Maximum-Leverage SCE Techniques

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This article describes a set of high-leverage Software Capability Evaluation (SCE) techniques that facilitate reuse of contractor-provided SCE data and that shift objective process maturity determination from an acquisition agency to contractors performing work for that agency. This approach can contribute to a substantial reduction in the number of SCEs an agency performs while ensuring contractor compliance with required process maturity levels. This article is of potential interest to any government agency performing SCEs and to any company that is currently or potentially subject to contractually based Capability Maturity Model requirements.

As with having nuclear weapons, the most successful strategy for SCEs is to never have to use them. If an acquisition agency or a prime contractor organization desires, for example, Capability Maturity Model [1] (CMM) Level 3 contractors to perform prime or subcontract work, it would be ideal to know confidently, without having to perform SCEs, the true maturity level of contractors submitting proposals. Additionally, during contract monitoring, it would be ideal if an agency could be confident that their contractors are continuing to maintain the required maturity level without the agency having to repeatedly perform SCEs.

Depending on the number of software contracts an agency monitors, the time and effort to perform SCEs on each contractor can become prohibitive. For example, consider the challenge if the Defense Contract Management Command (DCMC) wanted to ensure the maturity on the software-intensive contracts it oversees. Since the DCMC currently has 6,600 software-intensive contracts [2], it would appear nearly impossible to perform regular SCEs on each contractor.

This article describes a set of high-leverage SCE techniques that not only facilitate reusing contractor-provided SCE data but also shift responsibility for objective process maturity determination from an acquisition agency to the contractor performing work for that agency. This approach can potentially contribute to a substantial reduction in the number of SCEs an agency must perform to ensure contractor compliance with required software process maturity levels.

The premise of these techniques is that SCEs can be performed by an agency in a manner that, over time, encourages contractors to provide results from SCEs performed by other agencies. These techniques also encourage contractors to objectively self-appraise and self-report detailed appraisal information. This can minimize, for the agency and the contractor, the cost and effort associated with a government agency determining and monitoring process maturity. Simultaneously, this approach helps contractors have the clearest picture of where to focus their process improvement efforts.

Maximum-Leverage SCE Techniques

A high-leverage SCE technique is any technique that, when performed in support of an SCE, substantially improves the quantity or quality of SCE information or substantially reduces the effort required to gather it. Each of this article's high-leverage techniques is valuable in isolation, but maximum leverage is best achieved by using a majority of these techniques in combination. The techniques described toward the end of this article-which share the common characteristic of reusing existing appraisal data-are especially high leverage.

Select High-Content Projects

A high-content project is any project that can provide usable evidence across a significant number of key practices (presuming the project is above Level 1). In principle, a Level 2 project can readily provide evidence across nearly all of the Level 2 key practices. However, in practice, an SCE team may find that some projects-through no fault of their own-do not map well to the CMM.

The key is to find projects in which contractors own the processes they are following. In some environments, especially major government environments such as the Department of Defense (DoD) and the Federal Aviation Administration (FAA), it is common to find certain processes that are written, owned, and mandated by the acquisition agency. Therefore, it is almost impossible to gain insights into a contractor's configuration management practices, for example, if that contractor is contractually obligated to follow highly explicit and detailed configuration management procedures mandated by the acquisition agency. High-content projects are those in which the contractors own, and are responsible for, the processes they are following.

Additionally, do not too quickly exempt a project from an SCE simply because it does not involve writing code-it may still be a high-content project. Project managers might assert that their teams are not doing software development because they are not writing "IF" statements and "WHILE" loops. The project might involve designing a database schema or developing a requirements specification. However, from the perspective of ensuring the successful engineering of software-intensive systems, any contractor that owns the processes it follows and materially contrib-

utes to the success or failure of the specification, design, development, maintenance, or migration of a software-intensive system, can be a source of valuable insights into organizational software process maturity.

Ensure Some Projects Have Usable Subcontract Evidence

Subcontract management is sometimes outside the scope of an SCE team because the subcontract vehicle does not allow ready comparison to the CMM. Two common examples are subcontracts used to acquire the expertise of consultants and subcontracts used to provide temporary staff augmentation to an existing project team.

Projects may need consultants to provide expert opinions, advice, or specialized experience not available from existing organizational resources. These subcontractors are not expected to perform software planning, tracking, and oversight activity as reflected by the CMM Subcontract Management key process area (KPA) [3]. It is not uncommon for the Subcontract Management KPA to have little application to this type of consulting arrangement, even though such arrangements are sometimes put in place using subcontracts.

