TELECOMMUNICATIONS NETWORK EVOLUTION DECISIONS: USING CRYSTAL BALL® AND OPTQUEST® FOR REAL OPTIONS VALUATION

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ABSTRACT

By viewing investments in telecommunications networks as options to provide services in the future, Sprint and Nortel Networks managers make network evolution decisions with the help of a real options valuation tool that uses methods similar to those used for valuing financial options. Employing a combination of decision analysis, Monte Carlo simulation, and stochastic optimization with tabu search, the real option valuation tool helps to support network investment decisions in the telecommunications industry using Crystal Ball and OptQuest.

1 INTRODUCTION

Managerial flexibility has value. The ability of their managers to make smart decisions in the face of volatile market and technological conditions is essential for Sprint and Nortel Networks in the highly competitive telecommunications industry. Although computer models will never completely replace human judgment in decision making, the modeling process does enable managers to investigate many different possibilities, hone their intuition, and use state-of-the-art tools that are extremely beneficial for managing in dynamic environments. The real options valuation (ROV) tool developed at Sprint and Nortel Networks easily handles a myriad of driver variables of concern to telecom managers and is readily updatable to reflect changes in these drivers over time.

Traditional net present value (NPV) is the standard criterion used for evaluation of investment projects. Under the traditional NPV criterion, single-point estimates of the future cash inflows and outflows from a project are deflated to present value by using a discount rate adjusted for the project's risk. The discounted cash flows are then summed to obtain the NPV of the project. If this value is positive, the NPV criterion indicates that the project should be undertaken to increase shareholder value. However, the assumption that all investments are irreversible is a fundamental weakness of the traditional NPV method. Usually, managers have the ability to influence the results of a project as it progresses, abandon a project when results are poor, and expand projects when results are good. This managerial flexibility is not valued appropriately with the traditional NPV method.

Option pricing theory supplements the traditional NPV method by considering managerial flexibility as the ownership of real options. Managerial options to take actions that affect real investment projects are analogous to financial options. A financial option is the right, but not the obligation, to purchase or sell another financial asset within a specified time for a specified price. Just as a financial option derives its value from the volatility of the price movements of the underlying financial asset, a real option derives its value from the volatilities of the variables driving the value of the investment project.

The Sprint-Nortel Networks ROV tool enables managers to model investment-project drivers as stochastic processes parameterized by estimates obtained from historical data collected routinely by the firms, or by estimates made by subject matter experts within the companies who are familiar with the underlying uncertainties. By considering the volatility of inputs such as network traffic, demand, cost, efficiency, and government regulation, the ROV tool enables Sprint and Nortel Networks managers to evaluate real options systematically with an approach that is common within each organization.

In one application, the ROV tool was used to investigate the deployment of next-generation, voice-over-packet technology for three types of network traffic, an interconnection architecture, and a packet protocol in order to provide interactive media service bundles. For a model comprising 14 decisions and 21 stochastic driver variables in business cases developed by Sprint and Nortel Networks, the ROV tool identified a deployment strategy that yields an $13.87 million improvement in NPV compared to the traditional base-case value. This amount is the value of the deferral option available to Sprint in this situation.

2 ROV TOOL DESCRIPTION

The ROV tool consists of a Microsoft® Excel worksheet that is added to net present value models now used by Sprint and Nortel Networks for business case analyses. The additional worksheet contains:

1. Decision variables, which capture the managerial flexibility present in the options under consideration, for example timing of investments, number of each type of network component to put in place, or location of new components;
2. Stochastic assumptions, which represent the uncertainties faced by Sprint or Nortel Networks when planning for future expansion of the network; and
3. Random outputs, which typically are net present value calculations, but can be any other calculation of interest to management.

The tool uses the Excel add-ins Crystal Ball and OptQuest to generate the stochastic inputs and analyze the random outputs. Crystal Ball performs risk analysis by using the stochastic assumptions and Monte Carlo simulation to create the random outputs. OptQuest searches efficiently through a large number of possible choices for the decision variables to find a combination of values that yields the best output. In this application, the decision variable values represent the network evolution options of interest to Sprint and Nortel Networks managers.

2.1 Inputs

The inputs to the model are:

- Network traffic or demand forecasts;
- Revenue estimates and their relationship to network traffic; and
- Cost estimates and their relationship to components installed on the network.

