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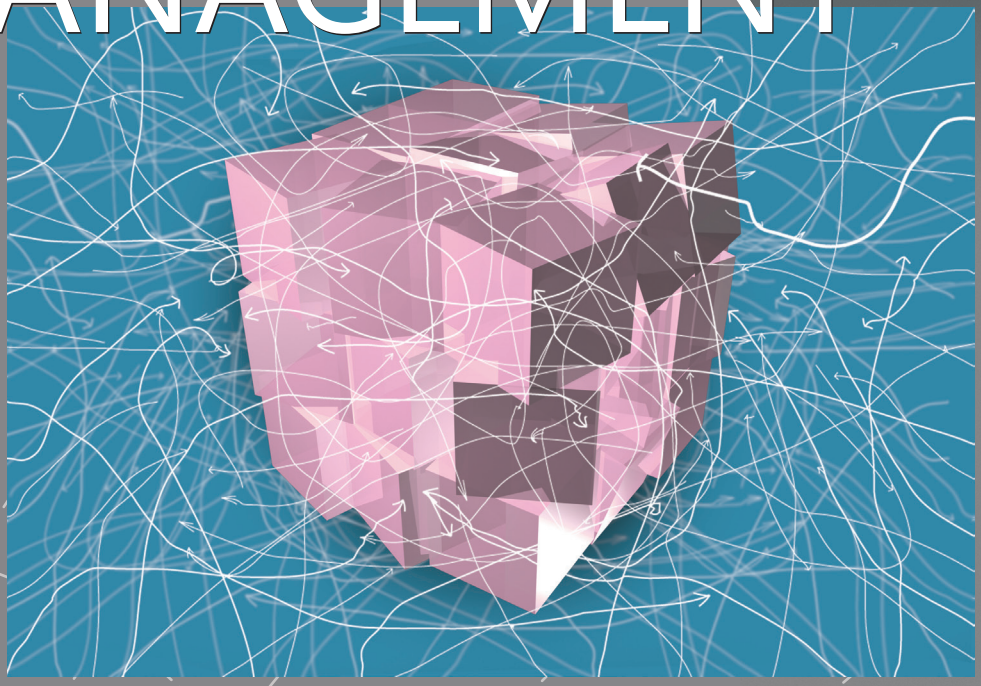

Case Studies and Practical Advice

Donald J. Reifer

Sample Chapters

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CHAPTER 6

Industrial Case: Utility Moving to the Clouds

Setting the stage

The utility company you work for is considering moving to cloud computing. Cloud computing, as you find out via the Internet, is a relatively new concept that refers to an assortment of logical computational resources that are made available via computer networks rather than on local computers.[1,2] Applications are hosted on multiple servers across the cloud. Data is also stored on server farms. In this manner, both applications and data can be made accessible via a browser rather than you having to install and run them on your desktop, laptop, or office server. Instead, both run on the cloud via its servers and results are made available through the network to clients on their computers. Clouds can be public and private, depending on the need. In addition, cloud services are sold on a demand basis using any of these three arrangements:

- **Software as a service** End-user applications services are accessed over the network rather than on client computers. Under this arrangement, you execute your business application remotely to get results typically at a fraction of the cost of licensing the software.
- **Platform as a service** Sets of application components can be put together by developers via plug-and-play and run on cloud-computing servers to get results.
- **Infrastructure as a service** Developers can build applications from scratch and run them in virtual machines on the cloud servers without having to license tooling that can be costly.

The major advantage of cloud computing is its significantly lower cost relative to the older model, where you would acquire and maintain hardware and software resources. It removes the need for large capital investments in equipment, infrastructure, and software and reduces related operating costs proportionately. It also increases potential mobility because the only thing workers need to do, wherever they are, to access computational resources is connect to the cloud.

The disadvantages of cloud computing are many and include becoming dependent on someone else to control your computational resources. As a consequence, you will fail if they do or if they are unwilling to pitch in to resolve a crisis. Besides other disadvantages, the cloud has serious security and privacy risks, especially if confidential data is not protected adequately. Obviously, there is lots of

information available about cloud computing in the professional literature[3,4] and on the Internet. (See the end of this chapter for pointers to these resources.)

Your task in this case study is to lead an internal team that has been asked by management to determine whether or not to use cloud computing to provide basic services for your firm and its customers. Customers are residential, industrial, and governmental users of the gas, power, energy, water, and waste-removal services that your firm offers on a fee-for-service basis throughout the municipality.

Organization

Figure 6-1 shows an organizational chart of the entire utility company.

