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Is SOA Really Dead?

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ABSTRACT

Integrating business processes, applications, databases, and systems is a problem that has plagued IT organizations for decades. The Service-Oriented Architecture or SOA, which employs web-based technologies, is the industry's latest attempt to solve the integration problem. Many firms have floundered with implementing SOA which encompasses a complex set of technologies. This has led some industry analysts to send out the word that "SOA is dead". We use the methodology of real options to establish a value for SOA. We conclude that SOA is not dead and is indeed a technology bet that most organizations would find worth making.

KEYWORDS: Managerial decision making, Firm decisions, Value of IT, Real options

INTRODUCTION

Moving to a SOA environment is arguably one of the most important priorities for IT organizations today. SOA holds the key to integrating a firm's many disparate applications, systems, processes, and data – a problem that has bedeviled IT organizations for several decades. SOA envisages a firm's portfolio of applications as essentially comprising services callable over the Internet, and these are referred to as Web Services (Bloomberg & Schmelzer, 2006; Erl, 2006; Krafzig et al., 2005; Marks & Bell, 2006). Business applications expose key functionality and information such as sales tax computation or the state of inventory levels as callable Web Services thereby enabling the reuse of software components and the integration of data and applications across system, organizational, and firm boundaries.

The industry-wide success of any type of software integration technology depends crucially on the industry acceptance of standards underlying the technology. The three main standards underlying Web Services are the Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL), and Universal Description, Discovery and Integration (UDDI) (WSDL Working Group, 2007; UDDI Working Group 2004). SOAP is the messaging protocol governing the exchange of messages between a client and a Web Service; WSDL is the language in which the functionality of Web Services is described to the applications environment; and UDDI is simply the standard for the directory service where these WSDL descriptions are placed and which is queried by applications to determine the services being offered. The SOAP messages are coded in a standard format called XML (SOAP Working Group, 2007). Whereas past efforts in developing integration standards, such as the Distributed Computing Environment (DCE) (DCE Open Group, 1996) and the Common Object Request Broker Architecture (CORBA) (Slama et al., 1999), eventually failed for various reasons such as the lack of agreement between Microsoft and the UNIX vendors which doomed the CORBA standard, SOA and its associated standards are widely embraced by all the key players in the industry.

With all the promise of Web Services, XML, and SOA and the breadth and depth of industry support behind them, a strange thing appears to be happening on the road to the brave new world of SOA. For many organizations, it appears that SOA has been a failure. So much so, the Burton Group, a respected analyst firm, declared “SOA is dead” in early 2009 (Krill, 2009). Anne Thomas Manes, research director at the Burton Group was quoted as saying “Once thought to be the savior of IT, SOA has turned into a great failed experiment – at least for most organizations” (Neubarth 2010). The economic recession of 2007 through 2009 and the overhyping of SOA in the first place of course have played a part in the gloomy sentiment now towards SOA in some quarters. But it is also quite plausible that is there more substance to the disillusionment with SOA beyond those two factors. That the disenchantment with SOA is not merely anecdotal was confirmed in more systematic research by the Gartner Group which indicated that more and more companies are choosing not to invest in SOA (Gartner Press Release, 2008). What is interesting is that amidst this gloom, there is a large and very much pro-SOA camp out there. Evidence of this exists in the growing number of SOA success stories on the SOA.org web site (SOA Industry Case Studies, 2010). IDC, also a respected market research firm, disagrees with the Burton Group stating that SOA is very much alive and has forecast increases in SOA spending worldwide (Nguyen, 2010).