The second type of subcontract arrangement involves augmenting an existing project team with outside people who have additional or internally unavailable skills. These arrangements are characterized by essentially identical treatment of the subcontractors and the prime contractor's team. In such an environment, an outsider may find it difficult to determine who is employed by the prime team and who by the subcontractor. Again, this is not "traditional" subcontracting, and such projects should generally not be considered a good source of insight into the ability of a prime contractor to perform CMM-compliant subcontract management.

Cover Seven to 10 Projects

Many SCEs include only three or four projects in their evaluations. The risk of this approach is that if one or two projects prove to be difficult to compare to the CMM, the entire SCE becomes difficult to complete.

Any contractor that claims significant accomplishments and the ability to perform software engineering projects should be able to offer a variety of projects for SCE review. Start with the objective of reviewing at least seven to 10 projects, which increases the likelihood of having at least four or five projects that can be readily compared and contrasted to the CMM.

To accomplish this, it is advantageous to first examine project profiles for 12 to 15 projects. First, it encourages a larger number of the contractor's project teams to consider whether they are performing at the required maturity level. Even the teams that are not selected for the SCE, having come so close, might thereafter work harder at improving their processes. Second, this improves the likelihood of finding the best high-content projects. And third, by starting with a larger pool of projects you can better accommodate contractor preferences with regard to selecting projects where the SCE will not adversely affect deliverable deadlines or critical milestones.

Pre-Qualify Interviewees

Pre-qualification starts with an analysis of contractor-provided project organization charts, which typically include names, titles, and a general depiction of management, reporting, and command relationships. You should tentatively identify approximately twice as many people as you intend to interview and ask the contractor to provide one-paragraph descriptions of the work performed by these people.

Upon receiving these descriptions, you should eliminate approximately one-fourth of the candidates, then request résumés for the remainder. Upon receiving and reviewing the résumés, you should eliminate approximately one-third of the candidates, which leaves you with a pre-qualified group of your intended size.

As you review and down-select the candidates, be sure to get a mix of all types of employees. You will want veter-

ans and new hires, highly experienced and novice workers, and generalists and specialists. Such diversity will typically result in comprehensive, complete, and accurate data regarding organizational process maturity.

Pre-Plan Extra Interviews

This step provides several advantages. First, it allows you and the SCE team to truly follow the evidence. As people describe their work, you can ask questions designed to elicit names ("Who else reviews your work?" or "Who from quality assurance helped you with this?) If a name is not on your current interview list but the person seems like a good source of information regarding organizational processes, you can insert that person in one of the open interview slots. Also, when an interviewee misses an assigned time due to sickness, a project crisis, or any other valid reason, it is easy to reassign that person's interview to an open slot.

Try to leave at least two open interview slots during each day of the on-site period. Also, have extra open slots scheduled for the last day or two of the SCE; this allows you time to identify additional interviewees. Be sure to fill at least half of these open slots with extra interviews.

Avoid Functional Area Representative Group Interviews

When assessing a project to initiate process improvement, simultaneously interviewing a group of eight to 12 people is an excellent way to obtain a wealth of information about its processes in a particular functional area. More important, it helps bond these people into a group and helps increase personal commitment and buy-in from the participants.

However, when conducting an SCE, functional area representative group interviews are much less effective. One or more participants may be perceived by others in the group as not completely trustworthy with regard to nondisclosure or confidentiality agreements. Participants will also be much less inclined to say anything useful, because anything they say will be heard by the group and

may therefore reach management. Subdued interviews lead to a bad irony for the contractor, because SCEs are generally a "proof-positive" exercise. That is, the SCE team should already be familiar with the contractor's documented processes, but if the team encounters no incidental evidence to verify that the contractors are truly working in a CMM-compliant manner, it may evaluate one or more KPAs as not fully satisfied.

It is usually to the contractor's advantage during the SCE to have an atmosphere where people feel they can openly discuss the work they perform. Having individuals meet privately with the SCE team usually best provides that atmosphere.

Double-Interview the Project Managers

It is difficult to know how to schedule project manager interviews. If you interview the project managers first (a fairly common practice), after listening to several days of technical and functional area interviews, you often wish you could bring the project managers back and ask a variety of more specific questions. Conversely, if you interview the project managers last, you often wish you could bring back a number of the technical people to further explore, verify, and validate the statements made by the project managers.

