ITIC Proposal responding to USDOT solicitation 'Designation of Automated Vehicle Proving Grounds Pilot'

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Introduction

The International Transportation Innovation Center (ITIC) is a 501c3 non-profit organization headquartered in Greenville, South Carolina, with the mission to build a network of open and closed testbeds of national and international scale to develop and validate technologies that support connected, automated and zero-emission driving. ITIC offers automotive OEMs, automotive suppliers, information and communication service providers, utilities, research organizations and start-ups a variety of services that help build an ecosystem of on-demand mobility services for multi-modal transportation systems to master strategic challenges that come with more connectivity, more automation and more electrification.

ITIC is affiliated with the South Carolina Technology & Aviation Center (SCTAC) which is an agency jointly governed by the City and County of Greenville. SCTAC manages a 2,600 acre business park - one of the largest industry parks in South Carolina which also includes the operation of a FAA certified airport. To meet its mission, ITIC is redeveloping about 600 acres of the 2,600 acres of SCTAC property into a closed testbed for advance mobility solutions considering all aspects of Automated Vehicle (AV) testing. The key element of this development is an inactive airport structure, which includes a one mile long and 300 feet wide runway. The masterplan for this redevelopment was designed by the engineering company Tilke, which has a long history in designing Formula 1 race tracks and automotive test tracks, with a special focus on surpassing the highest levels of safety standards.

In addition to developing a closed testbed for advanced mobility solutions, ITIC provides an ideal environment to combine closed testbeds with open testbeds as well as public road testing. Within the SCTAC business park grounds, ITIC can offer a large variety of road configurations to be used as an open testbed. Moreover, the open testbed capabilities can be further augmented by open testbed pilot zones at CU-ICAR, or downtown Greenville or at I-185 which are outside the business park area but within close proximity to ITIC.

The masterplan for ITIC developed by Tilke Engineering combines elements of R&D testing, driver's training and technology demonstration. ITIC is designed as a shared facility which can be used by different stakeholders of the transportation and mobility ecosystem in particular with respect to the regional automotive cluster.

The formation of ITIC in Greenville has been influenced both by the limitation of local testing capabilities of automotive stakeholders as well as by the creation of automotive research and education activities in the State of South Carolina.

From a local perspective, ITIC has developed strong relationships to the OEMs and Tier One companies with a manufacturing and engineering presence in the Southeast to offer the option of a shared testing facility that can provide an infrastructure in size and quality that companies may not be able to implement individually. Investments into smart grid infrastructure to evaluate new charging options as well as into intelligent communication and network infrastructure can be cost-prohibitive for individual companies and require partnering.

South Carolina has built a substantial automotive ecosystem over the last 25 years. Multiple OEMs and Tier One companies have a major manufacturing presence in the State and the implications of digitalization and electrification can be very significant on the supply chain. More co-location of engineering and manufacturing activities are a must considering the fact that many OEMs and suppliers located with physical assets in the Southeast are of non-US origin and their R&D headquarters are far away.

The automotive sector is one of the driving forces of the US manufacturing vertical and one of the largest regional manufacturing clusters is the South. The South has 17 major automotive assembly plants, ten of which are currently expanding having a secondary effect on the supply chain. The automotive sector of the South announced 111 big projects in 2015 which is more than a quarter of the manufacturing sector's 424 deals (a big project is defined by creating more than 200 jobs and more than 30 million USD in investment) [1]. In South Carolina, two new plants were announced in 2015: Volvo Cars [2] and Daimler Vans [3].

The original concept of ITIC was developed in the 2010-2011 timeframe as "Project Green" to become a center for advanced mobility solutions addressing the interaction of vehicle and infrastructure development. To further develop the concept a strategic partnership was formed between the Clemson University International Center for Automotive Research (CU-ICAR) and SCTAC. Between 2012-2013 substantial site improvements were completed and the brand of ITIC was developed. Partnerships with the US Department of Energy (DOE), Oak Ridge National Laboratory (ORNL), Cisco, Toyota and Duke Energy to develop wireless charging technology solutions for electrified vehicles utilizing V2V/V2I were also developed during this timeframe. During 2014-2015, ITIC engaged with the engineering company Tilke to develop a masterplan for the further development of the closed testbed in Greenville, SC and interacted intensively with OEMs and Tier One companies to understand the requirements for testing connected vehicle applications as well as highly automated and fully automated driving systems. ITIC also formed a strategic partnership with the Seaside Institute in Seaside, FL to develop an open testbed for on-demand, highly automated and zero-emission multi-modal transportation solutions in new-urbanism communities which led to the formation of the "30A Mobility Project".

