COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO:
NSF 14-577

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)
DUE - ATE-Projects

<table>
<thead>
<tr>
<th>DATE RECEIVED</th>
<th>NUMBER OF COPIES</th>
<th>DIVISION ASSIGNED</th>
<th>FUND CODE</th>
<th>DUNS# (Data Universal Numbering System)</th>
<th>FILE LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/07/2015</td>
<td>1</td>
<td>11040000 DUE</td>
<td>7412</td>
<td>098405459</td>
<td>10/07/2015 8:16pm</td>
</tr>
</tbody>
</table>

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)
570440170

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
Trident Technical College

AWARDEE ORGANIZATION CODE (IF KNOWN)
0001958000

NAME OF PRIMARY PLACE OF PERF
Trident Technical College

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE
Trident Technical College
P O Box 118067
Charleston, SC. 294238067

IS AWARDEE ORGANIZATION (Check All That Apply)
- SMALL BUSINESS
- MINORITY BUSINESS
- FOR-PROFIT ORGANIZATION
- WOMAN-OWNED BUSINESS
- IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
Trident Technical College

ADDRESS OF Awardee Organization, INCLUDING 9 DIGIT ZIP CODE
Trident Technical College
P O Box 118067
Charleston, SC. 294238067

NAME OF PRIMARY PLACE OF PERF
Trident Technical College

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE
Trident Technical College
SC ,294238067 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply)
- SMALL BUSINESS
- MINORITY BUSINESS
- FOR-PROFIT ORGANIZATION
- WOMAN-OWNED BUSINESS
- IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT
Creating Learning Opportunities for Undergraduates in Developing Technologies (CLOUDTech)

REQUESTED AMOUNT
$ 262,136

PROPOSED DURATION (1-60 MONTHS)
24 months

REQUESTED STARTING DATE
05/01/16

SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
- BEGINNING INVESTIGATOR (GPG I.G.2)
- DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
- PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- HISTORIC PLACES (GPG II.C.2.j)
- VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date
- PHS Animal Welfare Assurance Number
- FUNDING MECHANISM Research - other than RAPID or EAGER
- HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number Exemption Subsection or IRB App. Date
- INTERNATIONAL ACTIVITIES; COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
- COLLABORATIVE STATUS
- Not a collaborative proposal

PI/PD DEPARTMENT
Network Systems Management

PI/PD POSTAL ADDRESS
PO Box 118067
Charleston, SC 294238067
United States

PI/PD FAX NUMBER

PI/PD NAME
Dane Schupbach

High Degree
MS

Yr of Degree

Telephone Number
843-574-6195

Email Address
dane.schupbach@tridenttech.edu

Page 1 of 3
Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. For her, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide Part II: the Grant Proposal Guide (GPG). Wilful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that he organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of AAG Chapter IV.C., that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the No Ications and Requests Module in FastLane.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for one United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with his Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, “Disclosure of Lobbying Activities,” in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-8 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4092a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

1. Community in which that area is located participates in the national flood insurance program; and

2. Building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

1. for NSFR grants for the construction of a building or facility, regardless of the dollar amount of the grant; and

2. for non-NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)

(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the Institution has a plan in place to provide appropriate training and oversight for the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

Page 2 of 3
CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support
By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations
When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unpaid, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability
When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or liened, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions
When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

<table>
<thead>
<tr>
<th>AUTHORIZED ORGANIZATIONAL REPRESENTATIVE</th>
<th>SIGNATURE</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amanda Hollinger</td>
<td>Electronic Signature</td>
<td>Oct 7 2015 4:41PM</td>
</tr>
<tr>
<td>TELEPHONE NUMBER</td>
<td>EMAIL ADDRESS</td>
<td>FAX NUMBER</td>
</tr>
<tr>
<td>843-574-6068</td>
<td><a href="mailto:amanda.hollinger@tridenttech.edu">amanda.hollinger@tridenttech.edu</a></td>
<td>843-574-6109</td>
</tr>
</tbody>
</table>
NSF FORM 1295: PROJECT DATA FORM

The instructions and codes to be used in completing this form are provided in Appendix II.

1. Program-track to which the Proposal is submitted: ATE-Projects

2. Name of Principal Investigator/Project Director (as shown on the Cover Sheet):
   Schupbach, Dane

3. Name of submitting Institution (as shown on Cover Sheet):
   Trident Technical College

4. Other Institutions involved in the project’s operation:

   [Blank lines]

Project Data:
A. Major Discipline Code: 35
B. Academic Focus Level of Project: LO
C. Highest Degree Code: A
D. Category Code: J
E. Business/Industry Participation Code: NA
F. Audience Code: H
G. Institution Code: PUBL
H. Strategic Area Code: IT
I. Project Features: 3 5

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:
J. Undergraduate Students: 500
K. Pre-college Students: 0
L. College Faculty: 5
M. Pre-college Teachers: 0
N. Graduate Students: 0

NSF Form 1295 (10/98)
PROJECT SUMMARY

Overview:
Trident Technical College is seeking an ATE grant to develop an innovative educational pathway in Cloud Computing Technology in order to address a critical emerging industry need. The CLOUDTech (Creating Learning Opportunities for Undergraduates in Developing Technologies) project will add cloud computing and cloud security courses to the Network Systems Management curriculum. These additions will expand educational and career pathways, prepare students for high-skill/high-demand occupations in the region's burgeoning information technology sector, and provide opportunities for broad dissemination in this emerging field. The primary goal of CLOUDTech is curriculum and lab development for a series of virtualization and cloud computing courses that will lead to a certificate and stackable credentials toward an associate's degree, in an area highly sought after by industry. This goal will be met through four objectives: 1) Develop a rigorous curriculum that will foster an environment of learning and success through hands-on experience with Cloud Technologies which include virtualization, storage, Linux and Windows network operating systems, and network/cybersecurity; 2) Develop and share curriculum and NDG NETLAB hands-on labs with Regional ATEs such as ACE, CSSIA, Cyberwatch, CSEC, and more; 3) Provide professional development for faculty aimed at improving instructional practices and learning outcomes as well as obtaining of industry certifications; 4) Strengthen industry partnerships through collaboration in developing and reviewing cloud technology curriculum, labs and student learning objectives.

