Timberline Engineering, Inc.

SCADA System Integrator Selection Methodology

White Paper

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Introduction

When trying to select a SCADA system integrator, the decision-maker is faced with choosing one of several alternatives that will best meet a number of conflicting requirements such as cost, schedule, and quality. This is a classic decision analysis problem.

One traditional solution to the problem is to limit the field of bidders to ones that meet some set of standards and then select based on lowest cost. The assumption is that all bidders meeting the standards are equally capable of providing a system that meets the owner's requirements. This approach has the benefit of simplicity, but it is possible that two bidders offer solutions that are very close in cost but differ tremendously in benefit to the owner. In this case, the owner may save 5% of the project cost with the lowest bidder, but give up schedule or quality performance that is worth far more.

Another traditional solution to the problem is to evaluate the bidders based on technical proposals and use cost as one of many variables. This approach has a greater likelihood of resulting in the best system, but is difficult to apply fairly and in a manner that will withstand protest from bidders.

This paper presents a selection methodology based on decision analysis techniques. This methodology promises to be fair to all bidders, sufficiently well documented to prevent, or at least withstand protest, and to result in selection of the bidder with the greatest likelihood of providing the best outcome.

Selection Methods:
- Low bid
- Qualified low bid
- Qualifications-based
- Decision Analysis

Methodology

The decision analysis methodology presented herein is based on the book *Smart Choices*[1] from the Harvard Business School

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[1] John S. Hammond, Ralph L. Keeney, and Howard Raiffa, *Smart Choices,* (Boston: Harvard Business School Press, 1999)

Press. The approach involves six steps: properly phrase question, determine objectives, identify alternatives, establish consequences, perform tradeoffs, and assess risk. Each of these steps is discussed in detail below.

Properly Phrase Question

With any decision analysis problem, it is important to begin with a clear and precise understanding of the problem to be solved. Both the owner and the consultant must agree on the precise nature of the problem to ensure that the solution represents the best decision. In this case, the question can be stated as "Of the interested bidders, which has the highest likelihood of meeting the owner's objectives?"

Determine Objectives

The owner has a set of objectives with regard to the selection of a system integrator. The job of the consultant is to extract the objectives, distill them into their fundamental objectives, and translate the fundamental objectives into specific requirements that can be placed on the bidders.

The owner's objectives may include such factors as low cost, completion before a specified date, low risk, attractive system solution, and others. Objectives such as "low risk" are fundamental objectives. The objectives exist because they are important, not because they allow some other objective to be met. The consultant must convert the fundamental objective to a means objective that will ensure the fundamental objective is met. In the case of "low risk," the objective might be "successfully completed 10 jobs in the last five years." The development of means objectives is complex and deserves serious consideration and discussion with the owner.

Identify Alternatives

Once the fundamental objectives are understood and converted into meaningful means objectives with which everyone agrees, a questionnaire is developed that will elicit responses addressing each of the objectives. This questionnaire is sent to the set of vendors who have expressed interest in the project or were otherwise identified. The vendors that respond make up the pool of alternatives.

Establish Consequences

As questionnaires are received, each of the responses is tabulated in a consequence table. The table has one row for each of the objectives considered in the questionnaire and a column for each of

Decision Analysis Steps:
- Properly Phrase Question
- Determine Objectives
- Identify Alternatives
- Establish Consequences
- Perform Tradeoffs
- Assess Risk

the responders. Each cell in the table contains a measure of the degree to which the vendor meets the objective.

In populating the consequence table, it is important to consider each responder individually. The decision-maker must place himself in the future assuming the vendor was selected then ask, "How well does this selection meet the objective?" The consequences associated with each objective need to be described using a common scale that can be applied consistently to each responder. The most manageable, meaningful scales are objective ones such as dollars, months, or number of jobs.