In 2016, ITIC has focused on:

- Detailed track and facility planning for masterplan implementation of the closed testbed in Greenville, SC based on stakeholder input
- Planning of an open testbed in Seaside, FL
- Preparation of a public private partnership model to operate the ITIC testbeds
- Building an operational team for ITIC
- Establishing partnerships with international testbeds (e.g. in Europe and Asia)
- Developing a consortium concept "ITIC mobility services testbed alliance" under the leadership of IBM with a specific emphasis on "new urbanism mobility"
- Supporting the incubation of smart mobility start-ups that require the use of testbeds

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Eligibility criteria

Headquartered in Greenville, SC, ITIC is in an ideal environment to combine closed testbeds with open testbeds as well as public road testing.

Greenville City re-development

Creation of an automotive engineering cluster with CUICAR

Development of automotive testing capabilities with ITIC at SCTAC

US Southeast target for automotive supply chain with SC in its center

Figure 1 Greenville automotive ecosystem [4]

ITIC is surrounded by a ring of federal highways (13.5 miles of I-185 which is a toll-road, six miles of I-385 which connects Greenville with the coast, ten miles of I-85 which is the main transportation corridor between the metropolitan regions of Atlanta, GA and Charlotte, NC). It is in close proximity to downtown Greenville as well as the 250 acre automotive research campus CU-ICAR. Of all the states in the Southeast, South Carolina has the highest density of automotive OEMs and Tier One companies and is in the center of the automotive supply chain which also includes also a strategic logistics port for car exports.

ITIC offers **tests tracks and testing facilities** as well as **highway corridors** and **city/urban cores** as part of its open and closed testbeds. With this, ITIC meets the **eligibility criteria** established in this solicitation and the usage of the facilities as an AV proving ground is explained in the next section.

ITIC AV Proving Ground Concept

ITIC follows an inside-outside concept for testing automated vehicles:

1. Testing in a closed and controlled environment to fully understand the capabilities and potential limitations of situations the automated systems can handle.
2. Testing in an open testbed where interaction with other non-automated vehicles and participants of transportation such as pedestrians and bicyclists can happen under real-word conditions.
3. Testing on public roads following federal and state regulations.

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ITIC provides the following capabilities to achieve this testing concept:

1. **Closed testbed.** ITIC's closed testbed facilities offer testing in closed and controlled environments, with safety and security being considered fundamental elements.
   Test tracks and testing facilities (Figure 2): The 600 acres being developed by ITIC includes:
   - One mile long / 300 feet wide runway.
   - Urban track test bed to test urban scenarios in a controlled environment.
   - Other testbeds and tracks, including: handling course, driver's training course, off-road track, and others.
   - Support for testing of all vehicle categories.
   - Support for testing of urban, rural and highway driving simulated scenarios.