Intellectual Merit:
CLOUDTech will advance knowledge and learning by providing a new emphasis in the traditional Network Systems Management program that addresses a critical need for employers. This innovative path will strengthen knowledge in cloud technologies, including virtualization, storage, and network/cybersecurity. Employer input will be critical to ensuring that the new curriculum will meet industry needs while strengthening students' knowledge of these new concepts. The PI on the project has 30 years of experience in computer and network systems, with 20 years of experience in higher education and a vast knowledge of curriculum development. An industry Advisory Board and partners in the field will ensure that the curriculum is relevant and advances knowledge while allowing for widespread dissemination.

Broader Impacts:
Because of the emerging nature of cloud technology, institutions of higher education have not yet widely created curriculum and supporting labs to effectively train technicians in this rapidly growing field. Communication with key representatives at both CSSIA and NDG have confirmed strong interest in cloud technology curriculum and the need for lab development in this area. CLOUDTech will address these needs and in the process improve STEM education. Broad dissemination, including a User's Guide to facilitate adaptation, will promote national adoption. The PI will work with CSSIA to ensure that lab development and curriculum documentation quality is consistent with existing NETLAB labs maintained in the Repository. Locally, TTC's NSM department is involved in several initiatives aimed at increasing enrollment of women and other underserved populations, and information about cloud technology will be added to the work of these initiatives. Current initiatives include: Girls-Day-Out (GDO), an annual workshop for middle school girls and their parents to provide information about STEM careers; Charleston Women in Tech, a collaborative effort of Charleston's women leaders, educators, and tech professionals to support and mentor women of all ages in the technology industry and to educate women of all ages about technology careers; and a youth apprenticeship in computer networking that provides high school students with local industry employment which concludes with students receiving their high school diploma, an A+/Network+ Technician certificate from TTC, a national apprenticeship credential from the U.S. Department of Labor, and two years of work experience on their resume. After the conclusion of the CLOUDTech project, TTC will explore the potential of developing a separate Cloud Technology youth apprenticeship and incorporating elements of cloud technology into the skillsets of the Computer Networking youth apprenticeship.
**TABLE OF CONTENTS**

For font size and page formatting specifications, see GPG section II.B.2.

<table>
<thead>
<tr>
<th>Section Description</th>
<th>Total No. of Pages</th>
<th>Page No.* (Optional)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Sheet for Proposal to the National Science Foundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Summary (not to exceed 1 page)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Table of Contents</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) (Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</td>
<td>15</td>
<td>*</td>
</tr>
<tr>
<td>References Cited</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Biographical Sketches (Not to exceed 2 pages each)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Budget (Plus up to 3 pages of budget justification)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Current and Pending Support</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Facilities, Equipment and Other Resources</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Special Information/Supplementary Documents (Data Management Plan, Mentoring Plan and Other Supplementary Documents)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Appendix (List below.) (Include only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendix Items</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.*
PROJECT DESCRIPTION

Trident Technical College is seeking an ATE grant to develop an innovative educational pathway in Cloud Computing Technology in order to address a critical emerging industry need. We are proposing the CLOUDTech (Creating Learning Opportunities for Undergraduates in Developing Technologies) project to add Cloud Computing and Cloud Security to our existing Network Systems Management curriculum. These additions will expand educational and career pathways and prepare students for high-skill/high-demand occupations in the region’s burgeoning Information Technology sector and provide opportunities for broad dissemination in this emerging field.

Trident Technical College Background
As the largest community college in South Carolina, TTC is the Charleston region’s main provider of technician education and transfer preparation. TTC’s student population (detailed in the table below) represents the diverse demographics of its broader community and enrolls the largest number of African American students among all postsecondary institutions in the state. While nationally women make up approximately 28% of tenured faculty and 24% of full professorships in STEM fields,^{1} Trident Tech’s leadership defies this trend with 45.4% of its STEM leadership positions (department heads and higher) being held by women. With a diverse student body and leadership as well as targeted strategies, TTC is well positioned to increase underrepresented STEM graduates.

