Fostering Telecommunication Engineering Students via Cisco Test Engineering Center

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Abstract

An autonomous software and system quality assurance engineering facility, Cisco Test Engineering Center (Cisco-TEC), on the Texas A&M University Campus has been realized by the generous equipment and monetary contributions of Cisco Systems. We envision the Cisco-TEC is directly contributing to industry’s product quality improvement, to foster top quality engineering students with “hands on” experience, to establish student education and knowledge bases, to recruit more students into the field of test engineering, and eventually, to become an internationally recognized applied research facility in software and system test engineering.

Currently, 25 Cisco-TEC students are working as student workers on campus during the semester on various Cisco projects that include routers, switches, cameras, wireless access points, network management systems, networked storage systems, and Voice over IP devices. As a result, the Cisco-TEC provides, “hands on” opportunities for our students to work on projects using Cisco’s newest products. In fact, many of the products being tested are not even on the market yet.

As initially designed, the Cisco-TEC is autonomously run by student leaders, not by faculty members. Students teamed up with a leader are planning projects by negotiating directly with Cisco engineers. The experience not only improves students’ technical knowledge but also exposes them to real-world project management skills including deadline management, risk management, team responsibility, human networking, and so on, which skills are not easily taught in class. In this paper, we present how this year-long in house internship can foster our students to be successful in their engineering careers.

Introduction

An initial proposal to build an autonomous software and system quality assurance engineering facility, Cisco-TEC, that tests Cisco’s software features and products, performs test training for Cisco products, and builds engineering resource with motivated students, on the Texas A&M University Campus has been realized in Spring 2010. Cisco-TEC was made possible by the generous equipment and monetary contributions of the number one Internet company in the world, Cisco Systems. We envision the Cisco-TEC directly serving the following objectives:

- Contribute to Cisco’s product development and to feature quality improvement
- Equip top Engineering Technology students with product testing experience
- Formalize student education through new test engineering courses
- Establish a test engineering knowledgebase and test engineering certificate program
• Provide in-house training and workshop for professionals
• Recruit more students into the field of test engineering
• Become a internationally recognized applied research facility in the software and system test engineering

Some motivations of the software and system quality assurance engineering in Texas A&M University Campus include 1) 25% of bugs are detected after the product release and the fixing cost is 100 times expensive according to NIST’s software testing report\(^1\). Hence, it is very critical to detect and fix those bugs as early as possible; 2) When engineers become aware of the product well, they may also become biased and make more assumptions according to “Lessons Learned in Software Testing”\(^2\). Hence, there is a need for the fresh eyes to find defects; 3) Testing is far more than finding bugs. Excellent testing teams understand the entire equation of the product including usability, requirements, quality, and supportability. Hence, even if the engineering students won’t become a quality assurance engineer, we need collective and diverse education for engineering students to make them aware of the product quality aspect.

**Cisco Test Engineering Center (Cisco-TEC) Establishment**

In the given objectives and motivations, Texas A&M University was very well prepared to in the various aspects. First, we have the proven history of relationship with various computer networking industries. We have many Cisco provided equipment and assistance for LAN/MAN course and laboratory. Many of our alumni and students started their careers in Cisco already. Many faculties have their expertise in Networks, Wireless Communications, Embedded Systems and Software, Device/System Testing, Virtual Instrumentation, and Failure Modes and Effects Analysis. They also have successful history of industry interactions (i.e. Texas Instruments) as well as hands-on industry experiences including Cisco, IBM, TRW, etc. As shown in Figure 1, the department also shares the same vision by providing the facilities called “Networking Corridor Vision”.
To realize the Cisco-TEC, we have set up a careful execution plan from fall 2009. As illustrated in Figure 2, in fall 2009, we have built a task force team to identify the Texas A&M University and Cisco champion for the project. Initially, five students and one faculty took Cisco’s existing Quality Assurance (QA) training or boot camp as well as built a project plan with the first Cisco Business Unit (BU) engagement. We have been identifying detailed tasks, establishing work flows, defining bug report and tracking methods, building evaluation processes. According to that we have also created a new system and software Testing course with Cisco oriented labs. In spring 2010, we have executed the first Cisco project tasks by building two teams according to the project definition in fall 2009. We also have offered the first system and software QA course as well as trained students with test plan, execution, and documentation methods. We have used specific Cisco equipments for the lab training. During the class, we have identified and recruited several qualified students for Cisco-TEC. We have also built up a pilot Cisco-TEC lab facility.
To expedite the process of getting the Cisco-TEC up and running, a faculty along with seven students were hosted by Cisco for onsite internships and fellowships in Summer 2010. With this experience, we were able to achieve the followings:

- **Dedicate time to concentrate on Cisco-TEC project operation and enhancement**
  - Hands on tests with WAPs, Routers, Switches, Thunderbolt.
  - Performed complex test scenarios
  - Filed more than 30 bugs with Sev. 1 and 2 (high quality bugs)

