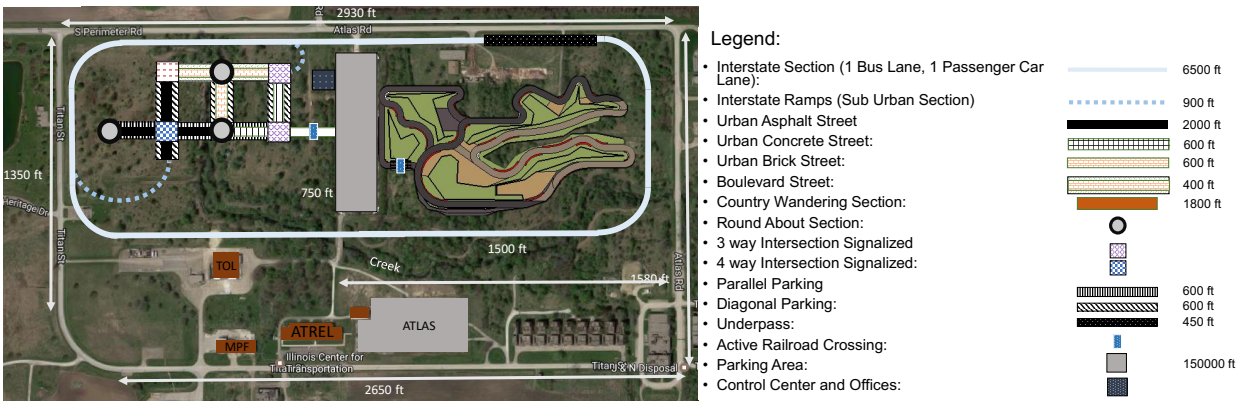

Figure 1. Existing Illinois Center for Transportation facilities with planned automated vehicle test tracks.

Housed within the ICT test facilities, the I-ACT proving ground will enable a safe and robust platform of laboratories, closed test tracks, urban and metropolitan road courses, urban-rural boundary road courses, and interstate corridor testing facilities to promote a new era of a national automated freight, passenger, and agricultural vehicle transportation system.

The I-ACT team is proposing a tiered research and development model to allow for fulfilling immediate needs of industry and government while developing paths toward advanced research. According to the proposed plan, the I-ACT vision is as follows:

- Tier 1: Deployment of Parking Lot (Figure 1) – Immediate opening to testing trucks and vehicles in open space.
- Tier 2: Test Track – Construction of 1.5 miles of track encompassing primary roads utilizing different designs of flexible and rigid pavements with a focus on freight testing.
- Tier 3: Smart Simulated City and Suburban Structures – Construction of tracks with existing built and natural features to test more advanced features of automated/connected vehicle technology and its communication with instrumented physical infrastructure.
- Tier 4: Real City and Highway Corridors – The use of interstate corridors and Village of Rantoul and surroundings once in the long-term

The proposed I-ACT facility will be used to test complex systems design optimization and life-cycle assessment (LCA) in the economic and environmental perspectives. Integrated design methods must account for design and operations coupling between multiple distinct aspects of an engineered system (e.g., human vs. machine, roadway vs. vehicles). Design and operations coupling refers to cases where

changing one element of a system design influences how another part of a system should be designed to improve overall system performance, which will in turn improve and benefit operations. Holistic system design methods can capitalize on design coupling (synergy mechanisms) to achieve new performance levels and functionality. In particular, these advanced system design methods can help explore the properties and tradeoffs for innovative types of systems without the benefit of design heritage.

The I-ACT Proving Ground is organized into three themes (Figure 2) to allow the comprehensive and safe testing of automated vehicles, especially trucks, heavy equipment, and their supportive infrastructure.

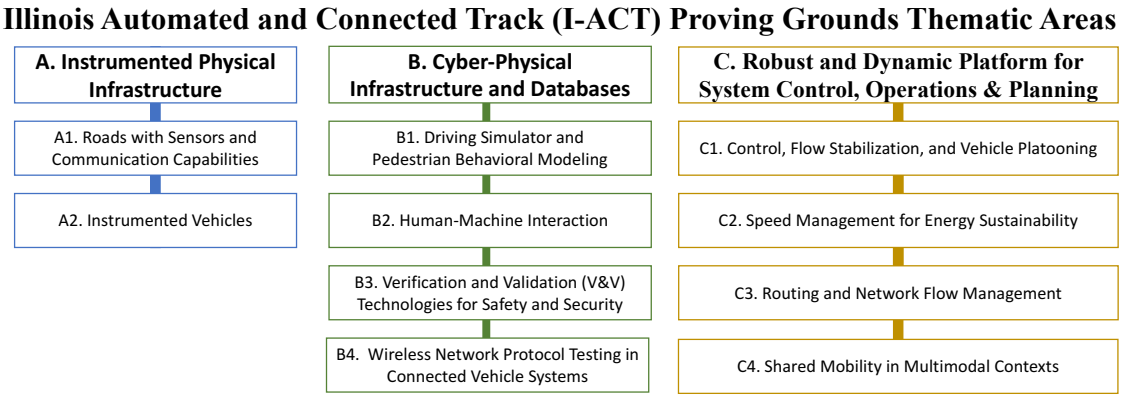

Figure 2. I-ACT research and resources to support proving ground activities by theme.

The Illinois Center for Transportation (ICT) is leading the coordinated the efforts among the UIUC, NU, and the UIC to team up with government, industry, and other academic partners to build the I-ACT over the approximately 100-acre testing facility. The I-ACT team is proposing to develop research infrastructure and capacities with an agenda focused on advancing automated vehicle technologies through safe conduct of testing to support the next paradigm of freight and passenger transportation.

I. Partnership of Proven Leaders in Transportation Innovation for Over 75 Years

The I-ACT proving ground consortium provides users access to state-of-the-art testing facilities and unprecedented level of expertise and leadership through partnering research teams that are already collaborating in areas of vital concern for automated vehicle research. The consortium members have proven records in their fields and their combined knowledge covers a wide range of expertise from transportation engineering, operations research, computer science, electrical engineering, mechanical engineering, aerospace engineering, human factors, and urban planning. Our consortium brings together the diverse strengths, knowledge, and experiences of our members to work toward the shared goal of developing an automated vehicle proving ground. To accomplish this, our consortium will also draw on and expand our many successful partnerships with public, private, academic, and not-for-profit entities, as well as with colleagues within our universities.