<table>
<thead>
<tr>
<th>TTC Student Demographics</th>
<th>Academic Year - Fall</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrollment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headcount</td>
<td>16,136</td>
<td>100%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9,926</td>
<td>61.51%</td>
</tr>
<tr>
<td>Male</td>
<td>6,210</td>
<td>38.49%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>282</td>
<td>2%</td>
</tr>
<tr>
<td>American Indian/Alaskan</td>
<td>97</td>
<td>1%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>4,917</td>
<td>30%</td>
</tr>
<tr>
<td>Hawaiian/Pacific Islander</td>
<td>46</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>752</td>
<td>5%</td>
</tr>
<tr>
<td>White/Non-Hispanic</td>
<td>9,374</td>
<td>58%</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>375</td>
<td>2%</td>
</tr>
<tr>
<td>Unknown</td>
<td>293</td>
<td>2%</td>
</tr>
</tbody>
</table>

MOTIVATING RATIONALE

According to the Charleston Regional Development Alliance, “Charleston is one of the fastest growing mid-size metros for software industries and occupations.”^{2} The growth rate for IT/Computer Occupations from 2010-2013 for the area was 42.9%, as compared to a national growth rate of 21.7%.^{3} The table below shows the number of current IT jobs and projected regional growth compared to projected national growth.^4
Moreover, the projected ratio of degrees to jobs indicates that more trained employees are needed to meet demand in this fast-growing field. For “computer programmers, software development & database” occupations, the ratio of degrees to jobs in the Charleston metro region is 9%. For “computer systems & information security analysts,” the ratio is 21%. This means that the projected average annual job openings from 2013-2018 compared to the number of degrees conferred must grow substantially.5

The Charleston metro region has earned the moniker “Silicon Harbor” because of its substantial growth in the IT sector. Governmental agencies and companies with a strong IT presence in the area include Joint Base Charleston, U.S. Coast Guard, National Oceanic and Atmospheric Administration (NOAA), US Department of Justice, Department of Energy, Blackbaud, Boeing, Google, Immedion, TwitPic, Amazon’s CreateSpace, PeopleMatter, and BenefitFocus. In 2013, Boeing announced that an IT Center of Excellence will soon be established in Charleston that will concentrate in this location half of all Boeing’s information technology work. Space and Naval Warfare Atlantic (SPAWAR) is based in Charleston, and there are a number of companies supporting various defense contracts, including Booz Allen Hamilton, Centurium Information Technology, Computer Sciences Corp., Honeywell, Lockheed Martin, QunetiQ, Scientific Research Corporation, and many other companies subcontracting to fulfill these contracts. All these companies create opportunities for TTC IT certificate and degree graduates to apply the skills they have developed while attending the college.

An emerging trend both nationally and locally within Information Technology is the use of cloud and virtualization. From Amazon and Google to local small businesses, employers are increasingly moving their IT data to the Cloud, thereby creating a need for technicians who can manage, troubleshoot, and support Cloud Infrastructure. “There are two types of emerging cloud computing careers: IT pros with specific cloud skills and IT admins with cloud architecture know-how.”6 Additionally, at the end of 2014 Wanted Analytics reported “3.9 million jobs in the U.S. affiliated with cloud computing today with 384,478 in IT alone.”7 Wanted Analytics’ research also indicated that “The Hiring Scale is 79 for IT jobs that require cloud computing skills with 9 candidates per job opening as of December 12, 2014.”
This acute need is confirmed locally through discussion with TTC’s Network Systems Management and Information Systems Advisory Board. The Advisory Board is comprised of approximately twenty representatives from area companies that hire TTC IT graduates. Advisory Board members attend biannual meetings to receive updates on TTC programs, review curriculum and ideas, and give feedback as to what courses, skills and competencies are currently needed in the industry. In recent Advisory Board meetings, including a focus group related to the proposed CLOUDTech project, employers have increasingly identified that the emerging field of cloud computing is the most significant gap in TTC’s current IT offerings. TTC also formally surveyed members of the Advisory Board in August 2015 about their businesses’ cloud computing needs. A full 100% of respondents reported that they currently use Commercial Cloud technology, and at least a quarter of them also use Open-Source. The table below details further responses:

<table>
<thead>
<tr>
<th>Within the company, over the next five years. . .</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>use of cloud technologies will increase</td>
<td>63</td>
<td>38</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>new hires will be expected to have cloud technology training</td>
<td>50</td>
<td>38</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>new hires will be expected to have cloud security training</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Commercial Cloud technologies will be part of the information technology infrastructure</td>
<td>75</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Open Source Cloud technologies will be part of the information technology infrastructure</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>new hires will be expected to have Commercial Cloud and cloud security training</td>
<td>38</td>
<td>50</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>new hires will be expected to have Open-Source Cloud and cloud security training</td>
<td>25</td>
<td>38</td>
<td>38</td>
<td>0</td>
</tr>
</tbody>
</table>

Given the rapidly expanding nature of cloud technology, TTC is eager to provide businesses with graduates equipped to meet this need and has worked with these business partners to identify the courses and credentials that will best prepare graduates for work in the field. Moving forward, these partners are committed to maintaining their close working ties with TTC to ensure that graduates are well-prepared to meet rapidly evolving industry needs.

In order to fill the existing gap in career technician training programs, TTC has recently embarked on a project to develop the curriculum needed by industry partners. Prior to this effort, there were no cloud courses or cloud certificates offered at any of the technical colleges in South Carolina, and no cloud courses were listed in the State Catalog of Approved Courses (CAC), which is still the norm at community colleges across the country. In an effort to address this deficiency, the TTC NSM department recently proposed the addition of three new cloud-related courses to the State CAC, which were subsequently approved and added. These courses will be developed as a part of the CLOUD Tech project.
CLOUTTech will leverage TTC’s existing NDG NETLAB lab scheduling infrastructure to provide a development environment and will share labs with other educational institutions and organizations through the NETLAB repository maintained by CSSIA (ATE). The current NETLAB infrastructure has two NETLAB scheduling servers backed by six high-end VMware vSphere servers and NetAPP Storage Area Network (SAN) storage. This current infrastructure is robust; however, there are limitations affecting TTC’s ability to add Virtualized Cloud Computing labs because of existing low bandwidth Storage Area Network interconnects. Upgrading the SAN interconnects requires replacing the SAN chassis and interconnects, which will support building and deploying complex Pods needed for the multi-vendor cloud PODS that will be hosted in NETLAB. The NETLAB and VMware infrastructure are maintained and supported by the Network Systems Management Academic department, which employs a part-time NETLAB administrator who also provides technical support and subject matter expertise for faculty and students. Faculty will require training and development so that they can gain skills needed to develop the curriculum and labs to provide students with the skills employers require to support Cloud computing.

