A Multi-Site Software Process Framework

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Today, software process leads to the new paradigm, "Better, faster, cheaper — through continuous software process improvement (SPI)." However, developing a standard software process might be considerably easier than the task of rolling it out to multiple locations across the U.S. and perhaps overseas, a concept we refer to as "zero geography." GTE Government Systems Corp. (GSC) successfully implemented its SPI program across North America using a framework based on the 3 C's: commitment, continuity, and communications. With zero geography, GSC was able to leverage its existing assets, accelerate schedules, and minimize investments while reaping the full benefits of SPI.

The Challenges to SPI

The challenges to the software community come in many forms. However, one of the most promising trends in software development presents itself in the form of SPI programs. In the past, the paradigm was, "Better, faster, cheaper; pick any two." However, adherence to a standard software process has brought about consistency, improved productivity, and reduced error rates. Software process, in fact, leads directly to the new paradigm, "Better, faster, cheaper — through continuous software process improvement."

GSC has successfully implemented SPI across a wide array of business and customer types and locations. This paper will identify the SPI challenges we have faced, the impacts the Department of Defense (DoD) acquisition reform has played, the 3 C's framework that we have and continue to use to implement our corporation SPI plan, the benefits reaped, and some lessons learned. This framework was essential to ensure that each geographic site maximized reuse of existing SPI assets, that opportunities for collaboration are identified to minimize effort, and that invaluable lessons learned are shared. In this article, when we use the term corporation, we are referring to GSC and when we use the term parent company, we are referring to GTE.

Diversity — Business, Technology, Customers, and Geography

As with many high technology companies, GSC is committed to SPI. Similar to other high technology companies, GSC has many software development sites, geographically spread across numerous business units. However, unlike other such companies, GSC does not concentrate only on its largest sites; all GSC sites with any significant development are under the GSC SPI program. GSC's diversity, however, extends far beyond just geography; there are significant differences in business sets, customer communities, domains, technologies, tools, and methodologies.

GSC consists of four major divisions and a headquarters organization. Three divisions and the headquarters organization involve software development — Communications Systems Division (CSD), Electronic Systems Division (ESD), Information Systems Division (ISD), and the GSC Information Technology organization. Each of the three divisions, with multiple sites, are involved in all aspects of development, from new developments to modifications, ports, enhancements, and maintenance. This means that the corporation's standard software process must address a very broad range of programs and tool environments. In other words, the process must be tailorable. A full description of the corporation's diversities of business, technology, customers, and geography are presented in [1].

The trend towards use of a multi-site software framework has become more commonplace in the past few years. This has been driven largely by the consolidations in the aerospace industry. For example, Lockheed Martin today is comprised of mergers and acquisitions of Lockheed, Martin Marietta, Loral, GE Aerospace, GD Space and Fighters, IBM Federal Systems, and Unisys — all since 1992. A corporate SPI program in such a large, geographically dispersed company requires an infrastructure to support it.

The Solution Set: The 3 C's: Commitment, Continuity, and Communications

To address the broad range of diversities and challenges, the corporation has employed the 3 C's as the basis of our SPI program.

Across the parent company, this had been on a division-by-division basis for many years, starting in the late 1980s. However, these divisional commitments tended to be narrowly focused on those organizations where software products were delivered externally. Their customers frequently determined the requirements of the Software Engineering Institute's (SEI) Capability Maturity Model® (CMM) that would apply to their projects. Due to the information technology industry's poor past performance and project failures, GTE began to focus on improving its ability to deliver quality software on time and within budget. This led to a 1996 study on software quality and focused on internal and external software systems. GSC, through its involvement in the DoD market, had its SPI program well under way when Kent Foster, president of GTE, levied process improvement goals on the entire parent company following this study. This corporate SPI goal is strong evidence that commitment can start at the top level of management. Foster presented well-defined goals for the corporation associat-

The Capability Maturity Model and CMM are registered in the U.S. Patent and Trademark Office.

ed with software process improvement and software acquisition. These goals have hard dates associated with them — to achieve Level 3 by December 31, 1999.

One — Commitment

To facilitate parent company-wide commitment, Foster formed the Software Quality Initiative (SQI). A small, but highly CMM-knowledgeable team was put in place to establish goals and guidelines as well as track and report status. Below that, key individuals were identified to coordinate the SPI activities across large business units (e.g., the National Operations, Wireless, and GSC). The president of GSC rapidly embraced and supported the initiative as the corporation already had a software quality-focused team in place.