University of Illinois at Urbana Champaign, Illinois Center for Transportation (ICT): UIUC and IDOT have worked closely since the early 1940's to be national leaders in transportation solutions related to safety, senior citizen transportation, pavement design and structural responses, and new standards for material durability. This partnership was strengthened with the establishment of ICT in 2005. ICT is located on the 47-acre Advanced Transportation Research and Engineering Laboratory (ATREL) facilities and testing grounds located on the former Chanute Air Force Base in Rantoul, IL, just 15 miles north of the UIUC campus. In 2016, IDOT supported ICT to become an approved Illinois automated vehicle testing and Village of Rantoul has donated another 52 acres (a total of approximately 100 acres of space) for automated freight and passenger vehicle testing. This includes a large parking lot that has been used to test and demonstrate automated vehicles. This recent addition will form the foundation of the new I-ACT. Further, the Village of Rantoul has given approval to utilize select urban areas for automated vehicle testing.

ICT has successfully completed over 250 projects in the past decade resulting in hundreds of new expert engineers, materials, technologies, system designs, and numerous publications, presentations, and

reports to inform policy makers. This has been possible because of the interdisciplinary teams that attract faculty from a diverse set of field from across the UIUC campus, 30 other universities, and more than 15 other industry partners. The I-ACT initiative at ICT is one such example as faculty from Aerospace Engineering, Civil and Environmental Engineering, Computer Science, Electrical and Computer Engineering, Industrial and Enterprise Systems Engineering, Mechanical Science and Engineering, Geology, Education, Economics, and Illinois Applied Research Institute have joined forces to tackle emerging automated vehicle challenges. This consortium of researchers represents world leaders in their fields of expertise, housed in top-ranked departments.

Northwestern University Transportation Center (NUTC): Since 1954, the NUTC has been a leading interdisciplinary education and research institution dedicated to understanding, serving, and preparing young professionals to contribute to the domestic and international systems for the movement of people, products, energy, and information. Faculty, students, and research staff conduct fundamental and applied research funded by agencies such as the National Science Foundation, the National Academies of Engineering and the Sciences' Strategic Highway Research Program, the National Cooperative Highway Research Program (NCHRP), the National Institutes of Health, the U.S. DOT, the U.S. Department of Homeland Security, as well as State Departments of Transportation, particularly IDOT. The Center works closely with the transportation industry through its Business Advisory Council, consisting of over 75 leading companies in freight, logistics, technology and finance for all modes of transportation (http://www.transportation.northwestern.edu/industry/bac.html). The Center also engages in collaborations with consulting and engineering firms in the private sector in conducting cutting-edge research that brings together advanced tools with practical applications. NUTC also has extensive international cooperation links with university-based as well as government-allied research transportation centers. NUTC and UIC faculty have a joint, active NSF Partnership for Innovation: Building Innovation Capacity project in collaboration with Roadie, a crowdsourcing delivery firm, since 2015.

University of Illinois at Chicago, Urban Transportation Center (UTC): In addition to the NUTC collaborations, faculty in the UTC also have also developed an integrated transportation and air quality impact analysis tool to evaluate the chain effect of a transportation demand profile on transportation network performance, vehicular emissions, air quality, and health exposure; and launched The Gateway Traveler Information System (GTIS) to provide accurate and timely traffic data and information to public and private entities. The GTIS is a collaboration with the Illinois DOT to develop a web based system that continually collects, integrates, fuses and distributes real-time traffic information throughout the Great Lakes Regional Transportation Operations Coalition region.

Industrial Partners: Industrial consortium partners are the driving force behind the constant redesign of facilities as these innovators attempt to bring emerging technologies to scale through testing not possible within their research and development units. The I-ACT team will establish an advisory board and develop membership categories targeting a range of industries to work toward next paradigm of passenger and freight transportation. These include auto manufacturers and automotive suppliers, intelligent transportation and traffic control systems, transportation safety technologies, big data management, cybersecurity, sensor technology, freight and trucking, etc. The advisory board will consist of selected stakeholders to serve and guide research and technology development focusing on advancement of technology and safe deployment. Initial members include AECOM, AutonomouStuff, FedEx, HERE, IntelinAir, Scheider, and Traffic Technology Services. (*Appendix D: Letters of Support-Industry*).

II. Building a Community of Practice for National Implementation

Building an AV Community of Practice: The consortium of researchers that are driving this proposed I-ACT proving ground bring with them a wealth of expertise, perspectives, existing safety plans, and emerging best practices that will be a great asset to the USDOT's new AV Community of Practice. From studying wrong-way driving on freeways and providing recommendations to improve "smart" work zone layouts, to helping Illinois better allocate resources for implementing safety and traffic countermeasures and initiatives (e.g., roundabouts, photo speed enforcement), these researchers have an established history

of collaboration focused on studying driver behaviors related to major contributors to crashes on Illinois highways. These past efforts will pave the way for an I-ACT proving ground focused on comprehensive transportation safety and congestion management by taking advantage of automated vehicles, and on connected vehicle-vehicle and vehicle-infrastructure. I-ACT aims to serve as a national and regional leader for automated and connected transportation best practices under restrict and controlled safe environment.

All research conducted by UIUC, NU, and UIC is governed by strict safety rules and procedures that are monitored and regulated by risk management organizations at each institution. The 75+ years of collaborative research with IDOT has also led to a vast library of transportation safety practices on topics such as work zone safety, speed harmonization, crash reduction, to name a few. These safety protocols change with technology and frequently result in best practices for safety, design, operation, and deployment of new transportation technologies and practices. Many of these plans are already publically viewable. The proposing team will share all of these plans and work with the Community of Practice to create a robust library to share with the broader automated vehicle community. This team will also work to develop an open platform for sharing automated vehicle testing and research data and progress reporting that is internationally accessible coupled with the development of new standards for encoding the diverse data sets related to emerging technologies in this field. The ICT has already established a well-explored website (ict.illinois.edu) that is visited by more than 2 million per month from 200 countries, where current research details and outcome of projects are shared. Quarterly reports are also distributed to more than 6000 interested parties. This system can be expanded to ensure the development testing in automated vehicle is shared through the web and direct publications and email with the transportation community.

One of the largest contributions the proposing team will make to the Community of Practice is their dissemination platform that consists of seminar series, technical workshops, planning meetings, and annual conferences. The diverse audiences that attend these events hosted by members in consortium will enable the Community of Practice to disseminate knowledge to fields closely aligned with automated vehicle development as well as connect to new audiences that may have an unrealized impact in these developments.

ICT at UIUC has hosted the Kent Seminar Series since 2006, bringing in authorities from around the world to discuss issues in transportation engineering. With attendance exceeding 400 students, faculty, and professionals, the weekly lectures provide an opportunity for students and guests with well-established research portfolios to talk about the solutions they have come up with to address challenges in the transportation industry today. The Kent Seminar Series (which is streamed in real time) will be enhanced and directed toward the focus of the proposed I-ACT proving ground. In addition, UIUC has hosted the annual Transportation Highway Engineering conference for the past 105 years, with attendance at more than 1200. The annual traffic, bridge, and bituminous conferences in Illinois are also conduits to share data locally along with the very active seminar program at NU for the industry, and the annual Lipinski policy symposium hosted by NU to address emerging regional issues.