Although currently an uncommon practice, you will likely find it useful to interview project managers both at the beginning of the on-site week (usually immediately following the executive interviews) and again at the end of the on-site period. For the initial interviews, follow the standard practice of asking prepared questions of a general nature. Then, during the week, build specific detailed questions as a function of the information you hear, or fail to hear, during the technical interviews. Use these specific questions during the follow-up interviews to gain additional insights into project process capability.

Never Go Completely Outside

It is often useful to use the services of one or more external vendors or government organizations that specialize in the performance of SCEs. One advantage to using these outside SCE resources is the high likelihood that they have more experience performing SCEs than your team. By augmenting the team with external resources, your SCE team members will likely become far smarter far faster than they otherwise might have.

However, there is a definite disadvantage to using only outside resources. Your team likely understands the details of your acquisition better than anyone outside the agency. These insights are an important factor in understanding the context in which a contractor's processes are being used. Furthermore, by providing a stable core of resources to perform SCEs, you leave yourself the option of switching between external vendors or using multiple external vendors simultaneously while still ensuring that the SCE approach used by your organization is consistent, and all of the contractors are treated equally.

Never Cancel the On-site

Many SCE teams now perform the majority of the document review prior to the on-site period. This can lead to the inclination to cancel the on-site period if there are clear and significant inadequacies within the submitted documents. For example, you might be reviewing for compliance with Level 2 and find no evidence of policies, procedures, or plans for requirements management, quality assurance, and configuration management. Since it would seem clear that the contractor is not performing at Level 2, it would seem logical to consider canceling the on-site period.

In reality, it will usually make more sense to continue with the SCE. First, there is the remote chance that the documentation you need does exist, but the contractor was too unfamiliar with the SCE process to know it should have been sent to you. During the on-site period, you may hear people repeatedly refer to material that you have not reviewed, which may contain the necessary evidence of Level 2 compliance. Second, the premise behind this set of high-leverage SCE techniques is to motivate the contractor to perform process im-

provement and self-appraisals in such a way that you rarely need to perform SCEs on that contractor. Therefore, once you commence with an SCE, you should perform the on-site period to provide the contractor with the most complete and comprehensive picture of their process maturity as reflected by their documentation and the activities performed.

In the case of a blatantly noncompliant contractor, you might want to replan and reduce the time spent during the on-site period.

Mutual-Aid SCE Resources

Fire departments and rescue squads routinely use mutual aid as a means to help, and be helped by, their neighboring communities in times of need. Each group maintains the approximate number of people needed for its typical workload, then assists other groups in times of crisis. Mutual-aid agreements anticipate future needs and are executed in a manner that is mutually beneficial to all involved groups.

With regard to performing SCEs, let us assume that you can perform current or routine contract monitoring with X number of SCE employees. A new acquisition, however, might require you to have 1.5X, 3X, or 4X SCE employees available to perform all the necessary SCEs in a timely manner (usually by performing simultaneous or overlapping SCEs).

Receiving SCE resources from another agency to augment your SCE team not only provides you with a surge-mode capability but also facilitates an increased exchange of SCE experiences and lessons learned. To help another agency, or a different area within your agency, by providing them with SCE employees allows your employees to become experienced more rapidly than they otherwise would.

Reuse Appraisal Data

As alluded to in some of the previous techniques, enough companies have been performing self-appraisals and have been evaluated by government agencies that there is now the possibility that you can avoid performing an SCE by reusing

relevant, recent, objective, and convincing appraisal data.

It is generally acknowledged that SCEs are more qualitative than quantitative. Consequently, during and after the performance of an SCE, the SCE team often finds itself having to deal with the issue of confidence levels. For example, if some members of the team are "extremely" confident that a contractor is Level 2, some are "highly" confident, and one team member is "fairly" confident, the team will typically come to consensus that the contractor is Level 2.

Given the above, a critical question for a specific acquisition is, how confident do you need to be that a contractor will perform at or above a given maturity level? To whatever degree you do not have to be "completely" confident, there is an increasing likelihood that you can reuse data from SCEs by other agencies and reuse data from contractor self-appraisals (remembering that self-appraisals can range from highly subjective to fairly objective). By carefully analyzing this data for objectivity, timeliness, relevancy, and consistency, a review team can become sufficiently confident that a contractor is at a certain maturity level, and there is no current need to perform an SCE on that contractor.

Refresh Appraisal Data

When asking contractors to submit details about SCEs and self-appraisals that have occurred within their organization within the last 12 to 24 months, you will sometimes find that the data submitted is somewhat convincing yet still somewhat doubtful. In essence, you need more data. One option is to perform an SCE. If a contractor has virtually no reusable appraisal data, this certainly makes sense. However, if the contractor had a considerable amount of reusable appraisal data, but it was not quite convincing, you might need to refresh the appraisal data by asking for additional information.

