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Certifications for Software Professionals Helps to Assure Safety, Reliability in Vital Systems

Jefferson Welch

Today (more than ever) we need software that is developed on time and on budget, as well as usable, reliable and maintainable. Software's influence on our lives and security continues to grow and for over 20 years, Carnegie Mellon's Software Engineering Institute (SEI) has been identifying, developing, and advocating practices for designing high-quality software and protecting networked systems. To help professionals put best practices into place, the SEI has developed the SEI Credentials Program. The twelve certificate programs and four certifications (highlighted in this article) guide help professionals develop expertise in specific areas of work including computer security incident handling, software engineering process management, and software architecture design.

Keywords: Certifications, Process Improvement, Professional Development, Security.

1 Introduction

Aviators know firsthand the importance of standard practices for professionals. The aviation industry has had a long history of ensuring safety through standard practices and procedures, training, certification, recertification, and continuing education. In aviation, pilots enter a lifetime of training, checking, and continuing education. This philosophy ensures that we are able to assure their competence and skill to enter the field and to continue growth beyond the initial qualification step. It's an approach that helps assure the safety of the traveling public.

The same need now holds true for professionals in the software engineering field. As more and more systems are used in the interaction with society, quality assurance and competence in the practice are necessary to ensure the safety of our systems. The recent creation of international standards for certification programs by the International Organization for Standardization (ISO) and American National Standards Institute (ANSI) are highlighting the importance that certifications have in a profession that is quickly developing some of the most important tools for protecting human safety.

The Carnegie Mellon® Software Engineering Institute (SEI) has been developing and delivering best practices in software engineering for nearly 25 years. Founded in 1984 as a federally funded research and development by the United States Department of Defense, the SEI aims to improve the state of the practice of software engineering particularly in the areas of process improvement, software architecture, software product lines, interoperability and integration of systems, acquisition, and security.

® CERT, CERT Coordination Center, and CMM are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

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The SEI works through the software engineering community and organizations dependent on software to encourage and support the widespread adoption of new and improved technologies and solutions through courses, licenses, workshops, conferences, books and publications, and education and training. Professionals throughout the world accelerate the adoption and impact of software engineering improvements through direct interaction with the SEI and with SEI Partners—organizations and individuals licensed by the SEI to deliver SEI services.

The SEI has an unsurpassed reputation as a leader in advancing the practice of software engineering. The SEI Credentials Program provides individuals to receive official recognition of their skills and expertise, learn how to lead and participate in efforts to improve processes within organizations, network with others facing similar challenges, and learn from experienced instructors with years of experience. The SEI has identified, developed, and advocated practices for designing high-quality software and protecting networked systems. The SEI offers certificates and certifications in security practices, software engineering, and software architecture and process improvement. Through our transition services, the SEI provides a wealth of learning products within the software and systems engineering professions

The SEI believes that establishing standards for practitioners is a necessary step as a technology matures. As society depends more and more on the software and integrated systems engineering in health care, transportation, security,

and law enforcement, the SEI recognizes the need to certify the professionals who are responsible for the software and systems that drive those industries. For example, patients need to feel confident that the medical devices used to diagnose and treat illness, such as magnetic resonance imaging (MRI) and heart defibrillators, are safe, secure, and reliable. There is little question that, with MRI as an example, the close scrutiny and testing of every software and systems component is literally a matter of life or death. Technological complex systems charged with vital responsibilities are driven by complex software programs and systems. The professional performing this work needs to maintain a high level of competency and skill to assure the tasking is successfully completed per required standards.

2 Meeting the Needs of a Changing Workforce

The SEI's Credentials Program (which consists of 12 certificates and 4 certifications) certifies professionals in software engineering methodologies to help assure the safety, reliability, efficiency, and security of vital processes, projects, and systems. Certifications are awarded after a professional's knowledge is assessed against a set of industry-relevant standards. Certifications include ongoing requirements that must be met to keep the certification valid. SEI certifications signify that an individual has obtained a specific set of skills and level of knowledge in a particular area.

We need to meet the needs of a changing workforce and the factors that are driving these needs. First is the globalization of the workforce. As the SEI has witnessed, the growth in the number of software developers, systems engineers, and process improvement professionals has dramatically increased over the past few years. Couple with this the outsourcing trend by organizations in both the United States and Europe, and the need for a globally recognized skilled workforce is ever more important. Complimentary to the growing demand of software is a workforce whose demographics are changing; individuals around the world need to show employers that they have obtained the competency and skills to successfully fulfill their job responsibilities. Employers are looking for credentials such as certificates and certifications that cross national boundaries.

In terms of technology (particularly software development) globalization is just the first important factor of an ever-changing world because a large transition is about to take place in the workforce. The second reason for stewardship of the profession is the changing demographics of software developers worldwide. The U.S. baby-boom generation (born 1946-1964) is preparing to exit the workforce in dramatic numbers. In fact, the U.S. Census Bureau noted in the report *65+ in the United States 2005*, commissioned by the U.S. National Institutes of Health, that many observers expect a major wave of retirement starting in 2011 when the first baby boomers turn 65 [1] The number of baby boomers worldwide closely aligns to the U.S. numbers.