The researchers involved in numerous professional organizations and conferences including TRB, ITS, etc. allows the sharing of the information. The researchers also have experience in developing database that can be shared through the web and makes it available for other users. Such information will be on the ICT website. The connection to these data is discussed later.

I-ACT consortium universities provide a full-spectrum of educational programs, ranging from incumbent worker training to upscale engineering programs, from 2- and 4-year degree programs to advanced education. This extensive educational structure provides students with a complete spectrum of workforce education and training in advanced transportation. The following table illustrates a composite picture of the number of graduates in the relevant programs (in civil engineering only) at UIUC, NU, and UIC. It also includes the number of full-time faculty in transportation-related field in each institution:

IACV Partner Institution	Associate 2011-2015	Undergrad					Master's					Ph.D.					No. of Full Time Academic Faculty
		2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	
UIUC		207	189	203	226	195	146	143	168	201	233	23	20	30	27	32	111
NU		97	115	103	110	116	34	38	51	51	46	15	20	24	24	24	70
UIC		214	210	273	247	349	222	232	238	308	233	33	29	30	40	36	102

UIUC has well-established programs for education and outreach to elementary, middle, and high school students. Through the I-STEM program, UIUC has built lasting relationships with K-12 school districts in Chicago, Champaign, Peoria, Urbana, and several districts in the Chicago metropolitan area. Selected outreach activities to attract young students to transportation include the Girls Adventures in Mathematics, Engineering, and Science (G.A.M.E.S.)—week-long camp, designed to give academically talented girls an opportunity to explore engineering and scientific fields through demonstrations, hands-on activities, classroom presentations, and contacts with women in these fields. These initiatives are designed to strengthen the future workforce, providing them with the education and career pathways needed to support emerging intelligent transportation systems.

III. Proven Safe Platform for Testing and Innovation

The leading motivation for autonomous vehicles is to improve traffic safety. This starts by providing a safe environment for testing automated vehicle. ICT has an excellent record of safety utilizing its accelerated testing facility with zero accidents since inspection over the past 15 years. I-ACT will continue applying strict control of safety through the construction of safety measures appropriate for the four proposed tiers of testing. The first tier is testing in open parking lot to gauge all safety requirement to be added during the construction of tiers 2 and 3 and then implement when testing in the Village of Rantoul as part of tier 4.

III.1 Designated Safety Officer

John Orawiec is designated as a safety officer for I-ACT. John is an accomplished safety manager with a decade of experience in general industry, construction, and research safety. He specializes in designing and implementing safety management systems (OHSAS 18001), performing root-cause incident investigations, managing complex multidisciplinary research safety, developing and delivering safety training, auditing for OSHA compliance, and general injury prevention. Currently, John is developing and implementing a safety management system (based on OHSAS 18001) focusing on research safety at College of Engineering at UIUC. He has worked in the pharmaceutical industry where he provided safety guidance for the maintenance and construction project management teams and their subcontractors. As a safety consultant, he served multiple general industry and construction clients across the Midwest, South, and East Coast. Previously, John received his Master of Science degree in Applied Health Science with a concentration in Safety Management from Indiana University in Bloomington, Indiana. Mr. Orawiec's experience as a safety officer, past positions in industry, and his familiarity with UIUC uniquely qualify him to be the designated safety officer for the I-ACT facility.

III.2 Facility Safety

The main location of I-ACT proving ground includes current land operated by ICT and owned by the Village of Rantoul and expansions to be added after land acquisitions from Rantoul to be a total of approximately 100 acres. The proposed test tracks are shown in Figure 1 along with the laboratory and office spaces and testing area currently used by ICT. The proposed I-ACT test tracks and facility provide a unique opportunity for safe testing of automated vehicle technology while having the potential to simulate a highway, city and suburban structure with built and natural features.

The proposed four tiers of testing provide the most logical testing considering safe testing of automated trucks and vehicles: open space, track, self-contained controlled suburb environment, and finally a city (the Village of Rantoul provides a typical authentic "city" proving ground with an added level of safety not present in typical urban settings).

III.3 Sharing Safety Data and Approaches

The I-ACT team is committed to share its approaches to the conduct of safe testing and safe deployment. ICT has a long track record of developing training materials, workshops, webinars, and technical reports disseminating the critical knowledge obtained through research through several conduits. Some examples related to transportations safety are:

- Safety project webinar series on modified right-turn lane design, flashing yellow arrows at intersections, pavement marking selection and installation inspection (2016)
- National State Safety Engineers and Traffic Engineers Peer-to-Peer Workshop (2012)
- Highway Safety Manual Lead State Peer-to-Peer Workshop (2010)
- National Safety Performance Function Summit (2009)
- Several webinars and reports on wide-base tire trucks
- Impact of oversize and overweight trucks

Further, the human-machine interaction research at the I-ACT proving ground will also generate large-scale databases that can be used to establish standards and serve as the basis to ensure autonomous vehicles drive like safe human drivers. Unhuman-like behavior of autonomous vehicles may cause unnecessary confusion or even aggression by human drivers. By allowing autonomous vehicles to learn from a large number of safe human drivers (possibly via machine learning and a large amount of video data on the driving environment and corresponding vehicle control data), this approach is expected to not only significantly shorten the training process for autonomous vehicles, but also create more human-like driving behaviors that accommodate passengers' acceptability of vehicle operation (e.g., riding comfort).

III.3 I-ACT Approach to Safety

The I-ACT is dedicated to protecting the environment, health, and safety for all those who work or visit the facility as well as protecting our community. This is accomplished through creating a safe and secure workplace; maintain a respect for the environment; and respect and adhere to all applicable laws, regulations, and local, regional, and national safety requirements.

The facility will be managed by the ICT director. The safety officer will be reporting directly to the director and will be responsible for the overall safety and security measures of the I-ACT operation and technology deployment, overseeing the engineering work at I-ACT and working with engineers to ensure that all safety and security measures are implemented. A safety manual of I-ACT will be created and shared with all testing entities. The safety officer will also coordinate with the Village of Rantoul and IDOT to ensure that local and regional safety regulations are implemented. This will be accomplished through regular quarterly meetings; especially, to coordinate the testing in the Village of Rantoul and possibly on I-72.