TTC will develop hands-on labs to enhance the quality of online, hybrid, and traditional Cloud Computing courses. With the necessary curriculum development and minor storage infrastructure improvements, existing students and other learners throughout the state and beyond can benefit from Cloud Technology Courses and Labs that will provide new skills that equip them to pursue promising employment opportunities.

**GOALS, OBJECTIVES, & ACTIVITIES**

The primary goal of CLOUDTech is curriculum and lab development for a series of virtualization and cloud computing courses that will lead to a certificate and stackable credentials toward an associate’s degree, in an area highly sought after by industry. Information Technology is constantly changing and cloud technology knowledge is a growing requirement for jobs across the IT sector. CLOUDTech will fund development of four courses, entry level through advanced, including commercial cloud offerings, Linux based Open Source cloud, and cloud storage, all of which will prepare students to work with cloud technology and pursue industry standard certifications. Cloud certifications include CompTIA Cloud+, EMC Information Storage and Management (EMCISA), Red Hat RHCSA in OpenStack, Rackspace Certified Technician for OpenStack and VMware VCA/VCP Cloud certifications.

<table>
<thead>
<tr>
<th>CLOUDTech Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a rigorous curriculum that will foster an environment of learning and success through hands-on experience with Cloud Technologies which include virtualization, storage, Linux and Windows network operating systems, and network/cybersecurity.</td>
</tr>
<tr>
<td>2. Develop and share curriculum and NDG NETLAB hands-on labs with Regional ATE’s such as ACE, CSSIA, Cyberwatch, CSEC, etc.</td>
</tr>
<tr>
<td>3. Provide professional development for faculty aimed at improving instructional practices and learning outcomes as well as obtainment of industry certifications.</td>
</tr>
<tr>
<td>4. Strengthen industry partnerships through collaboration in developing and reviewing cloud technology curriculum, labs and student learning objectives.</td>
</tr>
</tbody>
</table>
TTC constantly endeavors to keep curriculum up to date to address the needs of new technologies used in the workforce, as identified by research and recommendations of the Networks Systems Management and Information Technology Advisory Committee. Faculty must through research, self-study or formal training develop new skills and knowledge that they can use to create and support new curriculum courses and hands-on labs that will prepare students to work in these new technology areas. TTC has established academy and alliance partnerships with a number of technology vendors including CompTIA, Microsoft, EMC, NetAPP, Cisco and VMware. Through these partnerships students gain access to training tailored to the Academies and Alliances to help them pursue industry certifications offered by these vendors. As a VMware Academy, TTC currently offers courses in Virtualization to help students prepare for VCA and VCP Datacenter Virtualization Certifications. TTC will update existing curriculum courses to add cloud-related training to provide students with skills needed to pursue VMware’s VCA6-CMA and VCP6-CMA Cloud certifications. New Cloud Essentials, Cloud Storage and Advanced Cloud Computing courses will be developed in the curriculum and with existing curriculum courses will give students the skills needed to pursue industry certifications such as CompTIA Cloud+ and EMC EMCISA. TTC will also develop an advanced Linux course added from the CAC that uses the open-source OpenStack Cloud infrastructure to prepare advanced Linux students to pursue either the Rackspace Certified Technician for OpenStack or the Red Hat Certified Systems Administrator in Red Hat OpenStack Certification. In addition to NETLAB labs, TTC will create additional labs to familiarize students with commercial cloud hosting solutions from commercial providers such as Amazon, Google or Rackspace.

CLOUDTech will leverage the NETLAB Management System with VMware virtualization servers and infrastructure to set up virtualized cloud computing. Grant funding will enable upgrading of the NetAPP Storage Area Network Infrastructure to support additional course loads and improve NETLAB performance. Grant funding will also support the NETLAB Infrastructure by covering additional contractual NETLAB maintenance fees and funding a part-time NETLAB Subject Matter Expert/Curriculum Lab Developer. This SME will manage, maintain, and support the NETLAB infrastructure, assist in Lab development and deployment, and provide faculty and student tech support for the NETLAB infrastructure. The project will utilize technology-enabled learning (such as Lynda.com and/or PluralSight) to provide affordable video training on Network Systems Management topics including cloud computing for Faculty and students.

The NETLAB Cloud lab environment will consist of NETLAB PODs containing Virtual Cloud Infrastructure servers that are running virtualized on VMware servers with virtual machines stored on a shared NetAPP Storage Area Network (SAN). The Net Development Group (NDG) NETLAB appliances will allow students to login and schedule lab reservations with a POD made up of Virtual Machines. The reservation system will provide a virtual private cloud environment, with 24-7 availability via Java-based web browsers presenting the same infrastructure that can be provided in an on-campus computer lab. NETLAB works with a VMware infrastructure to automate provisioning, operation and teardown of the Virtual Cloud environment, which provides students with hands-on learning in a safe Virtual sandbox environment. This Virtualization on Virtualization implementation provides students with the ability to build, operate and troubleshoot a Cloud infrastructure remotely via the NETLAB web interface without
having to dedicate physical server resources for that purpose and allows students to test programs without corrupting an entire network.