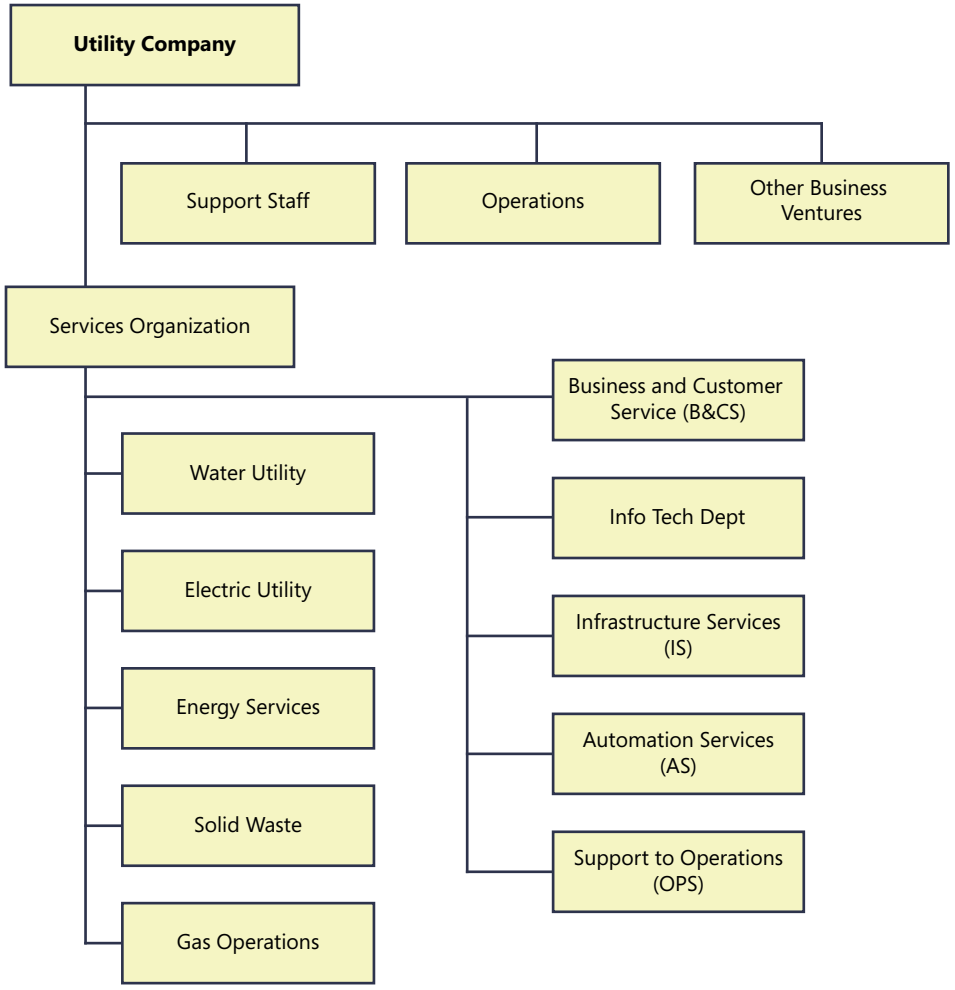

FIGURE 6-1 Organizational chart for the utility company.

The part of the company you are most interested in is the Services organization, which provides a wide range of utility services for a large city and its suburbs. The Information Technology (IT) department of which you are a part provides centralized support for each of these groups from the company's main offices located in a large city in the southern United States. The department provides infrastructure services for the enterprise as a whole, and automation and operations support services for each of the groups that are part of the Services organization. In addition, IT has a major field site co-located with the services group's Business and Customer Service (B&CS) organization, which is about 30 miles away. This field site was built as a backup for the main site in case a disaster occurs. Both sites have development facilities and service the firm's client/server networks. The IT department has 1,200 professionals located at these sites and 300 support personnel. The IT general manager also serves as the chief information officer (CIO) of the company. However, the vice president of operations is responsible for ensuring that the services provided by operations personnel is exemplary at the many sites the company maintains across the country in cities, counties, and government facilities.

Project

The project you are in charge of is primarily tasked with determining whether or not to use cloud computing within the IT department to lower operating costs for infrastructure services like payroll and travel. You have a team of three who are working with you part time to develop a recommendation regarding the use of what management views as a beneficial, cost-cutting technology.

During your team's kickoff meeting, the IT general manager provides the following added information and direction for the effort:

- Assess whether moving to cloud computing makes sense for B&CS and Infrastructure Services (IS) because they each maintain various resources that other groups access via the company's client-server network. The capital assets of each group (equipment, licenses, and other items) are listed in Table 6-1.
- The number of staff currently required to operate and maintain B&CS and IS facilities and equipment is listed in Table 6-2. These counts address common software used across the company. They do not include the staff used to develop new software applications, who are funded separately by the operational groups.
- Determine the impact of cloud computing on the IT department's capital costs of doing business. As part of this analysis, look at what happens to the equipment and facilities that will be disposed of when the department transitions to the use of cloud computing.
- Make sure that no matter what you do the same quality of service (or better service) is provided to your customers. This is determined by using the current primary measure, which assesses response time relative to a customer's request for service.
- Retain any applications that provide the company with clear advantages over the competition, such as the company's current ability to read meters remotely to tabulate billings.

- Investigate how to address the security and privacy shortfalls of cloud computing. Make sure customer proprietary information is protected regardless of the cost.

TABLE 6-1 Capital assessment for the B&CS and IS groups.

Organization	Asset	Purchase Price (in millions)	Accumulated Depreciation[b] (in millions)	Current Book Value (in millions)
B&CS	Computer equipment	$40	$20	$20
	Communications gear	15	8	7
	Software licenses	20	7	13
	Capital improvements[a]	25	10	15
	TOTALS	**$100**	**$45**	**$55**
IS	Computer equipment	$60	$25	$35
	Communications gear	20	10	10
	Software licenses	20	8	12
	Capital improvements[a]	50	22	28
	TOTALS	**$150**	**$65**	**$85**

[a] Expenses to improve leased facilities (long term)

[b] Using IRS guidelines for depreciation for different types of equipment and licenses

TABLE 6-2 Annual average staff expenses to maintain and operate computational resources.

Organization	Task	Annual Cost (in millions)[a]
B&CS	Hardware and software maintenance	$2
	Sustaining engineering, including user support	2
	Operational support (includes call center)	4
	Product management	1
	TOTALS	$9 (45 people)
IS	Hardware and software maintenance	$5
	Sustaining engineering, including user support	2
	Operational support	2
	Product management	1
	TOTALS	$10 (50 people)

[a] Cost for a staff-year of effort is assumed to be $200,000 at this price level.

Process

The approach your team decides to take to make your determinations and findings adheres to the practice your firm has in place for such analyses. The steps are outlined as follows:

- **Step 1: Develop a Concept Paper** Summarize your concept of operations in a white paper for cloud computing use in B&CS, and summarize its use in IS in a white paper that highlights the capabilities you hope to acquire from the vendors.
- **Step 2: Issue a Public Request for Information** Issue a public Request for Information (RFI) asking vendors to comment on your white paper and tell you how they would go about satisfying its requirements.
- **Step 3: Gather Information/Develop Requirements** Hold discussions with vendors who provide technically acceptable responses to the list of items you asked them to address in your white paper. These include the evaluation criteria you identified in the paper to be used to make such determinations and findings.
- **Step 4: Prepare/Issue a Request for Proposal (RFP)** Issue an RFP to vendors who responded to your RFI for the acquisition of cloud-computing systems and services based on a solicitation that contains your requirements, work statement, and preferred contractual terms and conditions. Make sure that your solicitation does not bias the acquisition by using vendor proprietary information gathered via the RFI process. Otherwise, you might have to deal with a protest from one of the losing vendors.
- **Step 5: Conduct Source Evaluation/Selection** Using criteria (responsive to requirements, lowest cost, minimum risk, and other such items) contained within the solicitation, rate and rank the vendor proposals. Make a selection based on the given criteria. Identify major strengths and weaknesses in the winning proposal, and forward it along with your recommendations to those responsible for negotiating a contract.
- **Step 6: Issue a Contract** Negotiate with the selected vendor to acquire the products and services using best value and fairness as your overriding principles. Work with the vendor to take advantage of its strengths and compensate for its weaknesses. Remember, the vendor must succeed for you to succeed.
- **Step 7: Monitor the Contractor/Accept Delivery** Provide oversight and direction as the contractor works to comply with your requirements for delivery of acceptable products and services. Accept delivery only when the vendor supplies evidence of compliance with your contract requirements.
- **Step 8: Commence Operations** Using your concept of operations, transition to the use of the cloud-computing products and services acquired in as disciplined, logical, and risk-free a manner as possible. Apply change-management principles during the transition. Remember to plan in detail because the transition might require you to operate systems in parallel to minimize potential impacts when running a shop 24 hours a day/7 days a week. Be sure to include recurring activities, such as maintaining ongoing communications with stakeholders.