Testing of new safety measures is an important part of the I-ACT research plans as presented under VI.2 section A.2. In addition, safety failures from software occur because of errors in coding (verification), errors in matching requirements to applications (validation), component problems and failures, and because of malicious manipulation. A sound safety program will give strong attention to these risks. UIUC has strong efforts in all of these areas, demonstrated through applications in the aerospace, energy delivery, and healthcare sectors, among others. We expect to build on this experience at the proposed I-ACT proving ground. One of the distinguished features of I-ACT is the ability to store, analyze, and secure very large volumes of data generated during experiments.

Software-Defined Networking (SDN) will be used to guarantee that stringent timing constraints for safe data transfer are met and also ensure prioritization of traffic in such systems. Coupled with the global view of the system provided by the use of SDNs, this allows managing the system better and also responding to unusual events (faults, denial of service attacks, etc.) in a more holistic way that could affect the safety during testing.

IV. A Robust Platform for Research, Applications and Data Sharing

IV.1 Authorized State and Local Sites for National Implementation

We have already secured the support of the Illinois DOT, Sandia National Labs, UIUC College of Engineering and Village of Rantoul to establish I-ACT (*Appendix C*). We will continue to work with the local and state entities as well national agencies to conduct the needed research to advance and employ automated vehicles.

IV.2 Research and Resources to Support Proving Ground Activities

While automated vehicle technologies hold the promise to substantially improve traffic safety and reduce traffic congestion, fuel consumption and emissions, there exist a variety of open questions and issues. The proposed I-ACT proving ground will help transportation agencies, the industry, and the general public address challenging research questions related to the planning, design, and operations of automated transportation systems. The research and resource available to I-ACT is illustrated in Figure 2 and details are provided below from the ground up:

A. Instrumented Physical Infrastructure

A1. Roads with Sensors and Communication Capabilities: With the entrance of autonomous and connected vehicles into the market, roadway infrastructure can be adapted to enhance the efficient and safe movement of all vehicles. Future roads will provide major benefits if they are interactive and compatible to accommodate automated and connected vehicles. I-ACT will incorporate traffic conditions, vehicles, and roadway infrastructure as part of a sustainable and interactive roadway ecosystem. The interaction between the components of this ecosystem will consider the safety and convenience of users, efficiency of vehicle movement, performance of roadways, and robust response to system problems or failures, while potentially harvesting energy from vehicles' movement to powering sensors and roadway lights. A paradigm shift in the way roadways are currently designed, constructed, and operated requires transformational changes that include advanced research and collaboration among industries (automotive, information technology, and roadway design and construction). The pavement of the Smart Road in Virginia was designed and instrumented by a member of the research team in the late 1990s and became a great success, illustrating how roads can facilitate mobility while simultaneously maximize motorists' safety and roadway durability. The I-ACT will further utilize state-of-art information and sensing technologies to advance the state-of-the-art and state-of-the-practice in pavements.

The I-ACT will have embedded instruments into the roadway for vehicle guidance testing, as well as for real-time measurements of vehicular and environmental response using cost efficient wireless sensors. This allows testing of passive and proactive control systems on automated vehicles (trucks, buses, and passenger cars) that interact with other vehicles and with conventional road infrastructure (roadside features, safety devices, and the road surface). In-vehicle devices include those developed by Google, Audi, Bosch, Tesla, Mercedes-Benz, etc., for adapting to extreme and rapidly changing weather conditions (rain, snow, ice, fog). Examples of active sensors include RFID and multi-functional piezoelectric sensors embedded into the roadway. The condition of the roadway will be monitored through real-time data provided by the embedded sensors.

The roadway system will also include wireless telecommunication system features that allow at least the following: (i) sufficient WiFi bandwidth, GPS, and crowd sourcing capabilities in an integrated multi-user contested environment to ensure safety of the vehicles and their passengers under even system-wide emergencies (crashes down the road, congestion, road construction, re-routing etc.); AV/CV situational awareness and autonomy, as well as passenger travel information interfaces (e.g., smart phone apps), in real-time and on a large scale.

The I-ACT will also be used to examine innovative construction material combinations that can be rapidly batched and retrofitted into existing roadways, e.g., narrow-width inlays containing carbon-fiber reinforced and conductive or magnetic aggregates, which will be actively sensed by autonomous vehicles and will assist in vehicle movement guidance. Innovation of such materials can be for using them as heat sinks as well as for energy harvesting. The I-ACT can be used to test materials for long-term durability, with the goals of achieving near-zero maintenance during their service life and resilience over a range of

ambient environmental conditions (e.g., extreme weather conditions, day and night). Machine learning techniques will be used to study and predict physical performance and deterioration rates for sensor-equipped roadway surfaces. Illinois is uniquely positioned to test the roadway materials, especially with its accelerated paving testing (APT) machine (the largest movable APT in the world), and to conduct robust evaluation. The ability for roadway systems to wirelessly charge electrical trucks/vehicles passing on the road will also be tested.

A2. Instrumented Vehicles: The I-ACT can be used to test fleets of automated trucks, buses and passenger cars that are equipped with real-time vision, location awareness, intelligence, and other sensing modalities. I-ACT researchers have developed key enabling technologies for AV, including geometric localization, 3-D environment mapping, and visual analytics and understanding for real-time mobile vision. The capabilities of instrumented vehicles, based on computer vision sensing and data analytics, can allow automated detection of (i) low-cost high-quantity highway assets; (ii) pedestrians, other vehicles, and bicycles; and (iii) ambient environmental conditions. Common algorithms for vision-based navigation are structure from motion and simultaneous localization and mapping. This simulation capability can be used for robust verification and validation at I-ACT.

Trucks/vehicles using the I-ACT will be equipped with wireless interconnected data storage capabilities that serve as a large-scale distributed information cache. It is possible for vehicles to notify each other of obstacles, road conditions, accidents, and other safety concerns. These notifications will be integrated seamlessly with each vehicle's own sensors and safety protocols. Data fusion between vehicle sensors and external information is a paramount problem that will be addressed in order to safely direct each vehicle and manage driving behavior. A communication network infrastructure and architecture capable of absorbing vast new data demands are likely to be created by autonomous cars and trucks. To this end, I-ACT researchers have developed successful products for commercial WiFi and distributed control systems and solutions based on computer vision and remote sensors.

To enhancing collision avoidance and crash safety for automated vehicles at I-ACT, tests will include electrified vehicles with instrumented electrical actuation sensors that allow fast emergency response on time frames of tens of milliseconds, faster than human reaction. Capabilities in this direction include four-wheel steering and thrust vectoring, active crumple zone configuration, active suspensions that optimize contact points, in addition to predictive defensive driving in adverse weather or other situations.