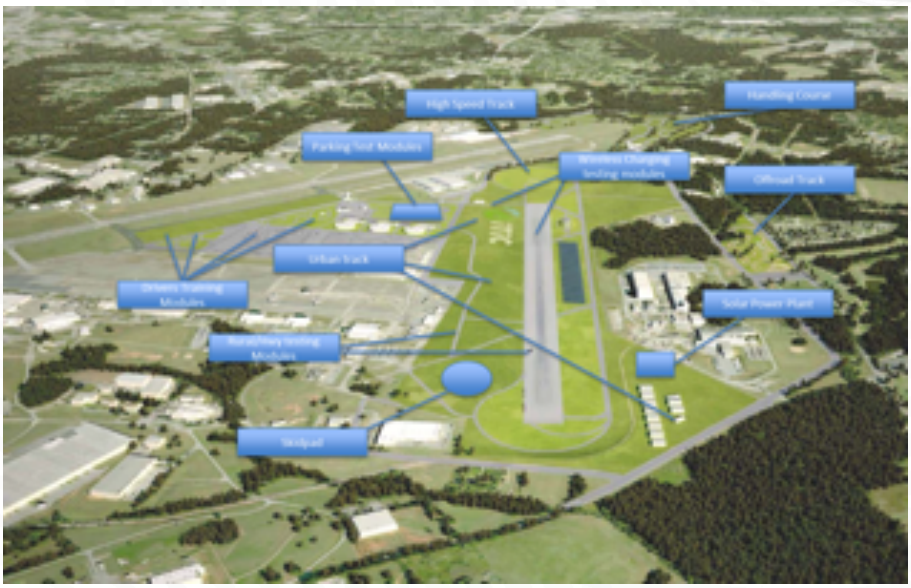

Figure 2 ITIC closed test track and testing facilities [4]

2. **Open testbeds.** ITIC offers different open testbed configurations to analyze the behavior of automated systems in mixed traffic conditions.
   a. **Highway corridors** ITIC offers the possibility of closing on-demand a portion of I-185. In this way, automated driving in highway scenarios can be tested in a controlled way, prior to testing in mixed traffic situations.
   b. **City/ Urban cores** Inside the designated business park area SCTAC (red line in Figure 3), ITIC can offer a large variety of road configurations as an open testbed. In addition, ITIC has an excellent relationship with the City of Greenville and CUICAR. Thus, it would be possible to provide testing capabilities in additional **city/ urban cores** and **academic campus areas.**

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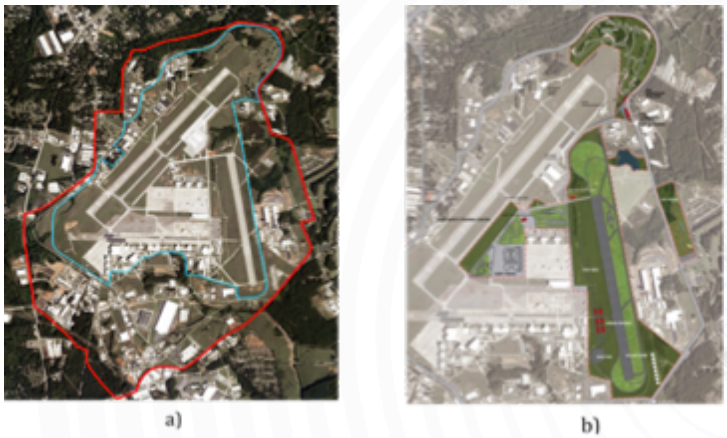

Figure 3 a) SCTAC business park (red line) and ITIC masterplan within SCTAC airport area (blue line); b) ITIC masterplan developed by Tilke Engineering [4]

Table 1 Eligibility information

Eligibility Information	
Type	**Location**
Test tracks or testing facilities	ITIC headquarters – Greenville, SC
City / Urban cores	ITIC headquarters/ SCTAC business park – Greenville, SC City of Greenville (potential) – Greenville, SC
Highway corridors	I-185/I-85/I-385 – Greenville, SC
Academic Campuses	CUICAR and Furman University Campus (potential) – Greenville, SC
Race track	Partnership with Atlanta Motorsports Park

Selection Criteria

Mandatory criteria

By responding to this solicitation, ITIC commits to meet all the mandatory criteria required by this solicitation:

1. ITIC will hire a designated Safety Officer to develop and implement a safety management plan for the site and who will be authorized to share experiences in a Community of Practice with other Safety officers operating AV testbeds.
   Currently, because of ITIC's location on the SCTAC campus, ITIC benefits from the exclusive fire protection provider of SCTAC-- Donaldson Center Fire Department - whose capabilities include:
   a. 24/7 Three minute or less response time to any fire, haz-mat, aircraft and medical emergency
   b. Exceeds NAS 3306 and FAA 139 military and civilian aircraft response standards
   c. ISO Class 2 (top 2% of U.S. fire departments)
   d. 22 professionally-trained personnel
   e. Two fully-equipped stations

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Furthermore, SCTAC was awarded by the South Carolina Chamber of Commerce the 2016 Safety Award which "honors those companies who have made safety a top priority" [5].

Figure 4 On-site first responder units

2. ITIC commits to share ITIC's safety management plan, as well as safety data generated through testing and operation. In addition, the Safety Officer will continue the already ongoing efforts of ITIC regarding the engagement with multitude of OEMs, Tier Ones, information and communication service providers, utilities, engineering service providers, smart community developers and architects, and other stakeholders, to understand the AV testing requirements, test use cases and test data generation to be considered from a safety perspective.