The response to the RFI is overwhelming. You received 42 replies, of which 18 vendors seem to satisfy your requirements. In addition, the telephone has not been idle for the past two days. Most of these phone calls are vendors asking for time to visit and present their wares to you and your team. However, your timeline will not accommodate them all. You need to cut the number to six vendors, at most. You do this by asking all of those responding if they have experience with utility companies similar to yours. Because only three of the six can respond positively, you can reduce the list of promising vendors accordingly.

Product

After discussions with the vendors, you feel that you have the information you need to pull together a briefing to your boss and his staff on how to exploit the use of cloud computing within your utility company. Your briefing will contain the following observations and recommendations relative to the changeover:

- The move to private cloud computing, where facilities are dedicated to the company, has many benefits as confirmed by government studies[5,6] and all of the vendor sales pitches. Costs can be substantially reduced, and the company's ability to expand and contract its computing resources as needed is greatly enhanced.
- Given the current business picture and constrained B&CS and IS budgets, private cloud computing seems to represent a viable path forward for the utility.
- The ability to implement a measured service under a pay-for-use paradigm, which provides services on an on-demand basis across a ubiquitous network, has many advantages.
- All those interviewed concurred that private cloud computing seems to make the most sense for IS because the services it provides are for the entire organization. Because B&CS is localized, it does not seem to make sense to use private clouds for them on a broader basis.
- Cost savings will be realized as a function of the substitution of virtualized applications software in the cloud for labor and facilities from current dedicated resources.
- Cost savings from the cloud can be realized in stages as various applications are replaced by vendor replacements. Transition to private cloud computing will outsource general business applications first and then operations and maintenance later.
- The team recommends going forward with private clouds for IS but not for B&CS. The next steps in the process will pull together the requirements, develop a solicitation, and issue an RFP for the acquisition of products and services.
- In preparing for the RFP, the team will identify and seek to retain core services that are fundamental to the way the utility does business and that represent a competitive advantage, such as the ability to read meters remotely and bill clients directly for services, as mentioned earlier.
- In the RFP, current systems will be kept operational and working in parallel during a transition period of three to five years. Some business process reengineering will be required during the transition to optimize how the new cloud-computing resources are used.

- In the RFP, as a risk mitigation action, those proposing solutions will be asked how they can address known weaknesses of cloud computing, such as those related to security and privacy.
- In the RFP, purchase and maintenance options will be included to provide the utility with leverage once the acquisition is completed and the vendor is under contract.

People

Your boss liked your briefing, nodded his head in agreement many times as he listened, and concurred when you concluded with all of your team's recommendations. However, the head of IS was infuriated and vocally criticized every one of your charts. Such protests were expected because IS would be taking the brunt of the cuts. When you were asked how much could be saved, you replied, "Based on vendor inputs during the question and answer sessions, they estimated savings between $50 and $60 million of equipment at book value and from 35 to 40 people with a total staff cost between $7 and $8 million. The total reduction based on these numbers is between $57 and $68 million from the current budget of $95 million."

The head of IS immediately responds to these numbers with a blistering rebuttal. He states that such savings are unrealistic because much of this equipment and the people will have to be retained to run existing facilities in parallel during the three-to-five-year transition period. In addition, at least five new people will have to be hired during this period to perform the business process reengineering tasks, including the staff needed to train users in their proper utilization. He estimates that the conversion costs during the three to five years will add $8 to $10 million to IS's current operating expenses. These numbers rattle you, the general manager, and the audience. "He is right," says the general manager. "You need to investigate the costs of transition more fully before I make a go/no-go decision on the acquisition," he continues.

The head of IS has a grin on his face and looks pleased. He volunteers to have two of his best senior people work with you part time as you develop a response. You politely decline, but the general manager thinks it is a good idea, and you reluctantly accept the offer of help. The general manager schedules an additional meeting two weeks from this one to review the cloud-computing recommendations again.

You should have expected and prepared for the IS response because anticipating and planning for resistance is a fundamental change-management principle. But you did not. Getting cloud computing accepted now will be harder. But it still seems doable.

Options, recommendations, and reactions

The team gets together to assess the options with the transition in mind. They identify the following four main transition scenarios to cloud computing that everyone agrees make sense:

- **Option 1: General Application-Only Transition** Transition most general applications to a private cloud, retain IS facilities and staff to run general applications, and continue servicing customers on a fee-for-service basis.

- **Option 2: Partial Facilities Transition + Option 1** Perform Option 1, and shut down unneeded facilities within IS. Sell off equipment, and reduce staff proportionately as private cloud services and applications become operational. Upgrade equipment as needed to address reliability issues.
- **Option 3: Transition to Upgraded Facilities + Fuller Set of Applications** During the transition to the private cloud, upgrade facilities to provide core processing and backup. Address current equipment reliability issues that are occurring as gear ages and failures increase, thus jeopardizing 24/7 operations. Sell off equipment, and adjust staff proportionately as facilities and cloud services and applications become operational.
- **Option 4: Operate IS As-Is** Upgrade IS equipment to address reliability problems, and continue to operate as-is. Perform some streamlining to cut costs and improve service to consumers.

Table 6-3 summarizes the results of the team's analyses after considerable debate. It identifies the major strengths and weaknesses of each option, along with the estimated costs and projected benefits. The table seems to highlight the overall conclusion that movement to one of the three private cloud-computing options is the right thing to do even though IS remains reluctant to support such a recommendation (that is, the two people assigned to your team neither concurred with this analysis nor agreed to put their names on the results).

TABLE 6-3 Strengths and weaknesses of cloud-computing options.