B. Cyber-Physical Infrastructure and Databases

B1. Driving Simulator and Pedestrian Behavioral Modeling: Automated driving changes not only human driving behavior but also the travel decision making process. Next-generation transportation systems will not be operating in 100% autonomous or 100% connected environments for at least 20 years. Dealing with mixed traffic, with varying levels of vehicle connectivity and autonomy is essential to any significant introduction and penetration of relevant technologies. The change of driving behavior will impact the design of the automated vehicle system that further impacts travelers' adaption as well as the system performance. To achieve these platforms, the simulator and biosensors in the lllinois Simulator Laboratory (ISL) will be used to investigate the factors that impact drivers' decisions to take over driving tasks, to optimize in-vehicle alarm systems to inform drivers to take over, and to quantify the psychological effect of autonomous driving. This will allow us to hit the ground running in translating concepts and technological advancements from our prior research to the domain of intelligent vehicles and infrastructures. The ISL Driving Simulator is based on a KQ Hyperion (now DriveSafety) driving simulator. Built on a full-size General Motors Saturn automobile, the simulator surrounds the vehicle occupant with multiple projected images driven by a constantly upgraded visualization cluster. Spatialized sonification and visual and haptic feedback are integrated into the software for research in human-automobile interactions. Head and eye tracking information from a three-camera SmartEye system provide time-stamped data synchronized with the visuals generated in the simulator. This will be a key tool to investigate human factors issues in mixed traffic.

In addition, the proposed I-ACT proving ground will leverage the existing 3-D room-sized immersive environment to investigate behavior pedestrians and bicyclists in automated transportation systems. Data from experimental tests will shed light on this critical factor. Differences in pedestrian behavior in

different contexts with varying degrees of connectivity and autonomy will be captured through behavioral models, providing essential information for device design, alert systems, and other countermeasures.

B2. Human-Machine Interaction: To account for traffic collision avoidance in dynamically evolving circumstances, optimal control solutions can be created to emphasize safe strategies and to test the emerging human role in AV/CV scenarios. The Advanced Controls Research Lab funded currently by NSF's EAGER program to develop a human-centered robotic system design framework that aims to provide an environment for the safe use of aerial and ground robots (including automated vehicles) in congested urban environments. Virtual reality simulations that gauge pedestrian comfort in human-robot shared spaces will be tested.

It is essential to ensure that enhanced autonomy does not have unintended consequences associated with decreased human situational awareness or a decreased ability to intervene manually in unanticipated situations. The facility can be used to test human performance compared to autonomous vehicle decision-making systems in ways not possible in a physical facility. Research programs at UIUC has been supported by NASA for some 25 years to focus on human factors and achieve safe and effective human-automation in highly automated aviation contexts.

A key focus is to ensure that safety and efficiency benefits brought by increasingly sophisticated control automation and system autonomy are not accompanied by unintended risks and safety or performance decrements associated with reducing the role of humans in the control loop. These include issues of over-trust in automation, complacency, loss of situational awareness and related phenomena. Concepts dealing with human acceptance and safe interaction with autonomous vehicles and smart infrastructures can also be designed and evaluated. This includes mixed human and autonomous vehicles traffic scenario testing; human-autonomous system interactions; vehicle-human-vehicle awareness testing; hybrid human-autonomous system testing; and virtual reality performance test tracks.

B3. Verification and Validation (V&V) Technologies for Safety and Security: Autonomous systems will have large-scale computing requirements (even current automobiles have multiple processors running tens of millions of lines of code). This complexity exposes a variety of attack surfaces –both on individual vehicles and on infrastructure components. Malicious actors can cause significant damage to the vehicles, the humans riding in them or even the environment by attacking such systems. System damage caused by weather or other problems can also have operational consequences. Unlike regular security threats (adversaries stealing data for instance), attacks against such systems must be cognizant of the *safety* as well as the *cyber-physical* issues inherent in such systems.

Creating a set of regulations or standards is not sufficient. Manufacturers need to be provided with a path to meet these regulations. They need to be provided with tools, processes, trained people, to prove out software surety and meet these regulatory standards. For example, autonomous cars are canonical examples of *cyber-physical systems (*CPS) with complex software interacting with physical processes. Verification is the problem of finding bugs in a CPS or showing that the system meets a given set of requirements (regulations). I-ACT partners have had several breakthroughs that enable their algorithms to verify (for the first time) CPS models with complex nonlinear dynamics and software-based decision making, including one of the first examples of formal verification of an autonomous vehicle module. An example is a software tool that has been used effectively to analyze powertrain control systems from Toyota. This approach works with black-box systems, with no need for details.

The I-ACT will come with a set to baseline vehicles on which researchers will build their control and coordination algorithms (e.g., platooning or coordinated adaptive cruise control). The V&V tools can be integrated with the baseline vehicles and the physical environment, in ways that allow data traces from experiments to be used automatically by the V&V tool to i) help find design bugs, corner cases, and unsafe behaviors; ii) guarantee safety; or iii) suggest new testing conditions. In addition, V&V can be implemented for developing the certification of speed and vehicle spacing.

Electrified and automated vehicles impose unique challenges for cybersecurity. In addition to known cybersecurity issues, some concerns need to be addressed such as the following: i) inverters and chargers in electrified vehicles have internal control settings and firmware. Some settings are relatively sensitive

and major problems can be created with relatively stealthy changes or small errors; ii) energy levels are high and systems are extensive and complex. Circuits like battery management, charger billing, implementations of traction control and stability, and many others provide vulnerabilities beyond securing V&V and communication protocols; iii) in some intentional operating modes (e.g. rapid acceleration), the operating conditions are difficult to distinguish from fault conditions, complicating safety and protection; iv) In typical electric drives, full torque capability is available across the spectrum of operation, from stopped and full forward speed to full reverse speed. Often software limits must have precedence over mechanical limits to maintain safe conditions; v) batteries are always energized, vs. internal combustion vehicles being de-energized when parked. In a vehicle with a substantial battery pack, there are vulnerabilities in battery management and charging circuits in ways that cause trouble even in parked vehicles; and vi) vehicles with an active grid interface introduce vulnerabilities linked to known challenges in utility systems, and energy flows from the grid can be manipulated in harmful ways.

B4. Wireless Network Protocol Testing in Connected Vehicle Systems: For connected vehicle systems, the wireless telecom system design features play a critical role in the effectiveness of traffic flow related measures. Beyond simply testing the wireless system from an integrity and security perspective, the facility will support research into testing its impact on traffic performance under different types of designs, controls etc. This is especially important for strategies relying on V2V communication for real-time traffic management, such as the FHWA's INFLO program (Speed harmonization, queue warning, and coordinated platooning).

Recent simulation work conducted at NU, combining telecom message transmission in ad hoc mobile networks with moving traffic flow under varying degrees of congestion, has demonstrated the critical role that telecom protocols and design features play in the effectiveness of these systems. The I-ACT will enable field testing of these essential aspects for the success of connected and automated vehicle systems.