Below the SQI team, the lead "SPI zealots" of each major organization (e.g., the GSC Electronic Systems Division) were assigned to a software process leaders group, which meets quarterly. The maturity, experiences, and assets of more mature organizations are used to leverage less mature organizations more rapidly than if each site were on its own and developing its SPI program from scratch.

Each organization established SPI objectives that are used to support the GSC business areas. The intent was to meet request for proposal needs and requirements and provide our corporation with a competitive edge in acquisitions. In the area of program performance, we set out to meet or exceed customer needs and requirements, provide our customers with better, faster, and cheaper products and improve the quality of our products and services with an overall goal of zero defects.

This level of commitment has ensured that each parent company organization has a clear objective in terms of the maturity of its software process. The SEI Level 3 requirements must be demonstrated through an approved assessment method (e.g., CBA IPI).

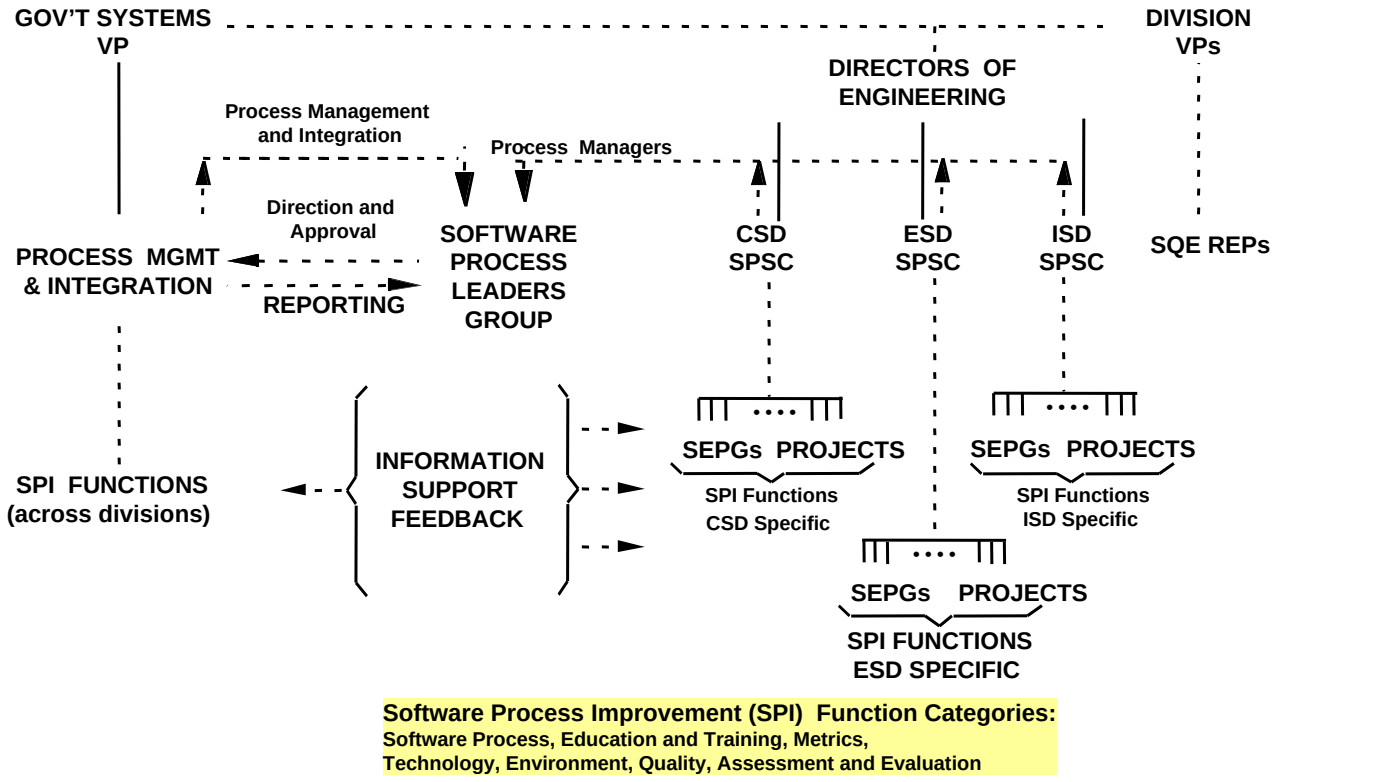
Two — Continuity

The second aspect of GSC's SPI program is continuity, in terms of continuity of the processes used on our software development programs. The GSC SPI focus includes the process management and integration (PM&I) organization that reports to the corporate level. The PM&I's role is to ensure that communications, leveraging, and status reporting routinely occurs. The PM&I organization is ultimately responsible for the satisfaction of the parent company corporate goal. PM&I works closely with the division SPI organizations, whose role it is to work with the projects within the division.