Options	Strength	Weakness	Cost	Benefits
General Applications Only in Clouds	■ Big gains, little effort ■ Can handle increased workloads ■ Minimal disturbance	■ Does not address the reliability issue	■ Transition cost of $25 million ■ Two to three years before benefits accrue	■ Cost avoidance of $40 million a year ■ Increased flexibility ■ Can handle a larger workload
Partial Facilities + Partial Applications in Clouds	■ Improve ability to respond quickly as business conditions change via the cloud ■ Addresses reliability issues	■ Transition is hard and takes time ■ New jobs must be found for displaced staff ■ Business processes must be updated	■ Transition cost of $50 million ■ Three to five years before benefits accrue	■ Cost avoidance of $50 million a year ■ Better business processes ■ Reliability issues handled ■ Less equipment and staff to worry about
Upgrade Facilities + Fuller Set of Applications in Clouds	■ Same strengths as Option 2 plus company can back up clouds with its own facilities	■ Same weaknesses of Option 2 plus more turmoil during transition	■ Transition cost of $65 million ■ Three to five years before benefits accrue	■ Cost avoidance of $65 million a year ■ All the benefits listed previously
Operate IS As-Is	■ Minimum pain	■ Minimum gain	■ Minimum cost	■ Reliability issue is addressed

Outcomes and lessons learned

Your next meeting with the IT general manager and the head of Infrastructure Services is stormy. It is apparent during the meeting that the head of IS is unhappy with the results. He continuously bombards you during your briefing with nasty remarks, and he accuses you several times of deliberately ignoring his people's inputs. In addition, he blasts the legitimacy of the numbers and asks for details on how each was derived. You respond with the spreadsheets that provide backup and tell him that his own people reviewed the numbers and found them reasonable.

Your boss finally has no option but to tell everyone to cool down. He states that even though the numbers speak for themselves and seem to present a solid business case for change, he has concerns. His major trepidations, he says, are the risks associated with the transition and the displacement of personnel. He says that equipment has to be changed no matter what option is chosen because it is wearing out and the reliability declines have to be fixed. Based on his remarks, it is not surprising that he accepts Option 2. In response, you and your team take the action to move to the next step in the process by preparing and issuing an RFP. You hope that several of the vendors who replied to your RFI will respond to your RFP with proposals that provide good value for your money.

Your team meets and tries to scope what goes into the RFP besides the requirements and boilerplate text. A member of your team who has been through a large purchase like this before advises you to pay attention to the boilerplate text because this is where the evaluation criteria for selection and the terms and conditions for the purchase go. That's good advice, you think. So you schedule a meeting between your team and the Purchasing staff.

The meeting with the Purchasing staff goes very well. They had lots of experience and advice about what to put in the solicitation document. Key provisions include rewards for delivering early and penalties for being late. They also provide options to acquire several products and services (additional applications and services, more equipment, training, and other such items) that can be taken after the contract is awarded at a fixed price. Maintenance terms and conditions for the first five years of operations were also spelled out so that you can get the vendor's immediate and undivided attention when problems occur after delivery.

At the suggestion of the Purchasing department, you send the solicitation out to the prospective suppliers for comment prior to releasing it. You get back a lot of constructive criticism and suggestions. You find that the most controversial clauses are those associated with late delivery and maintenance.

The lessons learned in this industrial case study were many and include, but are not limited to, the following:

- Even when you think there is a clear choice, resistance to change can pop up from unexpected sources. Therefore, also anticipate resistance and plan to deal with it.
- Resistance to change comes primarily from those whose power, staff, and budgets are threatened. In this case, such cutbacks are real threats to the Infrastructure Services group.

- Those who foster change need to anticipate the perceived threats and develop plans to help address them as part of their effort. In this case, figuring out how to find other positions for staff who are no longer needed might have alleviated some of the pain.
- There might be hidden issues that influence decisions relative to change. In this case, aging equipment and reliability issues did not surface until late in the process when options were being compared. Yet, the issue was one of the major drivers in determining which option was selected.
- Using competitive market forces to seek the best alternative can be beneficial, especially if you can get an expert review of your solicitation by stimulating the vendors to provide you inputs as to which of your requirements are feasible and which are not.
- However, relying solely on vendor inputs is dangerous. Because they want to make a sale, they might stretch facts and cloud reality by confusing current capabilities with future capabilities.
- Using strengths and weaknesses along with costs and benefits permits stronger cases to be made for recommended alternatives.
- Getting a vendor on contract takes considerable time and effort. It also forces you to solidify your concepts of operations, requirements, and contract terms and conditions.
- Getting selected vendors to deliver what they promise often takes patience, effort, and due diligence. Many will do a good job. Others may let you down after the contract is issued. To succeed, plan to manage rather than monitor the contract. Otherwise, you probably will get less than what you expect and less than what you are paying for.
- The challenge will occur after the cloud products and services are delivered and accepted. If you are not one of the vendor's key accounts, keeping their attention during operations and maintenance might become an issue. That is why I strongly recommend negotiating terms and conditions for any follow-on maintenance contract as part of the original acquisition.

Summary

This chapter provides insight into large procurements for Information Technology (IT) products and services. The major issues in this case revolve around addressing resistance to change brought on by a changeover to a new computing paradigm—for example, cloud computing. In this case, such resistance should have been anticipated and dealt with earlier in the process. The team should have gotten IS personnel involved earlier and solicited their inputs and resolved their objections prior to making the recommendation for one of the change options. In the process, they would have learned about and been able to attack the issues of reliability and placement of staff. Instead, they became involved in a war of words that detracted from the goal of the effort, which was determining whether or not cloud computing made sense for this utility company.

This is another chapter where I cut back on materials to save space and maintain a focus. Please understand that cloud computing is controversial and has many issues associated with it that deserve

further coverage. For example, the performance of the cloud is overstated—that is, the vendor often promises more performance at a lower cost than it can deliver. As another example, the tools you use may or may not work as advertised on the cloud. Be warned that you need to move carefully to the clouds because they are still in their early-adopter period.

References

References cited within this chapter include the following:

[1] Charles Babcock, "Why Private Cloud Computing Is Real—And Worth Considering," *InformationWeek*, April 11, 2009.

[2] Amazon web services provides numerous case studies on cloud computing at the following site: *http://aws.amazon.com/solutions/case-studies*.

[3] The Cloud Computing Journal has published numerous success stories that can be reviewed at *http://cloudcomputing.sys-con.com/node/1687873*.