Proposed contributions

In order to achieve its mission, ITIC has a structure of a public-private partnership, which allows private investors to invest in physical testbed assets and an operating company that manages the testbeds and provides R&D and event services. As it has been mentioned in the previous sections and will be elaborated during this document, ITIC has extensive experience in establishing partnerships to administer R&D programs. In addition, ITIC is currently developing other national and international partnerships to expand its model.

ITIC has demonstrated its leadership role in the development of advanced vehicle technologies. In particular:

1. ITIC collaborated with CU-ICAR in partnership with ORNL, Toyota, Cisco, Duke Energy and the start-up company Evatran on the development of a DSRC-based communication system to support stationary and in-motion wireless charging in the timeframe of 2012-2016 on a DOE-supported research project (10.6 million USD overall project budget with ORNL as lead institution [6]) where a physical testbed was implemented at SCTAC which is currently been operated and further developed by ITIC. In-motion wireless charging of electrified vehicles could lead to uninterrupted operation of zero-emission self-driving vehicles.
2. Some of the aforementioned team members actively contributed to the development of the standard SAE J2954 "Wireless Power Transfer for Light-Duty Plug-In/ Electric Vehicles and Alignment Methodology".
3. In addition, ITIC is actively involved in other standardization activities and communities, such as the Institute of Electrical and Electronics Engineers (IEEE), to support standards development for cybersecurity of connected and automated vehicles as well as standards development of automated in-motion wireless charging and offered to use its testbed for technical validation to support the expert teams.

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4. ITIC was jointly awarded in the last R&D 100 Awards sponsored by R&D Magazine for its contributions to the "Wireless Power Transfer Based Electric and Plug-In Vehicle Charging System" [7].
5. ITIC led the Greenville submission for the USDOT Smart City Challenge [8], it also supported the submissions of Moreno Valley, CA and Portland, OR.
6. ITIC has successfully developed the "30A Mobility project" concept in Florida (see figure 4), with the objective of solving the mobility issues of the communities in the coast of the Panhandle of Florida [9]. This project is based on multi-modal on-demand, zero emission and automated modes of transportation.

Figure 5 Open testbed development "30A mobility project" [9]

In addition, the mission of ITIC also facilitates the outreach of the contributions that may result from the use of its testing facilities. This includes the participation in specialized conferences, workshops and seminars, publications in specialized journals as well as other events for the general public. ITIC has already contributed in outreach activities such as:

Conferences / Workshops / Events

- ITIC organized in 2012 the first IEEE IEVC (International Electrical Vehicle Conference) in partnership with CU-ICAR and organized an EV technology demonstration event at SCTAC.
- ITIC co-sponsored and co-organized the 2nd IEEE IEVC conference in Florence, Italy in 2014.
- ITIC organized in 2015 a technology demonstration and driver experience event at SCTAC for the annual South Carolina Automotive Summit.
- ITIC organized in 2015 the first stakeholder workshop at Seaside, FL to develop the 30A mobility project with the Florida Secretary of Transportation being present.
- ITIC participated in one of the sessions of the 2015 FDOT Automated Vehicle Summit in Jacksonville, FL as well as in the 2016 FDOT Automated Vehicle Summit in Tampa, FL.
- ITIC organized in 2016 the second stakeholder workshop in Seaside, FL, to develop technical solutions for the 30A mobility project and to create the foundations of an open testbed.
- ITIC organized in 2016 a CV/AV/EV technology demonstration event for the USDOT Secretary at SCTAC (hosted by Jody Bryson, CEO SCTAC and John Hopkins, Executive Director ITIC) where the Federal AV policy was discussed.