LITERATURE REVIEW

RO Models

An investment project, or a program comprising a series of investments, whose returns are uncertain is exactly the type of investment scenario that is best examined using the lens of real options (RO). SOA would indeed qualify as an investment scenario fraught with uncertainty given the differing views that exist about the benefits of SOA (Gartner Press Release, 2008; Krill, 2009; Neubarth, 2010; Nguyen, 2010; SOA Industry Case Studies, 2010). A variety of RO valuation models have been developed for many types of IT investments. Dos Santos (1991) employs the Black-Scholes (1973) options pricing model (OPM) to an investment in integrated digital services networks (ISDN). Benaroch and Kauffman (2000) apply the Black-Scholes OPM to an investment in electronic banking. Taudes (1998) employs the Geske (1979) compound option to value investment programs involving software upgrades, such as upgrading SAP from R2 to R3. Bardhan et al. (2004) model a multi-stage investment in a series of IT projects made by a firm in the utilities industry. Each stage is modeled as a Black-Scholes option whose options value is deemed to increase the value of the cash flows from the previous stage. Benaroch et al. (2006) offer an alternative approach to valuing multistage investments where the options value of each stage is deemed to reduce the exercise price of the previous stage. Ghosh and Li (2013) develop a new OPM for what they refer to as generalized meta-staged projects. Clearly, there are different types of OPMs that can be developed and employed to view an investment scenario. All models are approximations of reality and Taudes (1998), Bardhan et al. (2004), Benaroch et al. (2006), and Ghosh and Li (2013) actually offer four different OPMs for valuing multistage IT investments from an RO perspective. Although Ghosh and Li (2013) also look at the SOA application, the focus of their research is more on developing an innovative OPM rather than on the SOA application per se.

The main target of this article on the other hand is the value of the SOA technology itself and to address the key question of whether firms should make a bet on SOA or not. Innovation at the level of the OPM itself is certainly useful but an innovative OPM also has the drawback of not being widely adopted. In fact, thus far, Ghosh and Li (2013) is the only article that applies this notion of generalized meta-staged projects. As our focus is more on SOA rather than a new OPM, we use the well-known approach of applying the Geske compound option (1977, 1979) to valuing multi-stage projects. The Geske compound option has been applied in multi-stage investments in the information systems (IS) field as well as in other disciplines and contexts

(Cassimon et al. 2004, Paxson 2007, Jensen and Warren 2001, Perlitz et al. 1999, Taudes 1998). Hence, the Geske compound option approach is a well-known and tried-and-true method for valuing multistage investments. The SOA investment program is multi-stage in that it involves a number of complex technologies, which necessitates a phased deployment.

SOA Technologies

Moving to SOA actually requires implementing several key pieces of technology as shown in Figure 1. The build-out of the SOA infrastructure is therefore best done in phases where in any given phase the organization deploys and absorbs a technology before moving on to the next. The key technology components involved in building the SOA infrastructure include an Enterprise Services Bus (ESB), a directory service (DS), a data transformation service (DTS), a business process management service (BPMS), and adapters (ADPTRS) for adapting existing applications to the Web Services environment (Bloomberg & Schmelzer, 2006; Erl, 2006; Krafzig et al., 2005; Marks & Bell, 2006). These key technologies are further described below:

- The ESB provides the communications infrastructure for transporting files and messages which can be either remote process calls (RPC) or document-oriented messages containing XML documents. The ESB is essentially a distributed message broker (Fiorano ESB, 2009; Progress Software Sonic ESB, 2009). The ESB ensures reliable delivery of the messages and will store them for later delivery if a destination endpoint is temporarily unavailable.

- A UDDI-compliant directory service (DS) maintains information about the various kinds of Web Services that are available in the SOA environment and where they are located. The UDDI server is populated with WSDL descriptions of the available Web Services thus providing external applications with the knowledge of what is available for reuse. New applications can then simply be built as compositions of preexisting Web Services and any new business logic that may need to be created.

- The data transformation service (DTS) provides a general capability for mapping message formats, such as from EDI to XML or from XML to XML (Pervasive ETL, 2007). As the so-called legacy applications deployed years ago employed various proprietary data formats, it is necessary to map these formats to newer XML-based standard formats in order for the legacy information to be consumed by newer applications. Such data mapping is often necessary when messages and documents move across inter-application or inter-organizational boundaries.

- The business process management service (BPMS) enables new applications to be written by simply "orchestrating" existing Web Services. This orchestration could involve invoking a set of existing Web Services in a certain sequence and processing the information returned by these services. The coordinating intelligence which invokes the Web Services and maintains information about the state of the exchanges with these service endpoints is the BPMS. New applications for implementing business processes are simply described to the process manager via an easy-to-use graphical interface, which results in the creation of a script defining the sequence of interactions with the service endpoints for implementing the new business process. A process orchestration engine then simply executes this script. Microsoft BizTalk Server is an example of such a process orchestration product (Microsoft BizTalk Server, 2007).