[4] Marc Benioff and Carlye Adler, *Behind the Cloud: The Untold Story of How Salesforce.com Went from Idea to Billion-Dollar Company and Revolutionized an Industry* (Jossey-Bass, 2009).

[5] Government Computer News devoted an entire issue of the magazine in 2011 to cloud computing successes that is accessible at *http://gcn.com/microsites/2011/cloud-computing-snapshot/index.aspx*.

[6] NASA Nebula Project. Information about their use of cloud computing is available at the following site: *http://nebula.nasa.gov*.

Web resources

Applicable web resources that amplify points made in this chapter can be found here:

- Amazon has many books and articles on the subject of cloud computing. Go to *http://www.amazon.com* to find relevant publications.
- Amazon also provides infrastructure web services via a cloud platform for commercial companies of all sizes via a fee-for-service arrangement for application hosting, backup and storage, e-commerce, media hosting, search engines, web hosting, and other services.
- YouTube has a number of videos on cloud computing, like the following one that introduces you to the technology: *http://www.youtube.com/watch?v=ae_DKNwK_ms*.
- Many technology firms in the cloud-computing business provide resources to help those investigating this technology. For example, Hewlett-Packard offers a planning guide at its cloud-computing digital hub at *http://www.techlearning.com/article.aspx?Id=39248*.
- The Open Cloud Consortium (OCC) manages cloud computing resources and develops reference implementations, benchmarks, and standards for its members that support scientific

research. Information about the consortium is available at *http://opencloudconsortium.org/about*.

- IBM and the European Union have announced the formation of a consortium to research new computing models. See *http://www-03.ibm.com/press/us/en/pressrelease/33067.wss*.
- The Cloud Computing Journal offers lots of articles on the use of the technology at *http://cloudcomputing.sys-con.com*.
- Another useful publication called the Cloudbook, located at the following site, provides relevant articles: *http://www.cloudbook.net*.
- Lots of technology firms, training companies, and universities offer training in cloud-computing areas.
- Major conferences and expositions on cloud computing such as the following are held in large cities worldwide: *http://www.interop.com/newyork/conference/cloud-computing.php*.
- A current list of cloud-computing discussion groups, list servers, and blogs can be found at *http://www.thedacs.com/databases/url/key/7848/7852*.
- A nonprofit group of major technology firms has been formed to address cloud-computing security issues. It is called the Cloud Security Alliance, and it has many resources at the following site: *https://cloudsecurityalliance.org*.

CHAPTER 9

Government Case: Introducing New Technology

Setting the stage

You have been working on a government research and development (R&D) contract to develop and mature a new technology for protecting network-based systems against attacks from intruders, both insiders and hackers, for the past six years. The defenses you invented (and which you have patent applications for) are called *active defenses*.

The defenses work by first identifying the attack scenario. Attacks are represented next in the form of a state vector, which is designed to capture and communicate as much information about the attack as possible. As the attack unfolds, these state vectors are updated with the dynamics of the attack. The defenses take the information and use game theory algorithms that exploit the Nash equilibrium concept[1] to determine how best to defeat the intruder. The worst case solution is a draw, which means the intruder goes in circles but does not get into the network. Interim solutions are represented in the form of another set of state vectors that contain constraints and transition information. The algorithms reconfigure the defenses as a function of time to ward off the attack as more knowledge about the attack is communicated via the state vectors. There is no need to hide information because the algorithms assume that the intruder has full knowledge of your defenses.

During the first two years of the effort, you developed the algorithms and validated them through a series of experiments. There was a lot of tweaking as the algorithms' parameters and optimality criteria were changed so that they could home in on an equilibrium solution. Because the Nash algorithms are extremely complex, learning how to manipulate them took some time and mathematical talent. When they were mastered in the second year of the effort, they were extended and adapted so that they could be used for this new purpose. The key innovation was the use of state vectors to capture and communicate knowledge about the dynamics.

During the next two years, tools were developed to make use of the algorithms easier. This toolset was then used to defend a simulated network against an organized attack to validate the algorithm's potential. Results were also compared line by line against a hand-calculated solution to ensure bit-for-bit fidelity with the mathematical algorithms. Because this activity went well, the customer funded

the follow-on activity, which was directed toward using the algorithms on a pilot project that allowed testing under representative operational conditions.

Finding a pilot defense project for the next two years of the effort turned out to be quite a challenge. Even with the sponsor's active support, all of the people involved with defense projects who you spoke with declined your offer to collaborate because they were afraid of the potential negative impacts associated with the use of what they considered a new and risky technology. The few project personnel who expressed interest refused to pilot the technology after some internal debate because of what they called "operational security issues." This really meant that they just could not secure permission to use the active-defense technology on an active network.

A commercial firm came in and saved the day. You met their chief engineer at a security conference, where he was looking for innovations in network security. This firm is in the gambling business in Nevada. They are one of the largest slot machine manufacturers in the business. They also operate machines that are placed in remote locations such as airports, gas stations, grocery stores, malls, and a host of other frequently visited places. When placed into operation, the machines are networked together and monitored at a central site because security in remote areas has been an issue. The machines also are programmed to send reports every hour to the central site on gambling activity and winnings. Such reports are constantly analyzed for suspicious activity using very sophisticated algorithms, and armed security teams are dispatched if there are signs of trouble. Management of the firm is interested in the active-defense technology because they had been repeatedly attacked by gangs of criminals who were using handheld devices to gain access and change the odds so that gang members playing the machines would win big jackpots. No two machines were ever targeted in the same area, and the players were in disguises. The agreement reached after lots of discussion and negotiation between this gambling firm, you, and your government sponsor was that all experiments on the network would be on a noninterference basis. In addition, visits to facilities would be controlled and publications would have to be approved by both the government and the gambling firm.

The past two years were spent working with the commercial firm to perfect the algorithms, enhance the toolset, and create an active-defense demonstration test bed to show off the potential of the technology to prospective users of this defense technology. This effort was very rewarding because it showed that the technology indeed held a lot of promise. It also demonstrated the merits of using Agile methods[2] to develop the toolset. Obviously, the gambling firm you were working with is interested in the technology and willing to buy the sole rights to retain it as its intellectual property. But agreements you have with the government prohibit you from doing this. The best you can offer the gambling firm is an exclusive five-year license to use the technology and associated toolset within the commercial gaming business area. To get this agreement, you spent a lot of time with government attorneys, whose position was that the government paid to develop the technology and therefore retains ownership rights for it. However, they are willing to give up the commercial rights in the future for some consideration if the technology pans out and is used extensively by military projects.