Cloud Computing can be implemented using one of three primary Cloud deployment models that students may experience with future employers. Public Cloud model implementations use an infrastructure hosted at a remote public cloud provider's site. Private Clouds are implemented internal to an organization in the datacenter. The third type, which is a Hybrid Cloud Model, includes both Private and Public Clouds integrated seamlessly to operate as one environment. CLOUDTech's Virtualized Cloud environment together with free and contracted Public Cloud hosting services will allow students hands-on opportunities in both of these environments to learn how to build and support multiple types of cloud computing. Course Labs will consist of labs developed in NETLAB and other Labs designed to be completed in a Public Cloud hosting environment. Providing experience with all Cloud Models will prepare students to work in organizations implementing any of the three Cloud Models while also helping them pursue industry-standard certifications. CLOUDTech will also provide the integration of collaborative learning technology using a product such as WebEx or Adobe Connect to provide remote students with opportunities to interact and participate in an online class environment including video, integrated audio, and real-time content sharing for synchronized learning. These rich online environments for learning and collaboration engage students beyond the boundaries of the traditional brick-and-mortar campus and beyond the boundaries of traditional online education. It promotes dynamic learning and improves faculty/student real-time communication and collaboration.

Below is a sample course summary for one of the proposed courses:

**IST 298 Lee: 3 Lab: 0 Cred: 3 BT**

**Advanced Cloud Computing**

This course covers advanced knowledge and concepts of Cloud computing. Topics include how to implement, administer and troubleshoot Private and Public Cloud computing implementations including Cloud services, Cloud delivery models, virtualization infrastructures, storage, networking, resource management, security, systems management and business continuity.

*Prereq: IST 198*

**Justification:**

This course covers advanced knowledge and skills required to work in the Cloud computing workforce and prepare for the CompTIA Cloud+ certification exam.

**Course Objectives:**

- Comprehend various approaches to server virtualization, its relevance to the modern data center, available platforms and important features.
- Comprehend the implications of virtualization on storage, networks, and applications, and recognize issues, challenges, and opportunities for managing this.
- Comprehend the implications of virtualization on the modern workplace, and recognize challenges and opportunities for managing this.
- Evaluate the impact and changes of virtualization on IT service management.
• Explain typical steps that lead to the successful adoption of virtualization techniques, and comprehend the implications for an organization.
• Recognize the compliance, risk, and regulatory consequences of virtualization and its financial and strategic impact on an organization.

The labs developed for the proposed courses will be written so that they can be performed in NETLAB Lab POD VMs, making them available to students both onsite and remotely. Below is a sample list of labs that have been recently developed for a Virtualization Essentials course. Each lab has detailed instructions that guide students step by step with screenshots illustrating what they should see as they perform the labs. A similar sequence of labs will be developed for the proposed CLOUDTech courses.

Lab 1: VMware Workstation Installation
Lab 2: Create a Windows 7 Virtual Machine in VMware Workstation
Lab 3: VMware Player Installation
Lab 4: Create a Windows 7 Virtual Machine in VMware Player
Lab 5: Create a CentOS Virtual Machine in VMware Player
Lab 6: VirtualBox Installation and create a Windows Virtual Machine
Lab 7: Enable Client Hyper-V in Windows 8
Lab 8: Create a Windows 7 Virtual Machine in Windows 8 Client Hyper-V
Lab 9: Install VMware ESXi 5.5.0
Lab 10: Create Windows 7 VM in VMware vSphere
Lab 11: Install XenServer
Lab 12: Install XenCenter and Win 7 VM
Lab 13: Enable Microsoft Server 2012 Hyper-V
Lab 14: Create a Windows 7 Virtual Machine in Microsoft Server 2012 Hyper-V
Lab 15: CentOS KVM Install
Lab 16: Configure CentOS KVM
Lab 17: Install CentOS VM in CentOS KVM

Employer feedback has been critical to the development of this project and will continue to be critical in its implementation. Local employers continually assist TTC with the identification of curriculum improvements based on industry and workforce needs. The four employers representing this industry that will partner with CLOUDTech are: STOPSO, Sonepar, Cantey Technology, and Santee Cooper. The table below details employers’ commitments to CLOUDTech; letters of commitment are attached to this proposal.

<table>
<thead>
<tr>
<th>Partner Description</th>
<th>Commitments to CLOUDTech</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOPSO is an IT strategy and management consulting firm specializing in cybersecurity, homeland security and defense, identity management, engineering, and training.</td>
<td>✓ Help identify necessary industry skills and competencies&lt;br&gt;✓ Help implement program strategies and goals&lt;br&gt;✓ Provide advice/recommendations on curriculum design and specialized...</td>
</tr>
<tr>
<td>Sonepar is a distributor of electrical materials products and services.</td>
<td></td>
</tr>
</tbody>
</table>
Cantey Technology is a service company providing IT services, including virtualization and cloud, to a large number of area businesses. Santee Cooper is South Carolina’s largest electric and water utility.

In addition to the participation described above, employer involvement will also include providing support to students, including developing or promoting internships, attending job fairs, assisting with mock interviews, and speaking to students about job opportunities in their sector and with their specific company, inviting students to code camps, and providing tours and mentorships. A regional industry group, AITP, will provide mock interviews, notify the Project Director of job or internship openings, and participate on the advisory board. Internships are offered as a TTC credit course within each of the degree programs, and employers have indicated an interest in providing internships for students and working collaboratively to increase the pipeline of workers with industry-recognized credentials in this rapidly changing sector. Employer engagement also takes place through TTC’s Student Employment Services, which conducts career fairs and guidance on creating successful resumes, interviewing, and networking.