The third reason for the growth of a practice is the ever-continuing thirst by professionals to continually to raise the

bar in terms of skills sets, knowledge and experience in order to assert their positions into the workplace. Through the SEI Credentials Program, the institute provides professionals with the type of credentials they can carry from job to job, organization to organization and country to country.

Analyzing the reasons for growth of the profession of software engineering (globalization, demographics, the need for individual professional development, and the application and portability of those skills) and the requirement of producing safe, secure, and reliable software, the SEI has created programs and credentials to support the growing needs of process improvement, software development, and systems engineering professionals.

3 Certifying Individuals

The SEI's CERT® Program has been on the cutting edge of research and development in the area of network security since 1988. The program develops and promotes the use of appropriate technology and systems-management practices to resist attacks on networked systems, to limit damage, and to ensure continuity of critical services.

The CERT® *Certified Computer Security Incident Handler* (CSIH) certification program was launched in 2003 partly in response to new laws and regulations worldwide requiring that organizations identify and implement response capabilities for networked security.

Most organizations today depend on networked computer systems as an integral part of their businesses. As applications become more complex and services become increasingly integrated, protecting network security and recovering from computer security incidents has become a critical component of an organization's IT security plan. Richard D. Pethia, director of the SEI's CERT Program testified before a U.S. House of Representatives committee in 2002 that public safety services, health services, defense operations, and commerce conducted over the networks can be disrupted, and increased use of computers in safety-critical applications, including the storage and processing of medical records, increases the chance that accidents or attacks on computer systems can cost people their lives [2].

The CSIH certification provides a tangible recognition of skills from the Internet's first and best-known computer security incident response team, the CERT® Coordination Center. This certification arms security professionals with the skills necessary to handle diverse aspects of incident response and team leadership. The rigorous certification process requires that individuals possess technical or managerial experience in incident handling and successful completion of an examination based on the fundamentals of incident handling. To date, the SEI has certified individuals in Europe and North America. SEI staff and SEI Partners (organizations and individuals who are authorized by the SEI to deliver SEI courses and credential programs) provide the course instruction required to pass the examination.

CERT-certified incident handlers are able to take back to their organizations a clear understanding of security risks

inherent to the organization. They will be able to describe the information security tenets of confidentiality, availability, and integrity, and apply these concepts to the protection of information and information assets in an enterprise using a variety of technical and procedural solutions, recognize and identify organizational risks and threats and recommend and implement best practices to mitigate and reduce risks and counter threats across the enterprise.

The CSIH certification allows employers to know that an individual is recognized as a computer security incident professional by the world's leading security center. These certifications are valid for three years from the award date. To renew certification, individuals must earn continuing education development units.

The SEI is also widely recognized for its work in process improvement, specifically its contribution to the Capability Maturity Model® Integration (CMMI®) framework. CMMI has provided a way for organizations to evaluate and describe the quality of their software and systems engineering development and maintenance processes. More than 55,000 individuals have been trained in the Introduction to CMMI course, and the SEI has authorized and certified more than 1,600 individuals to deliver courses and conduct appraisals.

In early 2006, the SEI began offering the SEI-Certified PSP Developer Certification program. In the late 1980s and early 1990s, the SEI had developed the Capability Maturity Model® (CMM®) (under the leadership of SEI Fellow Watts Humphrey) for organizations to improve their software development practices. Realizing that organizational improvement for software is only as good as the software engineers, Humphrey took the principles of CMM and began applying those to the software professional. The result was the Personal Software ProcessSM (PSPSM) designed specifically for the individual software developer.

In today's workplace, managers need assurance that employees can meet the demand for timeliness, efficiency, and quality. The PSP Developer certification was developed in response to the growing number of software-development professionals who found that incorporating PSP methodology into their software-development effort consistently improved their ability to produce quality products and predictable solutions.

PSP shows engineers how to manage the quality of their projects, make commitments they can meet, improve estimating and planning, and reduce defects in their products. The skills and the work habits of engineers largely determine the results of the software development process and contribute to the improvement of reliability, dependability, security, and interoperability of software.

Humphrey has stated that software developers inject on average one defect per thousand lines of code (KLOC). By applying PSP principles and extending them to the project team (via the Team Software ProcessSM (TSPSM)), organizations can greatly reduce the number of defects present when software reaches the testing phase and can achieve near-zero defects in delivered software. [3] This reduction in defects helps to assure that medical device companies, health care organizations, the automotive and aerospace industries, and other safety-critical organizations are producing quality products that are safe, reliable, and secure.

The PSP Developer certification is aimed at professionals who use or plan to use PSP within their organization. The certification is based on the guiding principles of the PSP Body of Knowledge (PSP BOK) and was developed in accordance with the testing guidelines set forth by the American Educational Research Association, the American Psychological Association, and the (U.S.) National Council on Measurement in Education. The SEI conducted alpha and beta testing to ensure the highest standards of certification examinations were met.