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Commitment to Safety

Throughout the years that ITIC has operated the site, ITIC has demonstrated its ability to operate a test facility and to successfully organize technology demonstration events as well as driver safety trainings which all have taken place under safe conditions.
Moreover, the development of the ITIC masterplan has been done by the engineering company Tilke, which has also been involved in designing AV testing facilities for major OEMs and Tier One companies. Tilke brings its design and safety knowledge into the development of ITIC open and closed testbeds. The primary role of Tilke is to develop an AV proving ground of the highest possible safety level – also considering use cases with mixed use with non-AV vehicles – and to regularly update the testbed infrastructure to client requirements.
ITIC will provide the infrastructure to execute an AV safety management plan in which the operations are fully automated and where all activities on the site are monitored by a control center. This control center can interact at any time in case of an identified risk situation, as all test vehicles will be connected via a communication backbone and constantly streaming data about their location, trajectory and operational status. In addition, the control center will have the needed tools to automatically generate on-demand safety reports resulting from the testing facilities operation.
Furthermore, ITIC has developed partnerships with In-Tech Automotive Engineering, SGS as well as with IBM and Cisco whose expertise can be used to provide AV safety services and for dissemination of safety data and practices. These partnerships will be explained with more detail in the following section.

Research, Application and Data Sharing

The fundamental driver of the ITIC mission is to build a network of closed and open testbeds for connected, automated and electrified driving where knowledge about technology, test procedures and infrastructure aspects can be shared in a community. Such a networking approach requires the development of partnerships with governmental, academic and industrial entities in a local, national and international context. Below, are the key partnerships that ITIC has developed that will contribute to research, application and data sharing.

ITIC Mobility Services Testbed Alliance

ITIC has teamed up with IBM and Cisco to develop an "ITIC Mobility Services Testbed Alliance" which is a consortium effort led by information and communication companies to create a community of CV/AV/EV R&D experts. They will be able to share software, data, big data analytic tools and IT infrastructure solutions which can be leveraged by mobility service providers and automotive manufacturers and suppliers. The Alliance is organized following principles of the Open Source software development community and has the intent to attract the best engineering talent to contribute to improve the operational safety of automated vehicles and related infrastructure. The Alliance will specifically encourage other non-ITIC operated testbeds to join in order to share methods of safe operation of AV proving grounds with support of IT solutions and to have OEMs validate the operational safety of AV systems with methods, tools and data provided via their community.

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The alliance subject matters experts recognize that testing of smart mobility services requires information and communication technology infrastructure to be embedded in the testbed itself. Thus, there is a unique opportunity to build and grow an ecosystem of industry partners around ITIC's network of testbeds.
Supporting connected, automated, and zero-emission driving requires 1) a secure, highly scalable Internet of Things (IoT) platform capable of ingesting large volumes of diverse data into the cloud, 2) a high-performance cloud platform that provides access to data, analytic, and cognitive services to build smart mobility solutions, and 3) an open framework for data exchange between diverse data owners.
IBM intends to partner with ITIC to provide access to IBM Bluemix Cloud Platform services, the IBM Watson Data Platform, the IBM Watson IoT for Automotive, and other IBM technologies to support the requirements of test configurations for automated driving and smart mobility solutions and address their data management, data privacy, security management, and data ownership challenges:
IBM is working with ITIC to create a "Mobility Services Testbed Alliance" to foster open collaboration among information and telecommunication technology providers, as well as OEMs and Tier One companies to build smart mobility services, and provide access to ITIC's international network of closed and open testbeds to validate and certify these services. The alliance is modeled after the Linux Open Foundation.
The Alliance will also actively work on outreach to the R&D community via workshops, conferences and technology demonstration events.

Collaboration with the City and County of Greenville

Through ITIC's affiliation with SCTAC, it has an excellent relationship to the City and County of Greenville which is the largest urban/rural community in the Upstate of South Carolina in terms of population. Whereas the County of Greenville is the center of the automotive cluster in the Upstate, the City of Greenville became a local magnet for business, entertainment, tourism and urban lifestyle through a successful redevelopment of the downtown area [10]. The City and County of Greenville are eager to improve the traffic problems that come with the economic success of the region. Despite substantial improvement of the transportation infrastructure the utilization of connected and automated driving technology is of very high interest for the local community and there is a strong willingness to provide pilot zones for experimentation as was pointed out in the Smart City Challenge Application of Greenville [8]. Of particular relevance is that the County is authorized to be a pilot site for autonomous vehicle design, development and testing [11]- [12].