Previously, network traffic forecasts were provided by Sprint analysts or from Nortel Networks marketing research as point estimates of future demand. In this application, stochastic models based upon historical data and expert input from Sprint and Nortel Networks analysts are used to represent the uncertainty associated with future network traffic. The revenue and cost estimates and their relationships to network traffic and components are contained in spreadsheet models constructed originally for deterministic business case analyses.

2.2 Outputs

The primary output desired by Sprint and Nortel Networks decision makers is a set of options that adds the most value to the firm, given the forecasted traffic. The ROV tool helps to identify the optimal set of decisions by comparing expected net present values. In this paper, we assume that optimality is defined by maximizing expected net present value, but the tool retains the flexibility to maximize or minimize other output measures if they are deemed more appropriate. For example, if Sprint or Nortel Networks wishes to choose the set of options that maximizes internal rate of return (IRR), or minimizes the Value at Risk (VaR), the tool can easily be adapted to these new objectives.

2.3 Reusability

A major advantage of using an Excel add-in to construct the tool is that it can be applied to a large number of existing spreadsheet models. These existing models serve as "calculation engines" that are used by Crystal Ball to transform the stochastic inputs into random outputs for specified values of the decision variables. OptQuest uses many runs of Crystal Ball with different sets of decision variable values to help select a set of values that yield the maximum or near-maximum expected net present value. A set of decision variable values that gives the maximum net present value is called an optimal solution.

An analyst comfortable with the ROV tool can use it with existing spreadsheet models without having to understand all of the minute details of the calculation engine. This makes the tool highly reusable, as it only requires the analyst to be able to link the top-level worksheet to the calculation engine in existing spreadsheets as depicted in Figure 1.