You are currently working on the final two years of the effort. This activity is directed toward what the government calls *commercialization of technology*. During this period, you try to stimulate widespread use of the technology in Department of Defense (DOD) projects. You are tasked with developing a commercialization plan. You have some core funds to make a product with the technology. A "product" in this sense is the technology packaged for consumption by target users with white papers, manuals, training, customer support, and other such items. There is even money available for the first company that comes forward and says it will use the technology that will be provided on a cost-sharing basis with a 50:50 split. In other words, your sponsor will match the project's expenditures dollar for dollar if that company commits funds for your commercialization effort. Because of your past failures when trying to get projects committed as pilots, you have asked your government sponsor for help in preparing a plan, the outline of which is summarized in Figure 9-1.

"Wow," you think when you look at what has to be done. "Do I really have to do all of this to commercialize a technology?" It should be noted that a National Science Foundation (NSF) outline[3] was used by the customer for the plan because it took a more commercial flavor.

Organization

Looking at the commercialization plan outline, you realize that you have to reorganize. Your firm is a small business that specializes in software development and R&D for defense contracts. You employ just over 200 professionals using the organizational structure shown in Figure 9-2. You modify this structure to add dedicated resources for marketing and outreach. You also create an advisory board to help you understand and tailor your active-defense technology for defense project needs. Of course, the chief engineer from the gambling firm will also be a member of this board because you want to satisfy commercial needs as well. The major change to your organization is the addition of a customer service group. Members of this team will staff the help desk and generate needed product support materials. Funding for these organizational changes comes from profits because the advisory board and customer support group will service clients at large, not a specific client. However, funding for products generated by this group for commercializing the active-defense technology will at least partially come from the contract with the government because this is in line with its scope.

1. Market Opportunity

a. Describe succinctly what product or service you are planning to deliver based on your innovation.
b. What customer needs will be addressed with your product or service?
c. Describe who your target customer is—providing generally known examples may be helpful.
d. How does the target customer currently meet the need you are addressing? Or convincingly describe how there is a significant problem that is not yet being addressed.
e. What is the business model you plan to adopt to generate revenue from your innovation?
f. How do you plan to exit the investment?
g. Is the target market domestic, international, or both?
h. Describe the channels you would employ to reach the targeted customer.
i. What is the current size of the broad market you plan to enter and the niche market opportunity you are addressing?
j. What are the growth trends for the market and the key trends in the industry that you are planning to target?
k. What are the barriers to entering this market?
l. Describe the technology/development objectives and critical milestones that must be met to address the market opportunity.
m. If there are potential societal, educational, or scientific benefits beyond commercial considerations, they should be included here and explained in sufficient detail to convey the significance of the effort.

2. Company/Team

a. Provide a short description of the origins of the company.
b. What type of corporate structure is in place?
c. What is the current capitalization?
d. What is the current employee count?
e. What is the revenue history for the past three years?
f. What are the sources of operating capital or revenue: product sales, consulting/services, license revenues, R&D grants/contracts, and other sources?
g. Give a brief description of the experience and credentials of the personnel responsible for taking the innovation to market.
h. What specific experience does the team lack, and how will this be addressed during the Phase II effort and beyond?
i. How does the background and experience of the team enhance the credibility of the commercialization plan? Have they previously taken similar products/services to market?
j. From what additional resources do you have commitment (Board of Directors, Board of Advisors, Technical Advisors, Legal Counsel, etc.)? Provide details on the names, affiliations, and expertise of these resources.

3. Product/Technology and Competition

a. What are the critical needs ("pain points") that your product or service is fulfilling for your customer?
b. What features of your technology will allow you to provide a compelling value proposition? How have you validated the significance of these features?
c. What is your customer willing to pay for your product or service? How have you validated this assumption?
d. What are your costs to produce the product or service? What are the assumptions that underlie your cost model(s)?
e. How does your technology/innovation allow your team to compete and win in the marketplace?
f. How does your product or service match up to that of the competition?
g. What do you anticipate the competitive landscape to look like when you get to market?
h. Describe the intellectual property landscape.
i. Do you have the freedom to operate?
j. How do you plan to protect the intellectual property associated with your technology?
k. What other sources of intellectual property will you need to access in order to address the market opportunity described above?

4. Finance and Revenue Model

a. Describe an appropriate staged finance plan given the market opportunity described above; enumerate the level of funding required for each stage along the path to commercialization.
b. How will you access the appropriate funds? Provide specific contacts, leads, previous relationships, and agreements already in place.
c. What commitments do you have for follow-on funding?
d. Describe the revenue streams (licensing, product sales, or other) associated with your commercialization plan. What are the adoption rates?
e. When do you anticipate first revenues from each stream?
f. When do you expect to reach breakeven?
g. Provide annual pro forma financial statements for the next five years (2 years of the Phase II effort plus 3 years of the post–Phase II effort). Income statements are required. Cash flow information and balance sheets can be included if they are considered critical for your strategy. If not included, these items should be available upon request from NSF.
h. What assumptions were made when developing your models? How have you validated these assumptions?

FIGURE 9-1 Commercialization plan outline for the new technology.