Grant Activities:

- Train Faculty Development Team in multiple Vendor Cloud Computing solutions to support course development and delivery.
- Fund NETLAB SME/Curriculum Lab Developer part-time position to assist in NETLAB Lab Development and provide Faculty and student tech support for developed Labs.
- Upgrade NETLAB Storage Area Network Infrastructure to increase throughput from bonded 1 Gigabit speed to 10 Gigabit to enhance the NETLAB performance and support additional Lab workload.
- Utilize industry representatives on the Advisory Committee and recruit new members from Cloud related industries to assist in creation, review and evaluation of course content for a minimum of 30 NETLAB and Commercial Cloud provider Labs.
- Complete development of three new courses that have been added to the South Carolina Catalog of Approved Courses (CAC) titled Cloud Storage, Cloud Essentials and Advanced Cloud Computing.
- Complete development of the Linux Network Security course added to the curriculum from the CAC to address the Open Source OpenStack Cloud infrastructure.
- Pilot new courses in Spring and Summer 2017.
- Share created Labs for NETLAB and commercial hosting sites and other course materials with CSSIA for distribution.

DELIVERABLES:

The primary deliverables for CLOUDTech are:

- Implementation of Approved Virtualization and Cloud Computing Certificate
- 4 new courses developed as Cloud Essentials, Cloud Storage, Advanced Cloud Computing and Open-source Linux Open-stack Cloud Solutions
- Minimum of 30 Labs developed for NETLAB and commercial Cloud hosting environments
- Presentation at NSF PI and/or other conference
- New Course designs shared with ATEs
- New NETLAB Labs uploaded to CSSIA ATE repository
- User’s Guide for Coursework and Lab adoption created and shared to facilitate adaptation and broad dissemination at other institutions

TIMETABLE:

In Year 1, faculty will participate in professional development, develop courses for the Cloud Certificate that have been added to the State Catalog of Approved Courses, fund the NETLAB Subject Matter Expert, and implement the NETLAB infrastructure upgrades needed to provide the advanced online curriculum, including the development of NETLAB and Cloud Hosting labs. The PI and Development team will also work with industry partners to develop and review the new courses. In Year 2, one section of each of the four new courses will be delivered. The upgraded infrastructure will benefit all NETLAB users because of expanded throughput accessing VMs on the NetAPP SAN.

<table>
<thead>
<tr>
<th>Project Activities Timeline</th>
<th>2016-2017</th>
<th>2017-2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter 1 May-Jul; Quarter 2 Aug-Oct; Quarter 3 Nov-Jan; Quarter 4 Feb-Apr</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Project Team Meeting and Quarterly Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advisory Committee Meeting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development team attend Cloud training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop four new courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Minimum of 30 NETLAB and Hosting Labs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review curriculum with partners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend ATE PI Conference; Year 2 Offer Presentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upgrade SAN Chassis and interconnects to improve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughput</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SME/Curriculum Developer Support and Lab revisions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for duration of grant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Reporting to NSF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot new coursework</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refine new coursework</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend additional conferences such as HI-TEC/3CS/RedHat/Openstack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disseminate Labs and Course information to ATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repositories</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### MANAGEMENT PLAN & ROLES AND RESPONSIBILITIES OF PI & OTHER PERSONNEL:

The leadership team consists of three members of TTC’s faculty, including a Principal Investigator who is a Department Head, a Network Systems Management Program Coordinator, and the PI’s Associate Dean. The PI will facilitate meetings with the leadership team and Advisory committee. The PI’s overall responsibility will be to manage the project, to submit timely reports to the National Science Foundation, and to ensure successful implementation of the CLOUDTech project objectives. The leadership team will provide feedback and oversight of project implementation and dissemination.

Quarterly meetings to review and evaluate project implementation will involve the PI, the PI’s Associate Dean and Dean, the Grants Accountant, a member of Institutional Research, and a member of TTC’s Grants Office. At each of these meetings, the team will review the prior quarter’s activities and accomplishments, discuss the current quarter’s plans, and review the financial standing of the project. The team will also review progress toward project goals and objectives according to the planned timeline and address any challenges that have arisen, crafting action plans as necessary so that by the end of the grant period all objectives have been achieved and deliverables completed.

#### Roles and Responsibilities

**Principal Investigator:**

Dane Schupbach, Network Systems Management Department Head, holds a MA in Computer Resource Information Management from Webster University and a BS in Workforce Education Development from Southern Illinois University. In addition, Mr. Schupbach has attained A+, Network+ Security+, MCP, MCSE, CEH, CHFI and CISSP industry certifications. He has thirty years of Information Technology experience and fifteen years’ experience in developing coursework. Mr. Schupbach has played a lead role in research, design and implementation of seventy five percent of the college’s current Network Systems Management curriculum, specifically developing courses related to all areas in which he has attained an industry standard certification. He will be responsible for overseeing all project management, including financial expenditures. He will design and supervise a new Cloud curriculum that includes modular E-learning and NETLAB hosted hands-on labs that will enhance the existing curriculum courses as well as providing content for two new cloud courses and an advanced OpenStack Linux course. He will organize regular meetings with the Subject Matter Expert/Curriculum Lab Developer, Institutional Partners, and External Partners as necessary to ensure the timely completion of all grant activities and deliverables, monitor budget expenditures and review progress toward grant goals. He will work with the college’s Grants Accountant on budget management and reporting for the project. He will also coordinate with the Internal Evaluator on evaluation activities and ensure compliance with all NSF reporting.
Subject Matter Expert/Curriculum Lab Developer

- Ron Sharman is a Trident Technical College Network Systems Management graduate who manages and administers the NETLAB environment where he has developed custom labs for a variety of courses. He has Network+ and VMware Certified Professional Data Center Virtualization industry standard certifications. For this project he will assist with developing labs to accompany all of the courses developed in the grant, maintain and support the equipment, and provide technical lab support to faculty and students.