- Adapters (ADPTRS) take existing applications built in the pre-SOA era, such as an enterprise resource planning (ERP) application, and expose its key functionality in the form of Web Services thereby allowing new integration applications to reuse the business logic embedded in existing applications. As an example, data adapters for an ERP application such as SAP map SAP's proprietary iDoc message format and the ABAP (Advanced Business Applications Programming) interface to standards-compliant XML and Web Service interfaces. While data adapters for major commercial packages can be obtained off-the-shelf from the vendors, the IT organization may have to develop data adapters for applications that were developed in-house. The adapters together constitute an adaptation service.

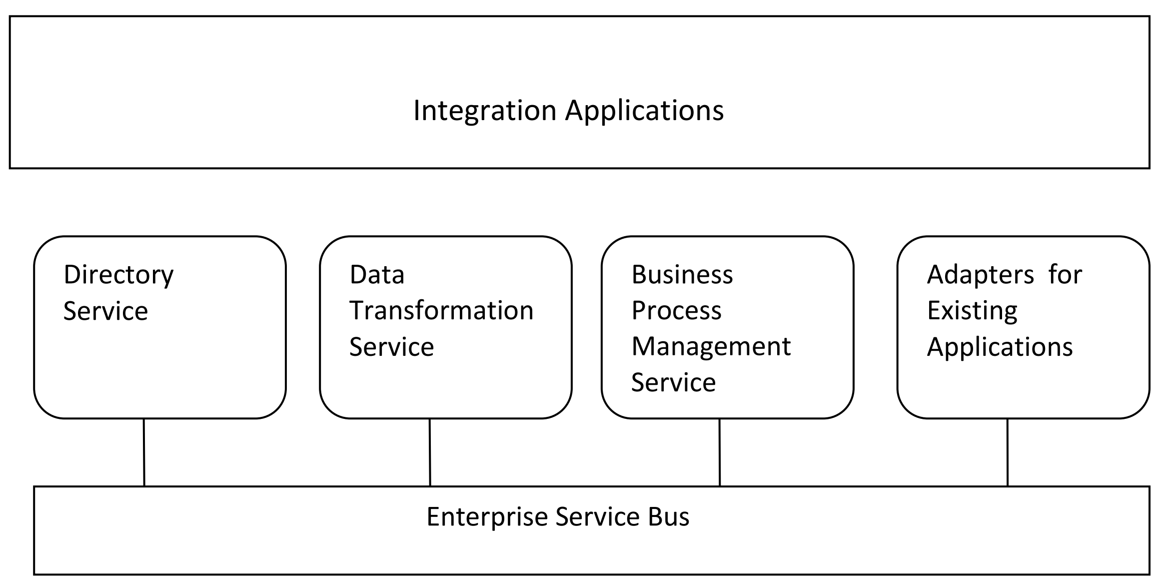

Figure 1: Technologies Comprising SOA

Once the SOA infrastructure has been set up as shown in Figure 1 then newer integration applications can be layered on top of this infrastructure. Each chronological phase in the build-out of the SOA environment refers to the period of time directly after the investment in a major technology component, such as the ESB or the BPMS, has been made and before the decision to invest in the next technology component is made. This phase includes all the activities necessary for the deployment and, more importantly, the absorption of the technology in question by the organization. Such activities include the installation, configuration, testing, and optimization of the technology as well as the training of personnel who will be using, maintaining or enhancing the technology. The complexity of enterprise integration technology ensures that each component of the solution, be it the ESB or the BPM service, takes a certain amount of time to absorb which is not trivial. Consequently, in addition to the cost of the software licenses, a major portion of the cost of the EI solution lies in the services that the firm must purchase from the vendor for the "hand holding" necessary for the effective transfer of knowledge and skills from the vendor to the user.