For some objectives, though, a subjective scale will be required. In those cases, a scale that directly measures the objective must be created. The scale needs to have the minimum number of levels required to make the necessary distinction called for by the objective. In some cases, simple yes/no scales are appropriate. In other cases, three or five levels may be appropriate. In any case, it is essential that the exact meaning of each level be defined before it is applied to any responder. Then it must be applied consistently. If in the course of populating the consequence table, it is found that the subjective scale is not constructed appropriately, the scale can be re-defined, but the new definition must be applied to each responder. The real value of defining a scale is that it forces the decision-maker to clarify what an objective really means before scoring the responders.

Bidders may phrase their responses to items in the questionnaire to hide or omit unfavorable information. Therefore, it is important that the solicitation allows the owner and consultant to question a bidder further on any item in the questionnaire to get accurate, meaningful responses. Reference checks are also useful to fill in blanks in the questionnaire and verify information provided. The solicitation must also allow the owner and consultant to check an integrator's references and use that information in the decision-making process. However, whenever a reference check reveals unfavorable or contradictory information, the responder should be allowed to comment on that information. This will serve to limit the danger of making a decision based on bad information from a reference and will limit the likelihood of protest based on that decision.

The selection committee as a whole must be involved in the generation of consequences. One effective method is for the committee to meet to arrive at the logic and scales to be used and then to delegate authority for actually constructing and populating the consequence table to one experienced member of the team. After the table is constructed and complete, the selection committee as a whole should meet to review the data, judgements,

Assessing Proposals:
- Assess how well a bidder would meet the objectives.
- Use objective scales when possible.
- Defining scales helps clarify objectives.
- Document data, judgements, and logic.

and logic to ensure that the process will withstand independent review. When the selection committee is satisfied with the results and can endorse the consequence table, selection can begin.

In short, the method of translating the free-form responses to the questions asked of the bidders into consequences that will be compared must be clear and transparent. Ideally, the process will be detailed in a Standard Operating Procedure that can be attached to the solicitation. However the process is performed, it is important that a full explanation of the data received, judgements made, and logic used is recorded.

Perform Tradeoffs

The first step in selecting between bidders represented in the consequence table is to make a ranking table that ranks each response numerically. Then any response that is worse than another response on each objective can be easily identified. Such responses are said to be strictly dominated and can be eliminated from consideration. A response that is worse than another on every objective except on one or two objectives where it has only a slight advantage is said to be practically dominated and can also be eliminated from consideration.

After strictly and practically dominated responses are eliminated, the remaining responses will be superior on some objectives and inferior on others. Choosing the best of these responses will require that the owner make decisions as to the relative value of the various competing objectives. For example, in the consequence table below, the owner must select one of three bidders. Bidder A has the best cost, Bidder B has the best experience, and Bidder C has the most attractive technical solution. The bidders are judged the same on all other criteria.

Tradeoffs:
- Elimination of inferior proposals is automatic.
- Selection between remaining bidders is based on the relative worth of the competing objectives.
- Decisions are based on the importance of the objectives not on characteristics of the bidders.

TABLE 1. CONSEQUENCE TABLE FOR BIDDER SELECTION

Objective	Bidder A	Bidder B	Bidder C
Price (bid amount)	$865,000	$925,000	$908,000
Experience (jobs in the last 3 years)	12 jobs	15 jobs	3 jobs
Technical Excellence (subjective A - C)	B	B	A

To resolve this decision, the owner must resolve the relative worth of cost, experience and technical excellence. The even swaps method, described in Smart Choices, is useful for resolving the decision. Using even swaps, the owner first decides how much money they would be willing to add to the bid price to gain the 15-job experience held by Bidder B. This is a complex decision that the owner has to consider carefully and individually. It is not

necessarily a linear function. In this case, the owner decides the difference between 12 and 15 jobs does not substantially reduce their risk; they judge it to be worth $10,000. The difference between 3 jobs and 15 jobs, however, is substantial. The owner judges that $75,000 contingency would be needed to compensate for the lack of experience offered by Bidder C. Based on those judgements, the owner can redraw the consequence table with each bidder having 15 jobs experience, Bidder A having an additional $10,000 added to their bid price and Bidder C having an additional $75,000 added to their bid price as shown in the table below.