Although the above infrastructure may appear large and cumbersome, it is very effective and does not require hoards of people to implement. Within our corporation, there is only one individual who is the PM&I representative. This person coordinates the corporate process plans, which include SEI and ISO 9001. At the division level, a single representative is appointed to be the point-of-contact with his/her division and across the corporation.

Each division has a software process steering committee, a software engineering process group and a series of process action teams (PATs). The PATs are the mechanism that we use to make SPI real to the engineers. There is great employee participation

Figure 1. *Corporate software processes.*



and interest in the PATs. A detailed description of the common SPI organizations within the corporation, and the roles of all the participants, was presented in [2].

Tailoring is the key to making our standard process work for projects of all shapes and sizes. We have four models that are used for our projects. With relative ease, we can select an appropriate model for use on the project. In [3], the four software process models (full, intermediate, basic, and special) are described; specific tailoring guidelines were presented.

Further, a tailorable CMM-based software process mini-assessment method [4] to meet the demands of our parent company SQI. This corporate mini-assessment method has evolved into a well-defined process, with components that are tailorable to meet the specific objectives and needs of our organizations. The corporate mini-assessment method includes guidelines for planning, preparing for, and conducting a mini-assessment in three to four days. Options for tailoring the approach and reducing risk in order to ensure accuracy and completeness are provided. Reusable mini-assessment assets are utilized to improve efficiency and ensure consistent application across our corporation. The mini-assessments conducted to date have been very well received by participating organizations due to the method's flexibility, accurate results, and ability to accelerate the momentum for process improvement.

Three — Communications

Just as important as setting goals is the communication of those goals to the organization. Otherwise, the "grass roots" efforts required to achieve those goals never get started and the initiative dies a slow, miserable death. One of the areas that we needed to overcome was the distance challenge. We found that there were enablers to address this tough issue. The corporate SPI focus includes the PM&I organization that reports in at the corporate level. Its role is to ensure communications, leveraging, and status reporting occurs. The PM&I is ultimately responsible for the satisfaction of the parent company goal.

In 1989, GTE formed a Corporate Assessment Team, which is comprised of authorized lead assessors and CMM-trained team members from throughout the corporation. This team is managed through the PM&I organization. There are quarterly meetings of the Software Process Leaders from throughout the corporation. The purpose of the meeting is to review status and provide a mechanism for sharing. There are other workshops, such as Metrics and Tools, that have helped in defining and refining the standards in these areas. Process tools have been deployed, such as FastAssess, LBMS, and CMMLive.

Web-based communications has increased, including web front-ends to division process asset libraries. E-mail, phone, teleconference, and videoconference are used to supplement our face-to-face meetings. The *GTE News-GS Edition* weekly newsletter has been used to spread awareness of SPI by featuring news articles on the recent happenings and accomplishments in the divisions. Presidents, vice-presidents, and directors, as well as process personnel have provided articles. Also, articles for division SPI newsletters have been provided by program managers, software project managers, and practitioners from software and systems engineering, CM, QA, etc.

Celebrations and parties are also a part of this initiative, including picnics, barbecues, and a CMM fair bolstering a rousing game of "Stump the Process Expert."

Further, ESD, with headquarters in Mountain View, Calif., has invested heavily in the development of a collaborative work environment called InfoWorkSpace™, or IWS. IWS has been deployed to more than 1,500 Department of Defense customers (with a contract in place to deploy 13,000 more over the next three years) and recently was named "Best New Product 1999" in the workgroup/departmental software category at FOSE '99 Conference and *Government Computer News* [5, 6]. ESD's SPI plan includes the future migration to IWS of its software project management training and phase-specific development training. This will facilitate distance learning for any employee, anywhere in the world, using any desktop platform with a browser such as Netscape or Internet Explorer.