At the completion of each phase, the firm has the option of making the next investment to continue building the SOA infrastructure or to abandon the investment program. After the SOA infrastructure has been built, the organization can now start to develop new applications leveraging the SOA infrastructure. The cost savings in building new applications leveraging SOA as compositions or orchestrations of Web Services represents the cash flow generating asset resulting from the investment in the SOA infrastructure. At time t_0, if the firm chooses to embark on the build-out of the SOA environment by making the investment to deploy an ESB, which is the foundation of SOA, then there are four investment decisions yet to be made in the future corresponding to the four infrastructure services. As such, if the firm chooses to invest in the ESB, it will then hold a 4-fold compound option on the value of the assets represented by the integration applications. The firm will choose to embark on the SOA build-out program if the value of this 4-fold compound option at t_0 exceeds the cost of the initial investment in the ESB.

THEORETICAL DEVELOPMENT/MODEL

Our model for SOA is based on the well-established Geske compound option model which has been used to model multistage investment programs in many different contexts (Cassimon et al. 2004, Paxson 2007, Jensen and Warren 2001, Perlitz et al. 1999, Taudes 1998). The deployment of each key technology component described in the previous section represents a stage in the build-out of SOA. Geske's original compound option model (Geske, 1977, 1979) was developed for two-stage investment programs where there are two future payments to be made in the program. This can be easily generalized to *n* stages where the n-fold compound option values the option at time origin t_0 to eventually acquire an asset whose present value is V after making n payments $K_1, K_2, \ldots K_n$ at future times $t_1, t_2, \ldots, t_n$ respectively. The asset is acquired at t_n. These payments are optional and the investor could choose to terminate this sequential investment strategy at any time t_i by not making the payment K_i and thus giving up the possibility to eventually acquire the asset. K_0 is the initial payment made at t_0 to acquire this n-fold compound option. Each stage or phase i begins with the investment K_{i-1} made at t_{i-1} and lasts until all the activities pertinent to that phase are complete and the firm can contemplate the decision on the next incremental investment K_i at t_i. The n-th phase ends with the culminating investment K_n. The value of the investment program at any time t during phase i is the value of an (n-i+1)-fold compound option denoted as $C_i(V,t)$ on the underlying asset where V is the value of the asset at t, for i =1,2,..n. The net present value (NPV) of the multistage investment program is then simply $C_1(V,t_0) - K_0$. The value of $C_1(V,t_0)$ is given by (Cassimon et al., 2004):

$$C_1(V,t_0) = VN_n(a_1,a_2,\ldots,a_n;A^n) - \sum_{m=1}^{n} K_m e^{-r(t_m-t_0)} N_m\,(b_1,b_2,\ldots,b_m;A^m) \qquad (1)$$

where

$$a_i = \frac{\ln\left(\frac{V}{V_i^*}\right) + r\tau_i}{\sigma\sqrt{\tau_i}} + \frac{\sigma\sqrt{\tau_i}}{2}$$

$$b_i = \frac{\ln\left(\frac{V}{V_i^*}\right) + r\tau_i}{\sigma\sqrt{\tau_i}} - \frac{\sigma\sqrt{\tau_i}}{2}$$

$$\tau_i = t_i - t_0$$

r = risk-free rate of interest

N_l is the l-variate standard normal distribution whose correlation matrix A^l is given by:
$A^l = (a_{ij})_{i,j=1,..l}\ with\ \{a_{ii} = 1,\ a_{ij} = a_{ji},\ and\ a_{ij} = \sqrt{\frac{\tau_i}{\tau_j}}\ for\ i < j\}$
V_i^* is given by the solution to the equation:

$$C_{i+1}(V_i^*, t_i) = K_i\ for\ i = 1,2,..,n-1 \qquad (2)$$
$$V_n^* = K_n$$

The firm would choose to embark on this investment strategy if $C_1(V, t_0) > K_0$ where K_0 is the initial investment necessary to trigger the multistage investment program.

The NPV obtained from applying an appropriate options pricing model (OPM) such as the Geske compound option model is also referred to in RO literature as the Strategic Net Present Value (SNPV) or the Expanded NPV (Park & Herath, 2007; Trigeorgis, 2005; Trigeorgis & Mason, 1987) where:

$$SNPV = Passive\ NPV + Value\ of Managerial\ Flexibility \qquad (3)$$

Here, the SNPV is simply $C_1(V, t_0) - K_0$. The passive NPV is the NPV obtained from traditional discounted cash flow analysis where the investment strategy is assumed to be fixed *ex ante*. The difference between SNPV and the passive NPV is the value of managerial flexibility, which in this case arises from the abandonment options embedded in this compound option model since management has the ability to abandon the investment program at any of the times t_1 through t_n. We denote as $\bar{V}$ the expected value at t_n of the asset that generates cash flows, acquired when the terminal payment is made at t_n, and μ is the firm's cost of capital for discounting risky cash flows. Then the present value of the embedded abandonment options is given by Equation (4) as:

$$Value\ of\ abandonment\ options = C_1(\bar{V}e^{-\mu\tau_n}, t_0) - \{\bar{V}e^{-\mu\tau_n} - \sum_{j=1}^{n} K_j e^{-r\tau_j}\} \qquad (4)$$

where the second term on the right-hand side of Equation (4) is simply the NPV from traditional discounted cash flow analysis.

Recursive Computation of Compound Option Value

The value of the n-fold Geske compound option is found numerically and we used a Mathematica[TM] program for this purpose. The value of the compound is found recursively. The SOA program represents a 4-fold compound option because after the investment in the ESB which initiates the program, there are four major investments left. These are the deployment of the DS, DTS, BPMS, and ADPTRS. To find the value of this 4-fold compound option, the program first finds the roots of the non-linear equations:

$$C_{i+1}(V_i^*, t_i) = K_i\ for\ i = \{3,2,1\} \qquad (5)$$

which results in the values V_4^*, V_3^*, V_2^* and V_1^*. Also, from Equation (2), we know that $V_4^* = K_4$. The V_i^* values are obtained successively starting from the end of the time horizon and working backwards since the formula for the compound option during any phase *i* involves the values V_i^*,. V_{i+1}^*, ... V_4^*.

Parameter Estimation

The assumptions on the cost and the length of time to deploy and absorb the relevant technologies are given in Table 1. We used industry data from IBM for the costs of the various key technology components shown in Table 1. In particular, the IBM WebSphere product line offers all of these components such as the ESB, DTS, and BPMS (IBM Software Online Catalog, 2010). Therefore, we used the IBM WebSphere price list to populate the cost data in the model. The benefits of SOA arise from the reduced cost of building applications since components of an application can be reused as applications are built as a collection of reusable Web Services. We used a value of $1.2M per application resulting from SOA based on benefits data from Ghosh and Li (2013). We assumed that five applications would be built using SOA. The benefits would of course rise as the firm builds more applications using SOA. We were exploring whether SOA could justified based on a moderate number of applications built using SOA such as five.

Table 1: Technology Deployment and Absorption Times and Costs

Technology Component	Length of Time for Deployment and Absorption (months)	Cost ($)	Value
ESB	3	361,000	
Directory Service	3	118,000	
Data Transformation Service	4	206,000	
Business Process Management Service	6	194,000	
Adapters for Existing Applications	8	250,000	
Integration Applications			6,000,000

A key parameter that needs to be estimated is the volatility in the value of the underlying asset as given by the standard deviation σ in the rate of return on the asset. The issue of estimating σ is not specific to the generalized Geske compound option model described in this article and has been extensively discussed in previous IS literature on the application of RO to IT investments (Bardhan et al., 2004; Benaroch, 2002; Benaroch & Kauffman, 1999; Benaroch et al., 2006; Dos Santos, 1991). One general approach is to use historical data on the standard deviation of the rate of return on similar projects to estimate σ. If in-house projects of a similar nature are not available, another possibility suggested by Benaroch and Kauffman (2000) is to look at the risk characteristics of publicly-traded stocks of vendors of IT products and services used in the IT project being invested in. Bardhan et al. (2004) have suggested an approach for the more accurate assessment of the volatility of individual projects belonging to a portfolio of projects based on computing “spreads” in the value of a project depending on different types of scenarios. Clearly, a number of estimation methods for σ have been discussed in IS literature and the Geske OPM described here can simply leverage these methods. We assumed a risk free rate of 2%, a volatility level of 0.6, and a cost of capital of 12%.