TABLE 2. CONSEQUENCE TABLE AFTER EVEN SWAP

Objective	Bidder A	Bidder B	Bidder C
Price (bid amount)	$875,000	$925,000	$983,000
~~Experience (jobs in the last 3 years)~~	~~15 jobs~~	~~15 jobs~~	~~15 jobs~~
Technical Excellence (subjective A - C)	B	B	A

At this point, the experience objective can be eliminated because all bidders score the same. Bidder B is then more expensive than Bidder A and has the same technical score. Thus Bidder B is strictly dominated by Bidder A and can be eliminated from consideration.

Now, the owner must decide if the technical offering by Bidder C is worth $108,000 more than the offering by Bidder A. After reflecting on the subject, the owner decides that as much as they like the offering by Bidder C, it is not that much more valuable than the offering by Bidder A. Therefore, they conclude that Bidder A provides the best overall offering. The owner can then select Bidder A and proceed to construction knowing they have made the best choice among competing alternatives.

This approach requires the owner to make some sophisticated decisions. There is no easy way to decide how much of one objective to give up to gain a set amount of another objective. Those decisions must be made by the owner in a clear, consistent, and logically defensible manner. The decisions, logic, and application of the even swaps method must be documented to validate the decision and to withstand scrutiny. In the example above, if the owner had decided that the difference between 15 and 12 jobs experience was worth more than $60,000, then the outcome would have been different; Bidder B would have been selected.

Performing the tradeoffs in a several-hour-long meeting with the selection committee might work if the committee was composed of personnel with the skill and authority to decide on the relative

Even Swaps:
- By trading ranking in one objective for another, the differences between alternatives can be systematically reduced.
- When only one objective remains, the choice is clear.

worth of objectives. However, better decision making would probably occur if the consultant met with the owner for a day to train them in the method and assess the easiest of the decisions. Then the owner could do the tradeoffs over a period of days with the consultant supporting them by telephone.

Whatever the structure of the method, the owner should be given reprints of the Harvard Business Review article on even swaps[2] before the meeting for them to review and then the owner should be trained in application of the method.

Assess Risk

Naturally, there is uncertainty in many of the values in the consequence table. It is important that the most significant elements of uncertainty be explored and resolved if possible. However, after performing the research and reference checks discussed above, it will still not be possible to resolve all uncertainty. Elements of uncertainty can be modeled and analyzed using statistical methods, if such effort is warranted. However, in most cases, it is sufficient to assess the risk elements and ensure that the same decision would be made regardless of where within the defined set of possibilities a risk element was ultimately shown to lie.

Conclusion

This paper outlines an approach to SCADA system vendor selection based on structured decision making. This approach overcomes the major limitations of traditional approaches and results in an optimum decision. The method consists of six steps based on sound academic and practical research. The steps include properly phrasing the question, determining objectives, identifying alternatives, establishing consequences, performing tradeoffs, and assessing risk.

The roll of the consultant in the process is to create the framework and provide training to the owner and facilitating decision making. The consultant does not make the decision, nor do they tell the owner what to decide. The decisions are made based on the owner's recognized set of objectives and the relative weight of the objectives.

Results:
- A sound selection improves the chance of a successful outcome.
- Selection based on the owner's values allows an optimum selection.
- Effort spent on an optimum selection should reduce the effort required in construction and result in a better result overall.

For more information on this or related SCADA engineering topics, please feel free to contact Timberline Engineering, Inc. as noted below:

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[2] John S. Hammond, Ralph L. Keeney, and Howard Raiffa, "Even Swaps: A Rational Method for Making Trade-offs," *Harvard Business Review* 76 (March-April 1998): 137-150.