Partnership with Clemson University

ITIC is in close proximity to CUICAR, a 250 acre campus where academic research for automotive engineering and manufacturing is co-located with industrial R&D facilities. ITIC has already partnered with CUICAR in a multitude of joint research proposals and research projects. In addition, ITIC keeps close relationships with key faculty on the Clemson University main campus in particular in civil engineering, architecture, computer science and electrical engineering and partners in joint research activities where professors and students can utilize the ITIC facilities. ITIC has a long collaboration history with CUICAR. This has been demonstrated several times:

- ITIC collaboration with CUICAR on the DOE project: "Wireless Power Transfer (WPT) and Charging of Plug-In Electric Vehicles" (DE-FOA-0000667) with several other partners [6].
- ITIC support to CUICAR's Deep Orange Program, providing its testing facilities to their students.

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- ITIC has a close collaboration with Clemson University Connected Vehicle Technology Group, which combines professors of several Clemson University departments: Automotive Engineering, Electrical Engineering, Computer Science, Mechanical Engineering, Civil Engineering, and others. These departments have long experience in working in USDOT and other programs, with several research contributions resulting from them.
- ITIC co-sponsors Clemson University "Creative Inquiry" courses addressing automated driving.
- ITIC collaboration with CUICAR in conferences and outreach events (see "Proposed contributions" section).
- ITIC participation in joint Conference and Journal papers with CUICAR.
- ITIC will be collaborator for the newly funded USDOT University Transportation Center "Center for Connected Multimodal Mobility" [13]. ITIC will support various research projects conducted through this Center, in particular with DOT's relevant research program offices.

Partnership with In-Tech Automotive Engineering

Of specific relevance is the partnership of ITIC with in-tech Automotive Engineering which is a key partner in AV testing and AV proving ground operations, especially from a safety perspective. In-tech has extensive practical experience at the OEM-level to perform engineering and testing tasks for highly automated driving systems and can be used to provide AV testing services as well as safety analysis for ITIC clients.

Partnership with SGS

SGS is a world-leading inspection, verification, testing and certification company that has deep working experience in North America with government agencies and is specialized on functional safety assessments. SGS will contribute to establish and execute safety automated vehicle management plans and methodologies, to develop a certification program with specific emphasis on safety considerations and to apply a safety training & personal qualification program.

Partnership with Seaside Institute

ITIC has a strategic partnership with the Seaside Institute in order to develop a collaborative effort on "new urbanism mobility" which is based on the result of the successful collaboration of the "30A Mobility project". The 30A mobility project is an effort to implement a multi-modal on-demand transportation concept leveraging automated and zero-emission vehicle technology along a corridor of multiple coastal communities in the Panhandle of Florida centered around Seaside. ITIC has developed a transportation innovation and open testbed concept which is currently being implemented and supported by the FDOT. IBM and Local Motors are working with ITIC to deploy an Olli (self-driving electrified minibus) pilot in the Seaside community as part of the 30A Mobility project and to use the ITIC testbed alliance as a development accelerator for the Olli program.

International partnerships

ITIC also developed a variety of international partnerships such as with Innovate Norway to develop a closed and open testbed in the Trondheim area, with the Swiss Federal Institute of Technology in Zurich to develop a closed and open testbed in the Zurich area, with the Technical University of Munich to develop a

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closed and open testbed in the Munich area and with URBAN.SYSTEMS [14] in Portland, Oregon, to develop an open and closed testbed in the Hongkong/Shenzen area.

Demonstrated Investments

ITIC has successfully demonstrated, with the masterplan developed by Tilke, that it can redesign the underutilized airport structure at SCTAC into a high-value advanced mobility technology validation, demonstration and training facility which can accelerate the adoption of automated driving and contribute to increased safety levels on public and private roads.

The ITIC business model is conceived to minimize financial risk of its activities. In particular, ITIC's business model is based on the following revenue streams:

- Usage fees for the different ITIC testbed elements and facilities
- Event fees
- Consulting fees for technical due diligence and technology oriented market research
- R&D contract fees and grants
- Consortium membership fees (for consortiums managed by ITIC)

ITIC has a structure of a public-private partnership which allows private investors to invest in physical testbed assets and an operating company that manages the testbeds and provides R&D and event services. The physical assets can be leased/acquired by the operating company from a public or private landowner. In some cases, land/assets from a public landowner can be bonded based on a long-term lease by private investors through the operating company. Essential for a sustainable business model is:

1. That the public entity receives sufficient revenue from land/facility lease, grant income and consortium management fees.
2. The private entity gets sufficient income from client activities to cover its cost and to serve the long-term profit expectations of its investors.