The examination enables candidates to self-study from the PSP BOK, but PSP courseware provides more information and a foundation for taking the PSP certification exam. The PSP BOK provides a high-level comprehensive overview of the knowledge areas and competencies of PSP. It helps individuals assess and improve their own skills, provides employers with an objective baseline for accessing personal process skills and capabilities of the team, and guides academic institutions that want to incorporate PSP into their software and other engineering curricula.

The examination covers the competency areas of:

- Foundational knowledge.
- Basic PSP concepts.
- Size measuring and estimating.
- Making and tracking project plans.
- Planning and tracking software quality.
- Software design.
- Process extensions.

As of early 2007, 108 individuals from academia, government, and industry have been certified as PSP Developers. There are 250 examination centers worldwide to enable interested candidates to easily take the exam. A certification for coaches of the Team Software Process (TSP) is in development with release scheduled for late 2007.

4 Ensuring Quality at the Enterprise Level

Built from the foundation of the original CMM, CMMI (developed by experts from industry, academia, government, and the SEI) is a process improvement approach that provides organizations with the essential elements of effective processes. CMMI can be used to guide process improvement across a project, a division, or an entire organization. The move to Version 1.2 of the CMMI Product Suite took place in August 2006 with the release of CMMI for Development (CMMI-DEV) [4].

SM Personal Software Process, PSP, Team Software Process, and TSP are service marks of Carnegie Mellon University.

SM CMM Integration is a service mark of Carnegie Mellon University.

CMMI has become the *de facto* standard for process improvement. The Standard CMMI® Appraisal Method for Process Improvement (SCAMPISM) methodology is designed to benchmark quality ratings relative to CMMI models. With the release of CMMI V1.2, there is a renewed emphasis on quality assurance and accountability of organizations that claim to have achieved high maturity levels [4].

SCAMPISM appraisals enable organizations to gain insight into their organization capability by identifying weaknesses and strengths, prioritizing improvement plans, focusing on improvements that are most beneficial to the organization given its current level of organizational maturity or process capabilities, deriving capability-level ratings as well as maturity-level ratings, and identifying development or acquisition risks relative to capability or maturity determinations [5].

The SCAMPISM *High-Maturity Lead Appraiser* (HMLA) certification supports the SCAMPI lead appraiser program in conjunction with CMMI. The lead appraiser is an individual who works with organizations to compare their organizational metrics to CMMI best practices before assigning a rating: Level 1 through Level 5. At Level 4, an organization and its projects establish the quantitative objectives for quality and process improvement, while at Level 5 an organization continually improves upon its processes based on the quantitative understanding of its objectives. The adoption and implementation of process improvement at the highest levels of an organization requires an appraiser to have a full and complete understanding of the CMMI model and its appraisal methodology so that appraisals can be conducted with the assurance that both the appraiser and the organization have followed the prescribed methods outlined in CMMI.

The SCAMPI HMLA certification adds another layer of quality assurance for organizations conducting an appraisal. The successful candidate must be an SEI-authorized SCAMPI lead appraiser in good standing; have education, training, and experience in high maturity concepts and practices; and have participated on high-maturity appraisal teams.

The examination covers CMMI model and method areas including:

- quantitative and statistical concepts.
- organizational business objectives and relation to CMMI.
- differences between generic goals and practices.
- implications of HM practices for projects and organization.
- elicitation of requirements from sponsor and education of sponsor regarding true weakness.
- case studies and scenarios.

The most recent certification offered by the SEI is its *SEI Certified Instructor for Goal-Driven Measurement* (IGDM). This program provides an individual with the knowledge, tools, practices, and methods for identifying and defining indicators and measures that directly support an

organization's business goals related to product development, process improvement, and project management.

SEI research has shown that organizations that adopt and implement measurement analysis processes can identify defects sooner in the development cycle, remove those defects, and thus take corrective action before product delivery. This would help to mitigate defective software in safety critical products before release. Measurement and analysis provides the opportunity to explore and navigate data to better understand project, process and product behavior.

As SEI-certified instructors, individuals will be able to combine the measurement and analysis processes with CMMI in their organizations to improve the processes used to develop and deliver safe, reliable and secure software. Educational requirements include successful completion of the *Implementing Goal-Driven Measurement* course, a degree from an accredited university, course completion in the area of probability/statistics, and at least seven years of experience in implementing and/or developing measurement programs.

As software's influence in our activities of daily living and our security continues to grow, the SEI is continuing to provide the educational resources required for successful software development professionals. The SEI has identified, developed, and advocated practices for designing high-quality software and protecting networked systems. The SEI Credentials Program provides an opportunity for individuals to expand their knowledge, develop new skills, and immediately apply those skills and knowledge to their organizations. It provides individuals with official recognition of their skills and expertise from a leader in software engineering best practices.

Technology driven by complex software is everywhere from our lighting fixtures to automobiles to the medical devices that save lives. As the information revolution continues its advance, integration of software dependent systems will continue to grow in importance and impact for all industries. Software developers, their organizations, and their customers need software that is of high quality, reliable, maintainable, and evolvable, but more importantly, ensures safety and security

Information about the SEI and its Credential Program can be found at <www.sei.cmu.edu/credentials/>. Questions about the Credentials Program can be directed to <customerrelations@sei.cmu.edu>.

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