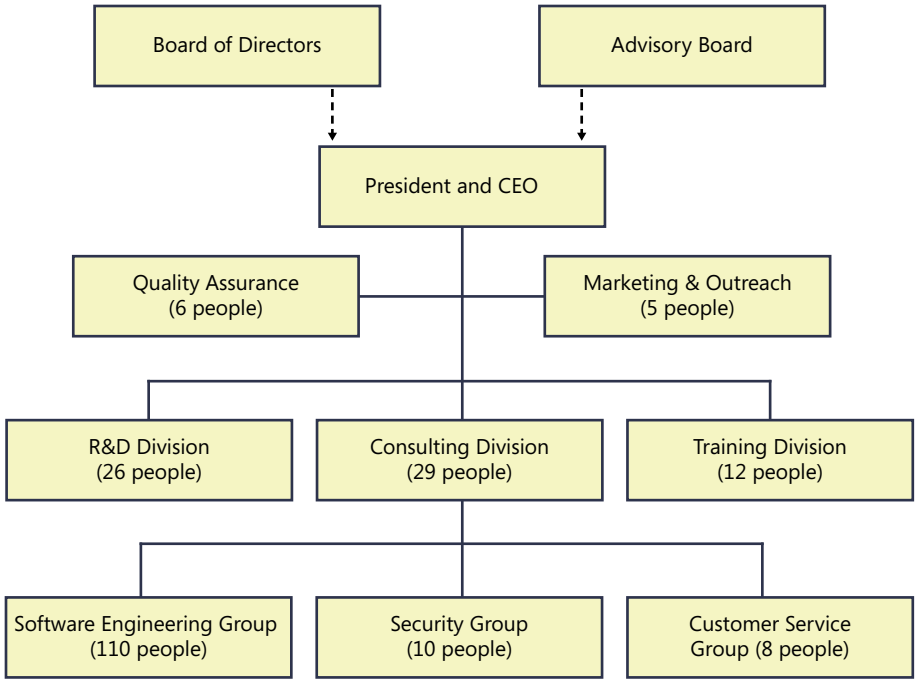

FIGURE 9-2 Small business organizational chart.

Project

As noted, the project being funded by the government customer is aimed at commercializing the active-defense technology. The twin goals of the project are to make a product from the technology and get it used by a defense project. The aim is to showcase the use of the product with the aim of interesting other defense projects in the use of the technology.

Based on your discussions with potential users, the maturity of the technology can be rated using Technology Readiness Levels (TRLs),[4] which are displayed in Table 9-1 as Level 7, a system prototype demonstration in an operational environment. Potential users say that a technology must be Level 7 or higher for them to consider it for operational use because of the risks involved.

Even though this rating scheme seems very hardware-oriented, you believe that you can still work with it to assess the technology's readiness level. You ask around to see whether there is a rating process for potential technology users. What you would like to do is assess their readiness to adopt the technology. You search the literature and make inquiries. Although your searches prove fruitless, you still think it is a good idea. Perhaps this can be a future research project?

TABLE 9-1 Technology readiness levels in the Department of Defense.

Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. An example is paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative, and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical and laboratory studies to physically validate analytical predictions or separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is low fidelity compared to the eventual system. Examples include integration of ad hoc hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include a high-fidelity laboratory environment or a simulated operational environment.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing of a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment	Prototype that works near or at the planned operational system level. This represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an actual operational environment. Examples include testing the prototype in a test bed.
8. Actual system completed and qualified through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system to determine if it meets design specifications.
9. Actual system is proven through use in successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last bug-fixing aspects of true system development. Examples include using the system under operational mission conditions.

Process

You have three project leaders interested in operational use of your technology. Two of the projects are for military customers, while the other involves commercial application. All three of these projects require their networks to be operational 24 hours a day/7 days a week (24/7), with at most an hour of downtime per month for planned maintenance. Before these project leaders will commit to using the technology, they plan to require that a technology readiness assessment be performed. They do this to evaluate the risks and benefits associated with the use of the technology. They each put one of

their senior technical leads on a team to perform this assessment. The key output of the assessment is the impact analysis. In the case of network protection technologies like active defense, assessors look at the potential positive and negative impacts of using the technology in terms of functionality, downtime, and potential to be compromised during an attack.

As the assessment team performs their impact analysis, you try to entice them further into committing to the use of the technology by using matching funds. You also show them your initial pilot results and your commercialization plan, and you have them talk with your gambling partner to raise their level of confidence in your technology. You even conduct several demonstrations to convince them that the potential benefits of using the technology are worth the risks.

Product

You are thrilled when you learn that the assessment team reports finding that the positive impacts associated with use of the technology merit the risks involved. However, only one of the projects is at a stage where the program manager for this military project is willing to commit to partnering with you and using the technology. In return, he wants your commitment regarding the packaging of the technology so that the product will be in a form acceptable for his team's use operationally. Such packaging involves your agreeing to the following terms and conditions of use:

- Under no circumstances will you provide information about the technology to anyone outside of the project once it is perfected for use on the project. He explains that his staff has classified inputs about threats that might force you to change your algorithms in terms of the design of criteria to find the best solution. This means that you will either have to terminate your relationship with your commercial partner or develop two versions of the technology: one for the military, and the other for commercial usage. While this is doable, managing two separate commercialization paths for the technology adds cost and a degree of difficulty to the effort.
- In addition to the promised documentation, you will also generate a maintenance manual for use by project personnel when updating the toolset and the platform it resides on. You will also pay for licenses for the platform software and commercial off-the-shelf (COTS) tools that are part of the toolset.
- You will conduct two training classes for project personnel in the theory and use of the technology. These will be hands-on workshops lasting at least a week each.
- You will develop and maintain a website that facilitates responses to project queries and problem reports associated with the use of the technology within a 30-minute time period. This site will be operational 24 hours a day/7 days a week (24/7).
- You will fund the entire project. The program manager for the military partner project explains that he does not have any discretionary funds available to commit to the effort.

People

The players involved in the decision on whether to use or not to use the new technology include the following people:

- **You** The technology developer and primary advocate for its use.
- **Your customer** The government organization that has been sponsoring both the R&D and commercialization of the technology.
- **The program manager for the partner project** The potential commercialization agent for the technology within the military who will take the active-defense product operational.

Even though your commercial partner in the gambling firm seems not to have any say, he is impacted by the decision. His firm has made a substantial investment, and he says that he will take legal action if you decide to not permit him to use the technology in the future.

Options, recommendations, and reactions

You, your government customer for the technology development, and the military's program manager for the potential partner project meet to discuss the possibility of pursuing a joint effort. While you do not like the partner project's terms, you are willing to accept all of them except the exclusivity clause so that you can move the technology forward the next step. However, your government customer is not willing to pay the full bill for moving the technology forward via the partner project. He wants the partner project to ante up at least a token amount of money to show its commitment. However, the program manager for the partner project is just as obstinate, saying that he has no money to put up and that you should be willing to accept his terms because he and his staff will incur most of the risk. A stalemate is reached and nobody seems willing to make a compromise.

Outcomes and lessons learned

The situation looks dire until your boss walks into the room and suggests that all three of you look at the options and develop a solution. He wants you to brief him on the options within the next week. You have no alternative but to try to solve the problem because your boss called his counterparts in the other organizations and forced the issue. You meet several times with the program manager and the government representative and develop a response for your bosses. The content of the briefing is summarized in Table 9-2. While the three of you have not reached agreement on a recommendation, you do concur that the table represents the current feasible set of options. You do not part friends. However, working together definitely eased the tension and made you see that your differences in positions were not that great.