- **Build on site experience**
  - Involved in the bug scrub and planning meetings
  - Involved in the next generation product planning meetings

- **Observe Cisco engineers’ engineering practices**
  - Stayed in the lab with students and other Cisco engineers to closely watch Cisco testing at work
  - Made suggestions for the improvement with lots of what if scenarios
  - Built longer term project plans between Cisco and Texas A&M University

- **Educational enhancement**
  - Received Cisco’s high end IOS routers (six 2900 series and six 3900 series) and Switches (12 3700 series) for Texas A&M ENTC 415 and 435 classes
  - Influence the content of undergraduate engineering education programs significant to Cisco
  - Gain contacts for future collaboration and student recruiting
  - Enrich and refresh the research activities (master projects)

- **Built more future projects with different teams**
  - A new team increased Texas A&M University funding
  - A few on-going discussions with other Cisco team

In fall 2010, we have started the first full scale Cisco-TEC. In one year, the Cisco-TEC has rapidly grown from one project with five students and one faculty member to eight projects with more than twenty student members. The new Cisco-TEC supports three separate Cisco Business Units. The Cisco-TEC students are working on various test projects for Cisco products that include routers, switches, cameras, wireless access points, network management systems, networked storage systems, and Voice over IP devices. We have established an in-housing Cisco system and software QA training facility for the students and professionals. We have developed and proposed several new QA methodologies and strategies.

As a result, the Cisco-TEC provides “hands on” opportunities for our students to work on projects using Cisco’s newest products. In fact, many of the products being tested are not even on the market yet. We were able to recruit and train smart engineering students on their early stage via Cisco-TEC fellowship and Cisco-TEC student worker position.

**Cisco Test Engineering Center (Cisco-TEC) Evaluation**
As initially proposed, the Cisco-TEC is autonomously run by student leaders, not by faculty members. Students teamed up with a leader are planning projects by negotiating directly with Cisco engineers. The experience not only improves students’ technical knowledge but also exposes them to real-world project management skills including deadline management, risk management, team responsibility, human networking, and so on; skills not easily taught by classroom teaching. The Cisco-TEC continues to provide opportunities to prepare our students for successful careers in engineering and the telecommunications industry.

As a short-term contribution, we have supported acceptance/usability test, test and requirement verification, unit/functional test, performance test, regression test script development. As a long-term, we will provide integration test, system test, agile testing for the cross functional projects, testing tool inspection, test case development, test strategy and methodology development, defect analysis and prevention, and product reliability analysis.

Cisco-TEC has also provided Cisco with the following direct benefits:

- **Cost Savings**
  - The cost of fifteen smart engineering students is equivalent to the cost of one permanent testing staff member
  - Enables flexible testing resource rearrangement (i.e. more staff member allocation to the business critical tasks)
  - Alternative & backup testing resource for the urgent projects
  - Cross-check testing resource
  - Test training facility for professionals
- **Professional Development**
  - Accumulation of the testing knowledgebase
  - New training course development
- **Recruiting**
  - Educating students for future recruiting
  - New and seasoned employees
- **Establishing a top notch test engineering research facility**
  - Applied research on systems and software testing
  - Long term influence on the testing methodologies and strategies
- **Generating Good Publicity**
  - Cisco committed for product quality with a leading university

Cisco and Cisco-TEC have task planning meeting in every semester to perform review and evaluation of on-going and completed tasks. We decide team size and tasks according to the Cisco’s demand projection as well as define review and evaluation criteria for the proposed tasks. We also plan the facility placement and access process and strategy including the equipment donation, temporary equipment placement, remote and seasoned equipment and software access, and temporary member relocation (in summer or weekend). Cisco-TEC have kept on recruiting and training test engineering team members via formal courses (testing and other fundamental networking classes) and lab projects.

**Conclusion and Future Work**
A student note to Cisco says it all. “As we have done more and more tests on Cisco devices, we have become more familiar with how the network [works] and also how all the [systems] fit together. We feel that we became more efficient as we were completing various test cases. We would be thrilled and privileged to continue testing Cisco equipment as we are always looking to learn and grow in the telecommunications area. Thanks!”

![Happy Cisco-TEC students](image)

Figure 3. Happy Cisco-TEC students

Based upon the accumulated knowledge and experience, the Cisco-TEC executes long term Cisco projects as an autonomous team including engagement into the earlier product development stage as well as doing task plan, project lead, and documentation by Cisco-TEC team. Cisco-TEC also trains individual members to work with the Cisco engineers upon the request to assist urgent tasks and unexpected resource shortage. Student training on the technologies as well as the practical industry experience including leadership and teamwork will be a great help for the success of our engineering students.

Bibliography


Biographical Information

DR. SEJUN SONG is an Assistant Professor in the Department of Engineering Technology and Industrial Distribution (ETID) at Texas A&M University. He is a founding director of the Cisco Test Engineering Center (Cisco-TEC) from 2009 to test Cisco’s cloud computing and networking products. He received his Ph.D. in Computer Engineering from University of
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