C. Robust and Dynamic Platform for System Control, Operations, and Planning

C1. Control, Flow Stabilization, and Vehicle Platooning: Traffic experts have known for years that the variability of the rate at which vehicles pass a location upstream of a bottleneck increases with the distance from the bottleneck. On a congested freeway, a slight deceleration of one vehicle may force many following vehicles to slow down more abruptly, which can often build to stop-and-go traffic (instead of smooth driving) or even gridlock. This instability phenomenon incurs significant driving discomfort, travel delay, extra fuel consumption, increased air pollution, and safety hazards. The use of automated vehicles holds promise to effectively mitigate or even eliminate such stop-and-go phenomenon. The I-ACT will seek ways to establish an integrated methodological framework by formulating system dynamics equations for network behaviors and system operational factors (e.g., information mechanisms) of vehicle-following traffic. The I-ACT will be used to answer questions such as: how should these distributed V&V controllers be designed and operated in a robust and safe manner? Also, as the platoon changes its dynamics (e.g., new and diverse vehicles enter and leave), how does the overall controlled behavior of the system change? How should the V&V controllers adapt to new information, if available and if useful, in order to maintain acceptable performance and safety levels? A new set of robust stability analysis models, stability conditions, and stabilization strategies that account for various nonlinear, stochastic behavioral and operational factors will be created to examine stability and coordination problems. Preliminary investigation has shown that the proposed strategies can be very effective in terms of "smoothening" traffic and bringing in strong economical, energy and environmental benefits. I-ACT will be used to in-situ validate these models.

Vehicle platooning is the proverbial low hanging fruit when it comes to increasing capacity and safety of trucking fleets. Several technologies are available to achieve this purpose, with varying technical specifications in terms of autonomy. I-ACT researchers have developed algorithms for distributed path generation, path following and coordination that allow for multiple vehicles to accomplish common missions and modify their paths on the fly during the mission, avoiding possible collisions. Although the framework is currently being developed for aerial vehicles, it can be adapted to ground vehicles. Stability and robustness of the developed algorithms can be tested at I-ACT to enable V&V of these technologies.

C2. Speed Management for Energy Sustainability: A key opportunity afforded by autonomous transportation is to substantially reduce the energy and emissions footprint of the transportation section by incorporating energy efficiency as an explicit objective in vehicular navigation and removing energy inefficiencies arising from sub-optimality of humans as drivers. This endeavor requires development of fuel consumption and performance models at two different levels of detail.

The I-ACT will allow fine-grained dynamic vehicle models to be developed that characterize energy and performance dynamics in sufficient detail. Energy consumption of vehicles depends on details of dynamic operation and performance. Although static energy maps are often used to predict energy consumption, many subsystems, especially electric drives, respond on time scales much faster than one second and do not function in steady state during many phases of driving. Dynamic models are important to examine the relationships between automated vehicle control and energy consumption. Dynamic models will be used for accurate characterization of vehicle energy flows, as well as to develop superior control strategies that minimize fuel consumption of vehicles. A combination of virtual reality and hardware is vital to use and validate dynamic models.

The I-ACT will allow macroscopic models to be developed that enable prediction and optimization of vehicular fuel consumption during navigation, given only a high-level characterization of road surfaces, routes, and expected traffic conditions. Models for vehicular fuel consumption that accommodate physical parameters of vehicles, parameters of roads, parameters of traffic regulators (such as locations and timing of traffic lights and locations of stop signs) and parameters of the real-time state of traffic, such as degree of congestion, have been contributed by members of the research team at UIUC. These models were used to develop accurate fuel consumption predictions for vehicles, making it possible to optimize their overall fuel cost. As an example of such optimization, a vehicular navigation service was developed at Illinois, called "GreenGPS," that finds fuel-optimal routes for drivers, customized to the parameters of for their individual vehicles. It was shown that fuel-optimal routes may differ from both the fastest and shortest routes because fuel consumption is a function of time, distance traversed, and details of the driving cycle (in addition to terrain, environment, etc.), which makes optimizing time or distance alone insufficient. In an evaluation of this service based on approximately 30 cars, it was shown that fuel savings of 10-20% can be achieved with GreenGPS compared to today's standard navigation options (e.g., Google Maps).

Systems such as GreenGPS may become an integral part of tomorrow's automated vehicles. A fuel optimization service for automated vehicles can influence selection of routes and control other navigation parameters such as vehicle speed, acceleration, and gear selection. It may be informed by sensors in its own vehicle, but can also leverage data from other vehicles as well as data from infrastructure (such as timing of nearby traffic control devices) to further improve its path planning and other navigation settings (velocity, acceleration, gear selection, etc). The I-ACT will be fitted with a capability for experimenting with smart algorithms that control fuel consumption in tested vehicles both to develop improved energy-saving driving modes and to test the savings in realistic road settings.

C3. Routing and Network Flow Management: As various business models emerge in association with autonomous transportation, all will require the ability to solve new classes of fleet management and vehicle routing problems while taking into account rigorous safety expectations. This is relevant for both cars and trucks, as well as hybrid transit vehicles. I-ACT provides an opportunity to deploy and test such fleets, operational strategies and business models in a live context. This is directly relevant to the future of public transit in low-density communities as well, as is currently explored in ongoing research at NU.

The I-ACT facility will be able to accommodate many classes of traffic interactions, merge lanes, and variable densities of traditional and autonomous vehicles. Put briefly, the routing aspects of autonomous trucks and vehicles will be addressed, in the presence of human drivers and a wide range of situations and obstacles. First is to solve the macro level problem of what safer routes these autonomous vehicles should take given their origin-destination pairs, considering also a sense of urgency or safe arrival time expectations, and range based on energy storage, especially for electric vehicles, and to do this in a manner that achieves a higher level of safety than is possible with any human driver. The macro level problems aim to "prescribe" routes such that the vehicles do not congest specific segments of the transportation network and other objectives are met subject to constraints of time and range, while

simultaneously avoiding unexpected safety challenges. Active communication and negotiation between vehicles helps with the solution to this problem. Each vehicle will negotiate with the other to ensure that we have a solution that is (i) safe (and guarantees no crashes or deadlock), and (ii) consistent with the price that each agent is willing to pay the other(s) for preferential use. Each vehicle must be able to avoid hazardous situations when negotiation is not possible. The broader objective is to provide efficient, quick routing that achieves or exceeds commercial airliner safety levels.