Benefits of the Framework

As a direct result of our SPI program, we have seen significant improvements in our productivity, quality, and predictability due to our emphasis on process. There have been cost reductions based on streamlining of processes. We have also experienced some qualitative differences including employee retention and hiring. It is more attractive to work in a more mature organization which has employee involvement in improvement efforts. The SPI work is becoming "real" to the people.

The success of our 3 C's framework is evident through our successful CBA IPI assessments in recent years; many of the sites have already achieved SEI Level 3 using this 3 C's framework to achieve zero geography:

- ESD-Mountain View, Calif.: Level 3, 3/94 and 9/97
- ESD-Tempe, Ariz.: Level 3, 9/97
- ESD-Thousand Oaks, Calif.: Level 3, 3/99
- CSD-Needham, Mass.: Level 3, 4/99
- CSD-Taunton, Mass.: Level 3, 4/99
- ISD-Chantilly, Va.: Planned 3Q99

Also, our corporation participated in the 1994 SEI return on investment (ROI) study [7] by providing actual program data. For the five-year period of the study, the results showed that productivity increased 37 percent in terms of source lines of code/hour, error reductions netted 55 percent less defects/thousand source lines of code, and the overall SPI ROI was 6.8. An internal division ROI study conducted in 1995 found similar results with their ROI being 7.8.

Other cost reductions have been seen throughout the corporation. The average software defect rate during system integration and test has been significantly reduced over time. Within one division, the level of formal quality assurance support has dropped from being 2.2 percent of the organization (based on head count) to under 1.8 percent (almost a 20 percent reduction). In 1997 that division tailored its software quality assurance (SQA) activities, taking advantage of the maturity of its peer review process, thereby reducing its SQA costs by 50 percent on its programs. In all cases, the improvements in our

software process have increased quality while reducing costs, thereby reducing time to market.

Lessons Learned

Top management commitment is essential. Process zealots are required. It is very important to have people who really believe that the effort will make a difference. It behooves you to have people who are respected in the organization in these positions. This could mean the difference between a successful program and the perception of just another "quality initiative." We have experienced enhanced communication between sites and are promoting reuse of knowledge, process, tools, and people. Delivering products better, faster, and cheaper is now achievable using our zero geography approach to software process improvement. Finally, our multi-site software process framework has become "Our way of doing day-to-day business!" ◆

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Ralph E. Porter Jr. is currently employed with General Dynamics Electronic Systems (purchased from GTE Government Systems Corporation on 9/1/99) as Director of Process & Quality Assurance for Electronic Systems (ES), with 10 sites directly involved in SPI activities. Ralph was managing the Software Process Organization at the time ES received their SEI Level 3 rating in March of 1994, September 1997, and March 1999. Currently he manages all activities associated with software process, software tools, ISO 9000, quality assurance, Y2K, and configuration management.

Ralph received both a B.S. degree in Mathematics (1972) and a M.S. in Statistics and Probability (1974) from Oklahoma State University. He is a member and Vice-President of the Silicon Valley Software Process Improvement Network (SV-SPIN) as well as Co-Chair for the SV-SPIN Metrics SIG. He has given numerous presentations on software process, metrics, and estimating to the Bay Area RoundTable, SV-SPIN, and SEPG conferences (1996, 1997, and 1999).

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References

1. Porter, R. and D. DeToma, "Software Process Improvement with Zero Geography!," SEI 1999 SEPG Conference, Atlanta, Ga., March 1999.
2. Dorsey, T. and D. McDonald, "Structured for Success: A Software Engineering Process Group Model," SEI 1996 SEPG Conference, Atlantic City, N.J., May 1996.
3. Porter, R., "Software Process Models — Tailored to Fit; Tailored for Success!," SEI 1996 SEPG Conference, Atlantic City, N.J., May 1996.
4. Pilch, C. and D. McDonald, "A Tailorable Software Process Mini-Assessment Method," SEI 1999 SEPG Conference, Atlanta, Ga., March 1999.
5. http://biz.yahoo.com/bw/990324/va_gte_1.html
6. http://infoworkspace.gsc.gte.com
7. Herbsleb, J., A. Carleton, J. Rozum, J. Siegel, and D. Zubrow, "Benefits of CMM®-Based Software Process Improvement: Initial Results," CMU/SEI-94-TR-013, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pa., August 1994.