The additional information you should request is entirely consistent with the data for which you would ask during an SCE. However, at this point you can ask for far less information since you are not yet performing an SCE. For ex-

ample, you might ask three or four projects to submit current documentation covering three KPAs within the CMM. This documentation should include policies, procedures, plans, status and tracking reports, etc.

Review of this data will yield one of three results. The review team
- will be convinced that the contractor has the necessary level of maturity.
- could not find convincing data and therefore recommends proceeding with a formal SCE.
- thinks that a brief on-site meeting with the contractor may provide the final necessary evidence. Only in this last instance will you need to use the following techniques.

Augment Appraisal Data

Certain data is typically included as part of a standard SCE process. This data, as mentioned above, includes policies, procedures, plans, guidelines, status reports, etc. At times you will have (somewhat) reusable appraisal data and (somewhat) refreshed project data, but the review team will still be unable to come to consensus regarding a contractor's software process maturity.

One option is to just give up and perform a new SCE. However, you may also be able to augment existing data with a series of briefings with the contractor. These briefings could help the review team better understand, for example, the relevance of a contractor's other Level 3 divisions as opposed to the division that will perform the work you require.

By carefully preparing a list of requested briefings, each of which addresses specific areas where you need more information, combined with the information you already have, you may achieve sufficient confidence that a contractor has achieved the maturity level needed for your acquisition without having to perform an SCE.

Give Considerable Lead Time to Contractors

There are instances when contractors have been given as little as three or four weeks notice that a government agency is coming on site to perform an SCE.

This essentially forces the contractor to focus on "successful SCE techniques" vs. "successful process improvement." Ironically, this situation causes some SCE teams to suspect they are witnessing more act than reality, leading to a lose-lose situation for everyone. But if contractors have three to six months to prepare, some will spend that time becoming higher maturity organizations-a win-win situation for all involved.

Share Detailed Evaluation Results with the Contractor

Sometimes, contractors receive little feedback on the results of their SCE. In extreme cases, they only learn whether they won the contract. In such instances, the SCE may have been worthwhile in the agency's search for a contractor, but it will have virtually no value in helping the contractor know where to focus efforts on CMM-based process improvements. Although it would be presumptuous for an SCE team to offer advice on how a contractor should improve its processes, it is in everyone's best interest for the SCE team to share its impressions of the contractor's strengths and weaknesses within various KPAs.

Summary and Conclusions

There are essentially four "golden principles" that govern the application of maximum leverage SCE techniques:
- If you have to perform an SCE, perform it in a manner that maximizes the likelihood of producing reusable SCE data.
- After an SCE, always provide detailed information to the contractor so that the contractor has the option of supplying that information to other agencies.
- Prior to an SCE, always request any pre-existing SCE and appraisal data.
- Aggressively strive to avoid performing unnecessary SCEs.

By following the techniques described in this article, you increase the likelihood that your agency and other agencies will be able to reuse the data from any SCE you perform. This data, when combined with other SCE data and data from contractor self-assessments, can be systematically analyzed

and may allow your agency to validate a contractor's assertion of a maturity level without having to perform yet another SCE on that contractor. (For details on a systematic, multiphase approach for validating contractor process maturity through reused, refreshed, and augmented appraisal data, see [4].)

It continues to be true that the SCE method is the most reliable approach available to evaluate software processes against the software CMM. However, the ongoing accumulation of data from agency- and contractor-conducted SCEs increases the probability that your agency can validate the maturity level of a contractor without requiring your agency (and the contractor) to invest the considerable time and expense required to prepare for and perform an SCE. Central to this idea is when you perform an SCE, you do so in a manner that facilitates potential reuse of the SCE data, and you provide the contractor with the detailed results of that SCE.

By performing maximum-leverage SCE techniques, you can expand the number of contractors being monitored for process maturity and expand the frequency of your monitoring without necessarily having to increase the resources needed to perform the monitoring. Additionally, by regularly and effectively monitoring contractors more closely, you can help prevent the occurrence of a contractor slipping from a higher maturity level to a lower one-an adverse situation that both you and the contractor would prefer to avoid.

Although an obvious objective of these techniques is the performance of highly successful SCEs, the most important objective is to support the performance of successful acquisitions and do so in a manner that recognizes, facilitates, and rewards successful contractor process improvement endeavors. ?

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