RESULTS

Optimal Deployment Sequence

We varied the sequence of deployment of the technology components in the SOA investment program to find the optimal sequence of deploying the SOA components; subject to the constraint that the program begins with the deployment of the ESB followed by the directory service. The ESB is the backbone on which the exchange of Web Service invocations messages occur. Hence, the ESB has to be implemented first before any Web Service can be called. The directory service is also one of the earliest elements to be deployed as it is crucial to the management of the SOA environment. It identifies the Web Services that are available in the SOA environment. But there is flexibility in how the remaining components of SOA are deployed. We varied the sequence of deployment of the remaining components to see which sequence results in the maximum SNPV. It turned out that the deployment sequence of ESB->DS->DTS->BPM->ADPTRS resulted in the maximum value of $3,826,120. This optimal deployment sequence is shown in Figure 2.

A net value of about $4M for building just five applications using the SOA approach provides a powerful case for implementing SOA. As more applications are built using SOA, the benefits would correspondingly rise.

Sensitivity Analysis

We studied the sensitivity of the results to key parameter values by varying volatility σ and the risk-free rate over a range of low, medium, and high values. In the prevailing climate of relatively low interest rates, we set the low end of the range at 1% and the high end at 6% for the risk-free interest rate. While we had chosen a base case volatility of 0.6, we varied volatility from a low of 0.1 to a high of 1.5. This represents a fairly dramatic change in volatility thus encompassing many different scenarios of possible volatility. In our base case, we had used a risk free rate of 2% and a volatility of 0.6.

The results are shown in Table 2. As expected, since the value of a real option rises with increasing volatility and increasing interest rates (Black & Scholes, 1973), the SOA net value as viewed through an RO lens rises correspondingly. Even though the variation in the parameter values was quite dramatic, the SOA SNPV varied in a $3.7M to $4.2M. Essentially SOA brings about $4M of net value in the medium term during which it is assumed that the firm would build five applications leveraging SOA.

Table 2: Sensitivity Analysis of SNPV of SOA

		σ		
		Low 0.1	Medium 0.4	High 1.5
r	Low 1%	$3,661,680	$3,683,710	$4,227,490
	Medium 3%	$3,780,440	$3,791,700	$4,235,660
	High 6%	$3,914,290	$3,918,190	$4,246,950

Value of the Abandonment Options

We also computed the value of the abandonment options by applying traditional or passive NPV analysis to the SOA program. For the base case, using a risk-free interest rate of 2% and a cost of capital of 12%, the passive NPV is:

$$Passive\ NPV = 6000000e^{-0.12(2)} - 361000 - 118000e^{-0.02(0.25)} - 206000e^{-0.02(0.5)} - 194000e^{-0.02(0.8333)} - 250000e^{-0.02(1.3333)} - 200000 = \$3{,}603{,}190 \quad (7)$$

Hence, the value of managerial flexibility which is the difference between the SNPV and the passive NPV is $222,930. This arises from the value associated with the options that management has to abandon the SOA build-out program at any of the points t_1, t_2,…,t_4. The value of these abandonment options is a non-trivial 6% of the total value of the SOA investment program.