In addition, I-ACT will allow other strategies to be tested. It is proposed to study the feasibility of improving operational efficiency of urban freight delivery fleets by using personal signal assistant (PSA) technology, and predicting real-time signal-induced delay in urban areas using crowdsourcing data collected from PSA users. The core innovation is a freight eco-router (FER) powered by enhanced PSA technology, a software application that targets urban express freight delivery. PSA technology will be further developed to predict queuing delays at intersections, with location and operational data collected from users. Express delivery trucks will be used as probe vehicles in the planned pilot studies. FER plans routes and speed trajectories for truck drivers in real time, subject to a comprehensive set of safety requirements, seeking to minimize a combined cost of time, fuel consumption, emissions, and reliability. It uses a novel eco-routing algorithm that takes into consideration predictive signal timing information and turning-specific delays and queuing at intersections on candidate routes; and on-board diagnostic (OBD)-based vehicle operational conditions such as instantaneous speed, acceleration and engine status.

C4. Shared Mobility in Multimodal Contexts: Automated vehicles bring in new paradigms of next-generation mobility service that combine the flexibility of automobile driving and the efficiency of transit service. For example, systematic ride-sharing service can be provided when the vehicles are operated autonomously. If massively used, such systems could significantly increase car occupancy and therefore reduce the vehicle-miles traveled per person-trip. Such services will also motivate a broad emerging industry (imagine a new app store for people commuting in autonomous cars). The I-ACT platform will lend itself in testing components that support new capabilities. At I-ACT, we can explore how wireless network infrastructure needs to change, what kind of person-to-person messaging and social networks emerge, what kind of advertisement models will emerge, whether new kinds of gaming platforms emerge, and, in general, how people will use time freed up by vehicle autonomy. These developments will build on ongoing research at NU and I-ACT consortium members.

Similar revolutions will also be tested in related domains. For example, while creative ideas for real-time parking management have emerged over the past decade, the emergence of autonomous and connected vehicles holds promise to bring a revolution to this field; e.g., by eliminating unnecessary vehicle circling (while looking for parking) and at the same time minimizing the need for parking spaces (even when some of the traffic is composed of human drivers). The I-ACT facility will develop an integrated parking management system which consists of state-of-art information infrastructure and advanced mathematical models that work together to efficiently and equitably allocate parking resources in real time. Dynamic performance-based pricing models will ensure that convenient spaces are always available at equilibrium market prices, while the network of sensors and informatics will facilitate reservations and transactions. Preliminary investigation has shown that this new parking management system will eliminate almost all circling for parking, resulting in significant reduction in side effects such as traffic congestion and vehicle emissions, and significantly reduce parking space needs. Prototype development and field testing will be pursued as part of the proposed work plan.

IV.3 I-ACT Education Program

Although automated transportation systems are still in their infancy, the pace of technology development is unprecedented. This is powered not only by the traditional transportation industry, such as auto makers, but also by the investment put forward by the IT industry such as Google, Microsoft, Uber, etc. Advanced transportation is a rising industry, and the need for a skilled workforce trained in these new technologies is rapidly emerging. This need exists for technicians as well as engineers. Current curriculum in traditional transportation engineering programs, however, cannot meet the needs of the

future workforce. Students must be equipped with modernized course offerings and hands-on training to accommodate new technologies and provide them with forward-looking technical skills.

Automated transportation systems will take advantage of the established transportation engineering program in UIUC, NU, and UIC. Unlike most programs, these transportation programs focus on next-generation transportation systems. Surrounded by top-notch engineering programs and having access to industry partners, the transportation programs have potential to cultivate future transportation leaders and innovators equipped with the necessary skills.

The consortium of researchers will enhance its degree-granting programs by developing a new course on connected and automated transportation systems that will be co-taught by consortium faculty members, bringing together researchers' knowledge on traffic dynamics, traffic control, vehicle dynamics, ad-hoc wireless networks, and field experiments. As far as we know such a course does not exist anywhere in the country, while the current trend of increasing automated vehicle suggested that the industry will demand engineers with such interdisciplinary knowledge in the near future. As planned, the course will include topics like car-following dynamics and connected cruise control design, Markov processes and delays in wireless ad-hoc networks, and experimental implementation. The course will include a hands-on project where groups of student have to design a connected vehicle application and implement the corresponding algorithm.

Researchers will also work on developing a scaled connected and automated vehicle testbed in the laboratory scale, which will provide test platforms for students to gain hands-on experience for automated vehicle technology development, test, and validation. These types of scaled vehicles can also be mixed with regular scaled vehicles to simulate scenarios of a mix of low-fidelity and high-fidelity vehicles, which will reflect the transition period before all vehicles are connected.

The partner universities will also develop a credentialing program for technicians to address the skills necessary to work within the rapidly advancing field of automated transportation systems. A blended learning approach consisting of extensive online learning and resources coupled with campus-based sessions that highlight critical thinking and problem-solving related to real-world case studies from industry-based partners will be established. Engineering professionals will serve as project managers of students placed in embedded systems test engineering practicums and/or other experiential learning practicums. Course credit will be awarded for these practicums. Industry partners may also provide internships students who wish to work on connected and automated vehicles related research projects.

IV.4 Disseminating Results

All I-ACT proving ground faculty, students and staff will uphold the UIUC mission to "transform lives and serve society by educating, creating knowledge and putting knowledge to work on a large scale and with excellence." The I-ACT will disseminate results through monthly presentations available to the public. This has been already done as a weekly seminar at ICT. In addition, UIUC and NU have several successful annual conferences in transportation. Annual meetings will focus on automated vehicles. Regular webinars will be organized to share projects' status and relevant data with the research and practitioner's community so testing results will be disseminated to the academic, public, and private sector participants. A website will be developed to publicize activities conducted within the I-ACT proving ground and housed in the already well-publicized ICT web. Research reports and publications, web briefings, brochures, and newsletters will be featured regularly on the website. I-ACT will employ social media channels to announce its latest news and research updates. The number of new technologies, procedures and policies, standards and design practices influenced by results of the I-ACT objective tests and applied by organizations; the number of media stories referencing I-ACT testing; the number of newsletters and press releases, and the number of visits to the I-ACT web site will serve as performance measures that will be used to measure the effectiveness of consortium technology transfer activities.

V. Comprehensive Facilities to Meet Future Transportation Needs

V.1 Existing Facilities

University of Illinois at Urbana-Champaign, Illinois Center for Transportation: Advanced Transportation Research and Engineering Laboratory's (ATREL) goal is to provide high-quality

education and research in transportation and to advance the state of knowledge by developing innovative, economical, and reliable technologies for airport, highway, and rail systems. The complex includes 67,000 square feet of laboratories, including equipment to evaluate connected vehicle and vehicle sensing. Most recently, UIUC was awarded a USDOT University Transportation Center, led by University of Michigan. This effort is fostering the development and implementation of advanced technologies in AV/CV at ICT's ATREL facility through the addition of 52 acres of land for automated vehicle research. ATREL is staffed and equipped to accommodate the investigation of a wide range of projects from basic science and theoretical research to full-scale field testing and transportation infrastructure evaluation, including pavements, bridges, railroad traffic, and transportation systems. The lab is AASHTO accredited in the categories of several testing. ATREL houses many state-of the-art laboratories and unequaled equipment, such as the Accelerated Transportation Loading Assembly (ATLAS), which can evaluate full-scale transportation systems subject to real-life traffic and environmental conditions. The system is capable of simulating aircraft, truck, or rail traffic distributions, testing all types of pavement systems, and applying load levels exceeding those of highway and airfield limits.