TABLE 9-2 Potential options and their assessment.

Options	Strengths	Weaknesses
Provide the military partner exclusive use.	Keeps the technology safe from bad guys.	Limits the potential commercial use of technology.
Maintain separate military and commercial versions of the technology.	Permits commercialization while safeguarding the algorithms from potentially being compromised.	Must manage the firewalls between the two versions of the technology. The technology might evolve differently.
Sponsor funds the entire effort for the military partner.	Partner funds are dedicated to the primary mission.	No commitment is shown for commercializing the technology.
Sponsor funds the development of manuals and conducts training for the military partner.	Manual is needed, anyhow. Training can be perfected through trial use.	Additional funds are needed to accomplish both tasks. Also, this option diverts resources.
Sponsor funds a dedicated website that is operational 24/7 and provides 30-minute response times.	Provides prompt attention and solutions to problems encountered operationally.	Seems like overkill. Moving to a single shift 7 days a week cuts costs by one third.
Do nothing.	Safe and no cost.	Technology stays on the shelf and the investment lost.

The briefing is given to your boss in a very tense atmosphere. The program manager for the partner project will not change his position regarding the funding. All other issues seem negotiable. Your government customer will also not budge. He says that the military partner must put up some funds, no matter how small, to show some level of commitment. He will find the funds to handle the other issues if this one is addressed. When your boss says that he will elevate the issue to a higher authority, the partner project's program manager walks out of the meeting. As he leaves the room, he says, "I will not be forced to pay a cent, and my boss will support me." Everyone seems unhappy with this turn of events. "Do not worry," your boss says. "I can convince his boss to ante up at least a token amount by trading on past relationships."

The lessons learned in this large defense project were many and include, but are not limited to, the following:

- Many technologies do not get adopted because of the wrong reasons. Inertia, politics, personalities, and the resistance to trying something new often get in the way.
- Even when the benefits are large, getting an organization to adopt a new technology is a difficult undertaking. An approach is to make the rewards (financial, personal, competitive, or other) associated with technology use large enough to stimulate risk-taking. Planning for the application of change-management practices, tailored to the project phase, can help alleviate adoption problems.
- A good way to represent technology maturity is by determining its TRL. Any of the many TRL models in use today can be employed to handle this task. My advice is to use the one your customer employs to ease any communications gap.
- Recognize that military managers are much more conservative in their decisions than commercial managers. The military emphasizes the use of proven technology for a reason. Lives and livelihoods are at stake if the technology is immature and fails in the field.

- Use actual results whenever possible to gain momentum to get a technology adopted for widespread use. Such results should be generated on representative projects operating in as realistic an environment as possible to be deemed creditable.
- Do not forget that you need to expend the effort to make a product of the technology for adoption by prospective customers. This involves building the tools to make the technology easy to understand and use, especially when the innovation is mathematically based.
- As you commercialize a technology, you need to create the support base (manuals, training, user support, help desks, websites, and other items) required to sustain the technology in the field.
- Partnering with potential users is a good approach, especially when it requires all parties to make commitments. Both cash and noncash (in-kind investments of equipment, facilities, or people) contributions can be counted when tallying the sums.
- When people get backed into corners, they react in irrational ways. In our case, the people involved dug in their heels and held fast to their positions. Instead, some form of mediation should have been used as the briefing was crafted to try getting all parties involved to agree to a compromise.

Summary

This chapter provides you with insights into how to assess a technology's level of maturity using Technology Readiness Levels and how to engage prospective partners in commercialization activities. The major issue in technology use is always its ability to stand up to operational and environmental constraints. That is why most technology transfer experts[5] recommend conducting trials with the technology in as representative an environment as possible prior to attempting a widespread transition and operational use. This chapter emphasized risk-taking with technology when the benefits are large enough to justify it. For example, your firm might take larger risks with technology if you are lagging the industry and need to make a large jump to stay alive.

References

References cited within this chapter include the following:

[1] Constantinos Daskalakis, Rafael Frongillo, Christos H. Papadimitriou, George Pierrakos, and Gregory Valiant, "On Learning Algorithms for Nash Equilibria." See the following paper: *http://www.cs.berkeley.edu/~georgios/papers/learning.pdf*.

[2] Mike Cohn, *Succeeding with Agile: Software Development Using Scrum* (Addison-Wesley, 2009).

[3] National Science Foundation, outline of a commercialization plan, see *http://www.nsf.gov/eng/iip/sbir/commplan06.htm*.

[4] Department of Defense, *Technology Readiness Assessment (TRA) Deskbook*. See *http://www.dod.gov/ddre/doc/DoD_TRA_July_2009_Read_Version.pdf*.

[5] Phyllis L. Speser, *The Art and Science of Technology Transfer* (John Wiley & Sons, 2006).

Web resources

Applicable web resources that amplify points in this chapter can be found here:

- The site that I believe covers Technology Readiness Levels (TRLs) best is Wikipedia. It identifies all of the models used and describes them well at the following site: *http://en.wikipedia.org/wiki/Technology_readiness_level*.
- The National Technology Transfer Center mission is to commercialize technologies developed by the government. More information on the resource and how it accomplishes its job can be found at *http://www.nttc.edu*.
- The Federal Laboratory Consortium for Technology Transfer maintains links to all sorts of resources on the topic of technology transfer at *http://www.federallabs.org/resources*.
- An interesting site in Canada looks at licensing technology across the university, government, and industry: *http://lesusacanada.org/MainNav/Member-Groups/Sectors/Industry-Government-Interface.aspx*.
- A government site that stresses the use of partnerships in technology transfer can be found at *http://www.ornl.gov/adm/partnerships*. Although the site is not software-oriented, it still can stimulate ideas on how to get commitment from others.
- The Association of University Technology Managers maintains an interesting site with resources, publications, blogs, and e-groups at *http://www.autm.net/Home.htm*.
- The University of Michigan provides resources for start-up ventures and entrepreneurs at the following site: *http://www.techtransfer.umich.edu/resources/venturecenter/index.php*.
- The Technology Transfer Society hosts an annual conference on the topic. Information on the 2011 conference can be found at *http://www.t2s-augsburg.com/*.
- A useful monthly newsletter on technology transfer topics is published by the Tech Transfer University at *http://www.technologytransfertactics.com*.