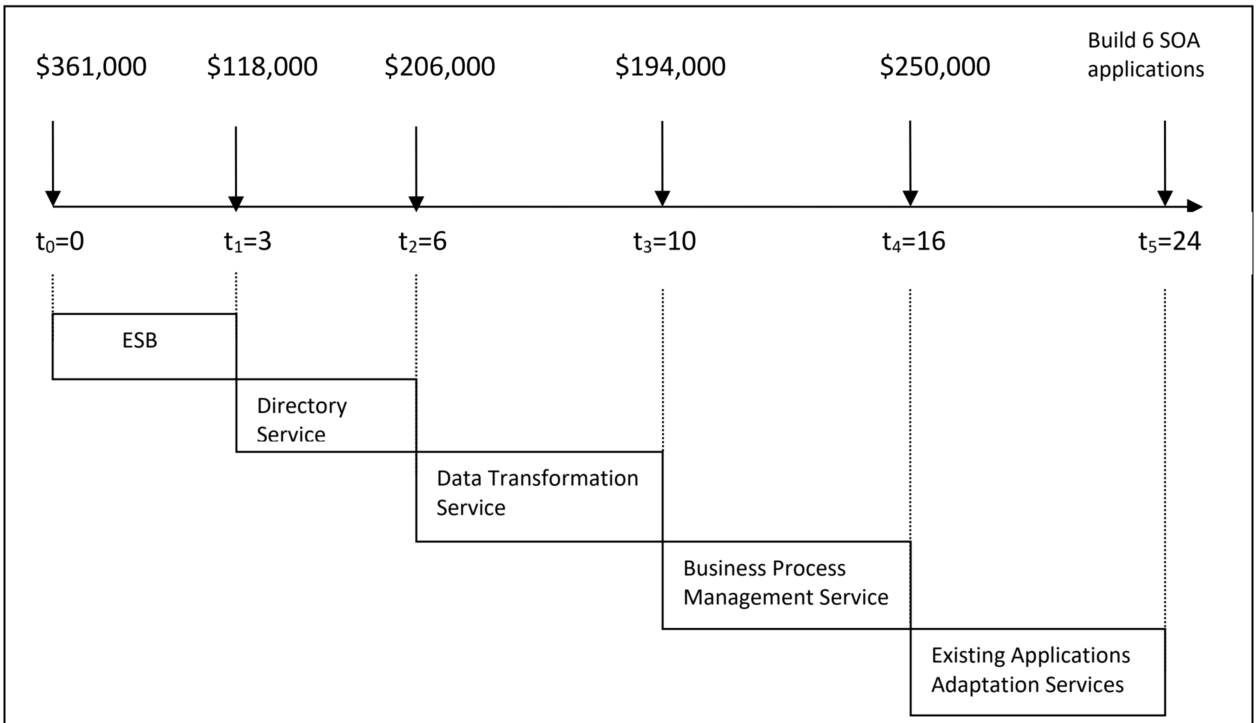

Figure 2: Optimal Deployment Sequence

Discussion of Results

There are two aspects that stand out in the real options analysis of the value of SOA. The first is that the SNPV of the SOA investment program is significant. We found the SNPV from SOA resulting from building just five applications to be around $4M using real-world values of various parameters. This makes a strong case for migrating to SOA. An IT project with a net value of

$4M is a project that any firm, even a major Fortune 500 firm, would find to be an attractive bet. The other aspect that stands out is that the abandonment option actually contributes a non-trivial amount of 6% to the net value of the SOA program. This means that while there is a strong case to be made for embarking on SOA, the firm should not stick to SOA to the bitter end if it turns out that the investment is not returning the value expected of it. A manager implementing SOA would need to explicitly recognize the value of abandonment and manage the program accordingly. A managerial mindfulness of abandonment is actually contrary to how many managers behave, which is why this is a key result which should drive how the SOA program is managed.

IS literature actually shows that managers have the opposite of an abandonment mindfulness. The literature is replete with studies that show that managers are loath to abandon failing IT projects and instead escalate their commitment to such projects (Keil, 1995; Keil et al., 2000; Newman & Sabherwal, 1996; Zmud, 1980). Our study argues from a real options logic that there is a case for embarking on SOA but at the same time the manager needs to shift their mindset from a “stick with the program” mindfulness, which is what the literature shows managers actually do, to an “alertness to abandonment” mindset. We note that recent research does suggest that management indeed gives weight to the real options embedded in an investment strategy (Tiwana et al., 2007). However, this research (Tiwana et al., 2007) speaks to managerial thinking at the point of entry into an investment program, and while it is interesting to note that real options logic does influence the entry, our model for SOA shows that real options logic should drive both the entry and the possible exit from SOA.

CONCLUSION

In this article, we address the key question of what firms should do about SOA. SOA is the key to solving the problem of integrating applications, business processes, databases, and systems that IT organizations have wrestled with for decades. While previous efforts to achieve standards for integration such as CORBA and DCOM failed because of fragmentation of the industry, SOA does appear to have the support from all quarters of the industry. While the vendor support is universal, there have been doubts raised about the value of SOA because some firms have struggled to implement SOA, which has led to calls that “SOA is dead”. We show in this article that SOA is far from dead and we encourage firms to make a bet on SOA. We note that while there is a powerful argument to be made for embarking on SOA, firms should not enter into this investment with a “stick to the program at all costs” mindfulness, which is what the literature shows that managers often do. They escalate their commitments to a failing course of action. Managers should instead explicitly recognize that a non-trivial portion of the value of SOA actually comes from the abandonment options embedded in the program.

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