An important aspect can be to open the testbed to incubators and start-up's to accelerate the incubation process and to identify potential customers quicker.

Since its creation, and as a result of the mentioned business model, ITIC has made the following major investments:

Table 2 Summary of major investments at ITIC

Investment	Expenditure Period	Expenditures Incurred
Test Track Infrastructure	05/30/2013 to 9/11/2014	$ 930,578.00
Tilke Master Plan	11/25/2014 to 5/9/2015	$ 236,174.14
ITIC Site Survey	06/30/2015	$ 5,250.00
Charging Station and Related	02/16/2015 to 12/04/2015	$ 143,119.00
Test Track Infrastructure Expansion	11/02/2016 to 12/09/2016	$ 35,060.00
ITIC Headquarters Building	2007 to 7/21/2009	$ 643,090.92
	Total	**$ 1,993,272**

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Readiness

As described in the previous section, since its conception in 2010, ITIC has performed several site improvements. In addition, the following aspects must be highlighted:

- ITIC has the required FCC permits for deploying and operating DSRC communications [15]and also the required Greenville County approvals for installing and operating high voltage systems [16]-[17].
- ITIC masterplan, which includes AV testbed element (with special focus on SAE L3-L5) was completed in spring 2016 including a full economic analysis and a preparation of a RFP to start detailed planning and construction work.
- Designated areas of the masterplan that were previously used for other activities have terminated its operations in order to make them available for the ITIC masterplan implementation.

Furthermore, all elements that are needed for the basic AV test elements can be funded by investments through SCTAC and ensure their availability in the test site by January 2018. A full-scale implementation of the Tilke masterplan requires a combined investment by public and private investors and is expected to be completed by January, 2020. The planning work for the 30A mobility testbed will be completed by the end of 2017. A full-scale implementation also requires a combined public private investment supported by the "New urbanism mobility" initiative jointly run by ITIC/Seaside Institute and can be expected to be completed in the 2020 timeframe.

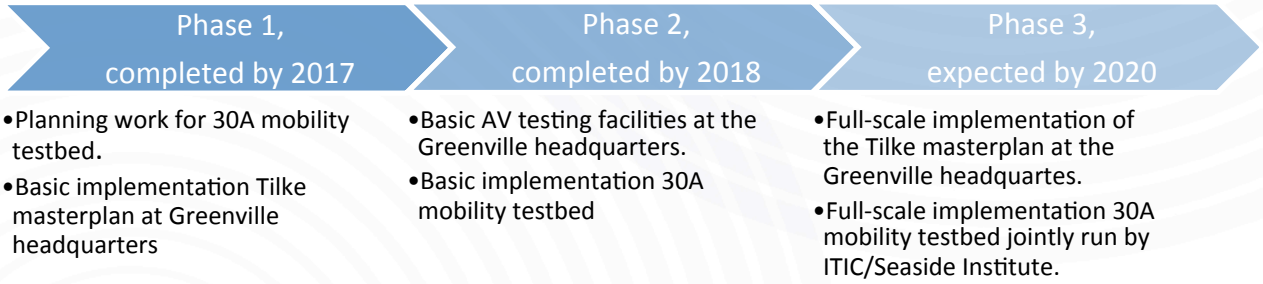

Figure 6 Timeline for future implementations at ITIC

Adherence to Laws, Regulations, and Federal Policy

The testing facilities associated to ITIC are considered private property. Thus, ITIC is able to perform automated driving tests in compliance with the existing laws. As it is expected for these laws to adapt over time, ITIC will work closely with local, state and federal leaders in the adaptation of its testing procedures to comply with such potential adaptations.

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Technical leadership team

Joachim Taiber (CTO, ITIC)

Dr. Joachim Taiber developed the technical concept of ITIC and as CTO also is responsible for its implementation. He holds a master and PhD degree in engineering from the Swiss Federal Institute of Technology in Zurich and held multiple leadership positions in the area of vehicle product development, information technology and innovation management at BMW Group where he served from 1997-2010. He was substantially involved in the concept development and implementation of CU-ICAR and directed the BMW Information Technology Research Center from 2005-2010, the first building being implemented on the CU-ICAR campus. From 2010-2015 he served as Automotive Research Professor and Faculty Member at the Clemson University Department of Automotive Engineering. During this time he founded the Sustainable Mobility Institute and worked with SCTAC on the creation of ITIC. Since 2016 he has been CTO of ITIC and continues to serve at the Faculty of Automotive Engineering at CU-ICAR as Adjunct professor.