Institutional Partners:

- The TTC Development office will provide general grants management oversight and assist with NSF reporting requirements as necessary.
- TTC Grants Accountant will provide records management of expenditures and monitoring of federal budget, as well as assistance with financial reporting.

External Partners:

- Eric Wright of STOPSO Incorporated, Doug Lauer of Sonepar-US, Willis Cantey of Cantey Technology, and Ed Bodie of Santee Cooper will act as industry advisors. These advisors will work with the PI and Subject Matter Expert to ensure applicability of coursework to local industry need, as well as provide feedback (post-award) on the training quality of new workers who have completed the newly developed coursework.

Evaluator:

James Green, Director of Institutional Research at TTC, received his B.S. in Mathematics from the College of Charleston and an M.S. in Mathematics from the College of Charleston. Mr. Green will lead a team that will conduct project evaluation activities, including data collection, evaluation of student outcomes, and evaluation of project accomplishments. Mr. Green has been employed by TTC since 1993, initially serving as Mathematics faculty; he has worked in Institutional Research since 2008, first as a Research Analyst, where he served as the lead statistician on numerous college-wide projects.

An additional internal resource is Ms. Robbie Johnson, who recently served as PI for a Small ATE Project in Mechanical Engineering Technology that ended in 2015. Her familiarity with FastLane and NSF grant implementation will make her a valuable mentor for Mr. Schupbach.

SUSTAINABILITY PLAN:

Funding provided by NSF for this project will enable TTC to create an educational credential in Information Technology that meets a developing industry need. CLOUD Tech’s new curriculum is strongly supported by institutional leadership and industry leaders (see attached letters of commitment). TTC is committed to continuing to support the ongoing faculty and equipment needed for the program.

The College has a vested interest in ensuring that the curriculum developed with this project will continue to meet developing industry needs, technologies and approaches. Curriculum review
and revision will be informed by regular communication with the department’s Advisory Council, and the strengthened relationships with the Council resulting from work on this project will ensure continued relevance.

One-time funding from NSF will enable infrastructure improvements that will allow for increased student enrollment and success without requiring ongoing costs. Subscription service for technology-enabled learning will be used for course development and not required on an ongoing basis. Equipment maintenance and Cloud Provider Services will be funded through increased enrollment in the certificate program, institutional budgets, or through external funding such as Perkins or private or corporate grants.

**EVALUATION PLAN:**

James Green serves as TTC’s Director of Institutional Research and will lead the evaluation effort. TTC’s skilled and experienced team of researchers has the technical experience and expertise needed to ensure that this project is effective and closely monitored. The office has extensive experience in data-driven research and evaluation, including participation in Achieving the Dream, a multiyear national initiative to help more community college students succeed; participation in the National Community College Benchmarking Project; and data collection and analysis with the Noel-Levitz Student Satisfaction Inventory. The IR team has successfully provided evaluation services for a number of federal grants, including Perkins, Student Support Services, Veterans Upward Bound, Title III, and Fund for the Improvement of Postsecondary Education (FIPSE).

For this project, IR will collect and analyze data specific to the project’s goals and objectives (see table below). Though this team is employed by the College, the IR department is separate from the IT Department in the institution’s organizational hierarchy, reporting to the College President rather than Academic Affairs, and thus has no conflict of interest that would compromise its objectivity. By utilizing strong in-house resources, the project can meet its evaluation needs in a cost-effective manner, targeting grant funds toward direct project activities.

The evaluation process will contain both formative and summative elements. It will be aligned with common evaluation standards and follow guidelines suggested by agencies such as the NSF-funded Evaluation Resource Center at Western Michigan University. The formative evaluation process will review progress toward goals quarterly, as identified in the Management Plan above. If the team determines that the project is at risk of not meeting any goals, changes to the program that address the root causes of risk will be suggested and implemented. At the end of each fiscal year, the evaluations’ findings will be used to compile the project’s annual report to NSF.

A summative evaluation will occur at the end of the grant cycle, initiated by the PI. The Internal Evaluation team will collect data and then collaborate with the PI, Subject Matter Expert, and Institutional Partners to assess completion of activities, review data, review expenditures and determine the project’s effectiveness in reaching project goals and objectives, as well as impact. Two guiding questions for the summative evaluation will be:
Does the new Cloud curriculum provide quality E-learning and labs that can be shared with other institutions of higher education?

Does industry indicate its workforce needs are better met as a result of this curriculum?

Information from this assessment will be recorded in the project’s final report to NSF.