Northwestern University Transportation Center: NUTC is located in Chambers Hall in Evanston, Illinois, which is home to NUTC administrative offices, conference rooms, transportation computing labs, graduate student space, and a conference center for executive and distance learning and executive meetings. The computer labs include the Dynamic Network Traffic Simulation and Management Laboratory, housing high-power servers and computing facilities, a configurable LCD video display system, and software tools for network analysis, traffic simulation, state estimation and prediction as well as optimal routing and control algorithms.

NUTC also manages the Center for the Commercialization of Innovative Transportation Technologies. The Center identifies and funds research on novel technologies with promising potential for application in the short to medium term by transportation agencies and companies.

University of Illinois at Chicago Urban Transportation Center: The UTC's Research Laboratory (Translab) consists facilities for travel forecasting methods, survey methods, freight modeling, air quality and emissions modeling, transit planning, and traffic assignment problems. The UIC Artificial Intelligence Laboratory will also be utilized by I-ACT users to support applied intelligent systems projects for solving real-world problems (e.g., improving the utilization and efficiency of existing roadway transportation systems using information technology).

V.2 Designated Point of Contact

The I-ACT proving ground team consists of a number of researchers who are national and international leaders in their field. The team will be led by Professor Imad Al-Qadi, Founder Professor of Engineering at UIUC, founding director of ICT, and the director of ATREL. Al-Qadi is an internationally recognized leader in pavement mechanics, rehabilitation and preservation, flexible pavement materials, sustainable materials, and LCA. He has authored or coauthored more than 600 publications, more than 300 of which are fully-refereed papers. He has served as the principal investigator on more than 120 projects sponsored by various federal, state, and international agencies and industry and has managed more than 230 projects sponsored by ICT.

As ICT director, Al-Qadi has grown the UIUC- Illinois DOT partnership and grown the ICT portfolio to include 54 research projects per annum, partnerships with 26 universities and 14 organizations across the nation, including more than 140 researchers, and innovations for transportation education, workforce development (supporting more than 370 graduate students and many undergraduate students in the past decade), technology transfer (hosting weekly seminars and more than 30 short courses annually attended by more than 1400 engineers) and research activities.

Dr. Al-Qadi will work with an executive committee consisting of representatives from the major university consortium members, including Dr. Peter Nelson, Dean of the Engineering School at UIC, Dr. Hani Mahmassani, Director of the Northwestern University Transportation Center, and Dr.Yanfeng Ouyang, Associate Director for Mobility at the Illinois Center for Transportation.

V.3 An Open Data Sharing Platform to Support Multiple Users

ICT has been working with many researchers over the years and ATREL has been used by many researchers to perform their work. Weekly meeting is usually conducted to study the proposed plans of using the facility and the work is planned according to several criteria including the urgent need, the compatibility of the facility, coinciding with I-ACT overall vision, the level of impact, among others. Two types of tests will be conducted: Tests that will have data readily available for sharing via our website as indicated earlier, and tests that will be temporarily confidential pending system development to ensure the success of product development and deployment.

V.4 Facility Implementation Timeline

The I-ACT will be built on four stages (tiers) as depicted in Figure 1. Stage 1 has already been built and is a large 15,000 ft^2 parking lot. This facility will be used for initial testing of automated vehicle. During that time, the second test track stage will be constructed as an approximately 1.5 miles of primary road comprises of various pavement surfaces and has embedded sensors for measuring vehicular response and communicating with automated vehicles during testing. I-ACT will focus in Stage 2 on testing automated trucks, although passenger vehicles can be still tested. In addition, these roads will cross lands to be used for testing automated equipment such as construction and farming equipment. Stage 3, Smart Simulated City and Suburban Structures, will be the authentic "city" proving ground that included various features of a neighborhood including intersection, and sidewalks. Stage 4, Real City and Highway Corridors, will make sue of interstate corridors and Village of Rantoul and surroundings. Plans for Stages 2, 3, and 4 will be ready by 1/1/2018 along with plans for construction.

V.5 Existing Testing at ICT/NUTC Facilities

UIUC, NU, UIC researchers have been working with many government and private industry entities over the past two decades including the NCHRP, FHWA, FAA, Michelin North America Inc., Illinois State Toll Highway Authority, NSF, AFOSR, Toyota, AFRL, Intel, USDOT, Caterpillar, Seagate, Army Research Office, NASA, John Deere, Draper (Charles Stark) Laboratory Inc, DOE, Motorola, Rolls Royce, ONR, and Samsung among others.

VI. Proven History of Regulatory Adherence

ICT has created an excellent partnership with IDOT through several steps to ensure sharing of information and proper management. I-ACT plans publishing regular quarterly report (shared on website for public review) for all projects and administrative tasks, weekly conference call for administration with partners, monthly face-to-face meeting for the managing teams, including the safety officer, and a monthly conference call or face-to-face meeting between leadership of involved entities. In addition, a yearly meeting of the executive board. Checks to ensure adherence to regularity will be implemented.

In addition, regular meetings between the I-ACT safety officer and Village of Rantoul will take place on a monthly basis to ensure that safety regulations are followed and to abide by local rules. Similarly, such meetings will be conducted with IDOT to ensure that IDOT and NHTSA regulations and laws are carefully followed. Given the excellent relationship with Village of Rantoul and IDOT, and the regular meetings already in place, the implementation of such plans will be easy and appropriate.

VII. Closing Statement

Designating the I-ACT proving ground will unveil a new era of national automated personal and freight mobility facilitated through a safe and robust platform of laboratories, closed test tracks, urban and metropolitan road courses, urban-rural boundary road courses, and interstate corridor testing facilities. The proposed I-ACT Proving Ground is positioned to enable and accelerate the development and deployment of automated trucks and vehicles; ensure safe and efficient freight and transit operations; and maximize public benefits by leveraging connected vehicle technologies. The consortium of researchers leading the I-ACT is pushing the envelope in science and engineering, advancing automated vehicle technologies through safe testing. Building on the expertise of these renowned field experts, the I-ACT proving ground will definitely be well-equipped to lead the next revolution in roadway safety.