Mac Devine (VP and CTO, Emerging Technology and Advanced Innovation, IBM Cloud Division)

Mac has 27 years of experience with networking and virtualization. He became an IBM Master Inventor in 2006, an IBM Distinguished Engineer in 2008 and is a Member of the IBM Academy of Technology since 2009. He served 2 years as the Chief Architect for IM System z Enterprise Software and 2 years as the CTO for IBM Cloud partnerships and client innovations within the IBM Corporate Strategy team.

Mac served 2 years as Director and CTO Cloud Portfolio within IBM Global Technology Services. He led the technical due diligence for the SoftLayer acquisition which lead to the creation of IBM Cloud Services Division. He co-authored Springer's Handbook of Cloud Computing used by colleges and universities. In 2016, Mac received IBM's highest technical honor when he was appointed an IBM Fellow. Mac currently serves as Vice President and CTO of Emerging Technology and Advanced Innovation, IBM Cloud Division and as a faculty member for the Cloud and Internet-of-Things Expos. Mac also serves on the Internet of Things Community Advisory Board as well as the advisory boards for more than a dozen cloud companies.

Ronny Chowdhury (designated USDOT UTC director, Clemson University)

Mashrur Chowdhury is the Eugene Douglas Mays Professor of Transportation in the Glenn Department of Civil Engineering at Clemson University. He is Co-Director of the *Complex Systems, Analytics and Visualization Institute*. His research primarily focuses on connected and automated vehicle technologies, with an emphasis on their integration within smart cities. He works actively in collaborative transportation-focused Cyber-Physical System (CPS) research and education efforts with many industry leaders. He has received both national and international recognition for his work on Intelligent Transportation Systems (ITS) and Connected Vehicle Technology. He previously served as an elected member of the Institute of Electrical and Electronics Engineers (IEEE) ITS Society Board of Governors and is currently a senior member of the IEEE. He is a Fellow of the American Society of Civil Engineers (ASCE) and an alumnus of the National Academy of Engineering (NAE) Frontiers of Engineering program. Dr. Chowdhury is a member of the Transportation Research Board (TRB) Committee on Artificial Intelligence and Advanced Computing Applications, and the TRB Committee on Intelligent Transportation Systems. He is an editor of the IEEE Transactions on ITS and Journal of ITS, and an Editorial Board member of three other journals. He is a Registered Professional Engineer in Ohio.

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Summary

In conclusion, based on the evidence presented in this proposal, ITIC meets the criteria put forth in the solicitation issued by the USDOT for AV Proving Grounds designation as shown in Table 3 below:

Table 3 Summary of selection criteria met by ITIC

Selection criteria	ITIC contribution
Mandatory Criteria	• Appointment of ITIC Safety Manager • Access to SCTAC fire protection provider • Commitment to share safety management plan, as well as safety data
Proposed contributions	• Critical mass in resources through partner network • Standardization activities • Development of mobility solutions for communities • Participation in specialized conferences, workshops and seminars, and publications in specialized journals
Commitment to Safety	• Previous experience operating test facilities and organizing technology demonstrations considering a standard of safety • Master plan developed by Tilke Engineering addressing safety • Commitment to develop a fully automated operation center • Safe Management of OEM AV programs via In-tech Engineering and directly by OEMs or designated engineering service companies • ITIC Testbed Alliance to share best practice in operational safety
Research, application and data sharing	• Creation of ITIC Mobility Services Testbed Alliance • Management of IBM's Olli program • Support of State of South Carolina, City of Greenville, County of Greenville • Utilization of Clemson University for state-wide education program • Partnership with In-Tech Automotive Engineering • International Partnerships
Demonstrated investments	• Capital improvements
Readiness	• Ongoing test activities in AV • Basic components for AV testing ready for January 2018
Adherence to laws, regulations and federal policy	• Utilization of public roads for AV testing • Resolution of Greenville County regarding AV testing in place

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