<table>
<thead>
<tr>
<th>Project Objective</th>
<th>Evaluation Measures / Assessment Data</th>
</tr>
</thead>
</table>
| 1. Develop a rigorous curriculum that will foster an environment of learning and success through hands-on experience with Cloud Technologies which include virtualization, storage, Linux and Windows network operating systems, and network/cybersecurity. | • Number of new courses created  
\- Number of existing courses revised  
\- Student surveys of course and instruction evaluation                                                                 |
| 2. Develop and share curriculum and NDG NETLAB hands-on labs with Regional ATEs such as ACE, CSSIA, Cyberwatch, CSEC, etc. | • Number of NETLAB Labs and Cloud Hosting Labs created  
\- Number of Labs shared with Regional ATEs                                                                 |
| 3. Provide professional development for faculty aimed at improving instructional practices and learning outcomes as well as obtainment of industry certifications. | • Number of faculty receiving professional development  
\- Number of industry Certifications obtained                                                                 |
| 4. Strengthen industry partnerships through collaboration in developing and reviewing cloud technology curriculum, labs and student learning objectives. | • Industry evaluation of curriculum                                                                 |

**DISSEMINATION PLAN:**

Dissemination of the results of the CLOUDTech project is integral to the project and will be addressed through three main avenues:

1. During the course of the project, faculty will develop and, with the assistance of industry partners, evaluate the project’s resource collection (the collection of all curriculum materials). The collection will include a User’s Guide to facilitate broad dissemination and adoption at other institutions.

2. The PI and a Subject Matter Expert will present project information at the annual NSF ATE PI conference, if accepted, and/or at other conference opportunities, such as HI-TEC/3CS.

3. Post-award, CLOUDTech will refine labs as needed and will integrate them with other resources available nationally at CSSIA NETLAB Lab repository, as well as submit course materials to the ATE Central Resource Collection.
BROADER IMPACTS OF THE PROPOSED WORK

Because of the emerging nature of cloud technology, institutions of higher education have not yet widely created curriculum and supporting labs to effectively train technicians in a rapidly growing field. Communication with key representatives at both CSSIA and NDG have confirmed strong interest in cloud technology curriculum and the need for lab development in this area. CLOUDTech will address these needs and in the process improve STEM education. Broad dissemination via CSSIA, including a User's Guide to facilitate adaptation, will promote national adoption. The PI will work with CSSIA to ensure that lab development and curriculum documentation quality is consistent with existing NETLAB labs maintained in the Repository. Locally, TTC's NSM department is involved in several initiatives aimed at increasing enrollment of women and other underserved populations, and information about cloud technology can be added to the work of these initiatives. Current initiatives include the following:

- Girls-Day-Out (GDO) is an annual workshop for middle school girls and their parents to provide information about STEM careers, including computer science and other information technology careers. GDO is a collaboration between SPAWAR Systems Center Atlantic, the College of Charleston, and TTC.
- NSM department faculty as well as other faculty in the Business Technology Division participate in the Charleston Women in Tech organization. Charleston Women in Tech is a collaborative effort of Charleston's women leaders, educators, and tech professionals to support and mentor women of all ages in the technology industry and to educate women of all ages about technology careers.

Another recent initiative TTC undertook was to create a Computer Networking Youth Apprenticeship. High school students who participate in this program are hired by local industry and begin employment while enrolled in high school and college classes. At the conclusion of the apprenticeship, students receive their high school diploma, an A+/Network+ Technician certificate from TTC, a national apprenticeship credential from the U. S. Department of Labor, and have two years of work experience. After the conclusion of the CLOUDTech project, TTC will explore the potential of developing a separate Cloud Technology youth apprenticeship and incorporating elements of cloud technology into the skillsets of the Computer Networking youth apprenticeship.

Between broad dissemination, local initiatives, and the diverse demographics of TTC's students, the college is well positioned to benefit technician education on a comprehensive scale while promoting teaching and learning among faculty, students, and youth populations.

RESULTS FROM CURRENT AND PRIOR NSF WORK

The PI is currently participating in an NSF-funded project on which Laurie Boeding, Associate Dean (on this proposal's leadership team), serves as a Co-PI. Award number 1204800, with a total award amount of $1,834,931, is the Southeastern Advanced Cybersecurity Education consortium (ACE) and is funded from September 15, 2012 to an estimation of August 31, 2016. This project involves the development of distance-delivered, hands-on cyberforensics courses, with core knowledge, skills, and competencies based on multiple sources, including those
developed by the Department of Defense Cyber Crime Center, NIST, and existing ATE Centers. For this project, the PI is developing Linux and Forensics Curriculum.

**Intellectual Merit**
This consortium strives to serve as a leader for cyberforensics education and workforce development in the Southeastern region and to further cybersecurity broadly. Each course developed by the project includes dozens of streaming video lectures -- providing for anytime, anywhere education -- slides, quizzes, and hands-on assignments implemented through virtualization technologies. The courses being developed range from foundational to advanced level work and include operating and file systems, incident response, and network forensics. The courses are being disseminated to interested colleges to address the evolving, converging, and emerging technical workplace and new technologies.

**Broader Impact**
New information technologies that affect consumer and job markets are created on an almost daily basis. The 'unforeseen' consequences of these new technologies creates an ongoing need for cybersecurity professionals. As such, it is crucial for new college and community college graduates to become familiar with these technologies, ethics and related laws, as well as having demonstrable hands-on experience with the technologies. The consortium has contacted schools including Seminole State College and Valencia Community College and is exploring collaboration with additional Navy Cybersecurity organizations.

**SUMMARY**
CLOUDTech will advance student learning by providing four (4) new courses and at least thirty (30) NETLAB and Public Cloud hosting labs that will lead to a certificate and stackable credentials toward an associate's degree while providing much-needed training for employment in the Information Technology field. This innovative program will strengthen knowledge in Virtualization and Cloud Computing and allow students to learn skills that industry needs and pursue industry-standard Certification on multiple vendors' solutions. The project will engage employer partners and, with the help of the national CSSIA ATE Center and ATE Central, will make the project deliverables available to educational institutions across the country.
References Cited


3 Ibid.