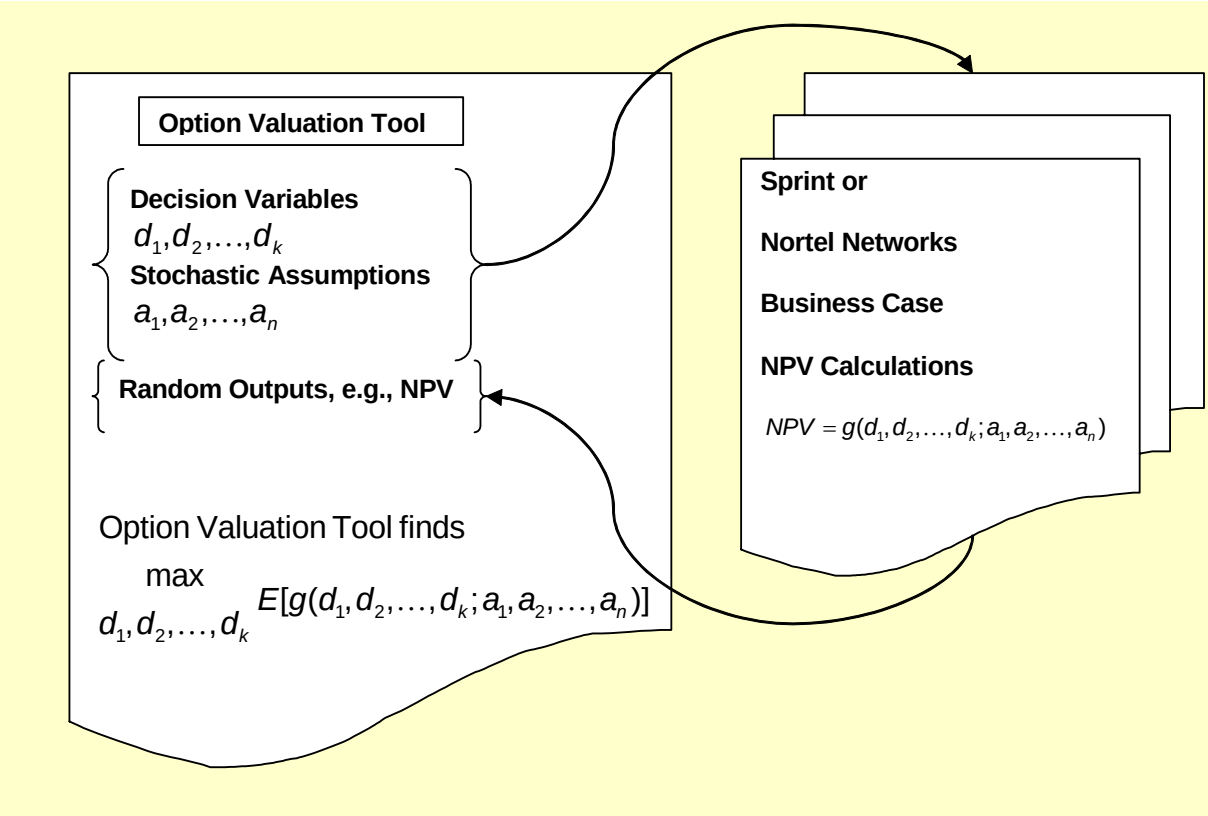

Figure 1: Schematic depiction of Sprint-Nortel Networks option valuation tool. The tool consists of an Excel worksheet containing decision variables, stochastic assumptions, and random outputs (forecasts) that are linked to existing, deterministic business case analyses. Then Crystal Ball and OptQuest are used to find an optimal solution.

2.4 Protection of Proprietary Information

Some high-level knowledge of the business case represented by the calculation engine is required to make the link to the top-level worksheet. However, the options analysis can be performed independently of the analysis leading to the construction of the calculation engine. This feature allows the tool to be used with any existing or future financial worksheets at Sprint or Nortel Networks. Further, the tool is such that Sprint and Nortel Networks need not share all of the details of their business case assumptions with each other. This feature allows both organizations to use the tool to their own and mutual benefit while maintaining the desired protection level of the proprietary information of each organization. For example, cells and worksheets in a Nortel Networks business case can be protected to avoid disclosure of proprietary information while the rest of a Nortel spreadsheet is used by Sprint for its purposes.

2.5 Scalability

Because the tool is independent of the calculation engine, it is scalable to any size desired by Sprint or Nortel Networks. The only limits on the size of the model are those imposed by Microsoft Excel. Crystal Ball and OptQuest can handle a virtually unlimited number of decision variables.

2.6 Necessary Data

Options derive their value from uncertainty. Given the business case financial calculations, the network traffic forecast model is likely to be the most important input to the tool, because of the great amount of uncertainty surrounding traffic forecasts. Thus, great care should be used to select the network traffic forecasting model. Experience shows that when available, historical data should be used to select and help parameterize the model initially. In situations where historical data are not available, e.g., for new products and services, subjective estimates and sensitivity analysis should be used.

2.7 Potential Uses

The ROV tool can be used at various phases throughout the product development process as depicted in Figure 2, which is intended to represent a generic decision problem in telecommunications network management. During Phase 1 two technologies under consideration are evaluated along with the markets for the services provided and the network service delivery and assurance costs. The width of the boxes representing the technologies, markets, and costs are widest here because the least information is known at this earliest phase. The ROV model helps to quantify the uncertainties and measure their impact on expected net present value. At Gate 1, decisions about which technologies to install are made, and some of the uncertainty is resolved as decision makers learn more about the project in part through developing and parameterizing the ROV model.

During Phase 2, the reduced uncertainty regarding the technology is depicted by the "Tech" bars having smaller widths and thus moving down in the tornado graph. At this phase, most of the uncertainty is in regard to markets and operating costs. Decisions regarding the design of the network architecture are made at Gate 2. Matching network scalability to market opportunity is critical at this stage

Because the technology and architecture have already been chosen at Phase 3, the greatest uncertainties surround the markets for the services during this phase. Market uncertainty is represented in the traffic forecast models employed in the ROV tool. Some uncertainty remains in regard to costs and supporting technology, but in this example, the ROV model is most useful for evaluating the options available for deployment.

At Gate 3, the deployment decisions are made. By linking the ROV model to network traffic or demand forecasts, and taking into account technology, architecture, operating costs, and regulatory environment variables, decision makers gain an understanding of the impacts of these variables on their decisions. The ROV tool provides confidence bounds on its estimates, enables sensitivity analysis of its inputs, and leads to sound business decisions based upon expected net present value.

The ROV tool is an extension of the business-case spreadsheet models developed previously at Sprint and Nortel Networks. Thus it can be used for strategic planning, comparing products offered by different vendors, or estimating return on capital invested with existing financial models. Further, by adapting models to changing business conditions or decisions that have been made, it helps to facilitate corporate memory and fosters consistency in decision making over time. With endorsement and commitment from top management, its use adds value to existing decision-making processes, encourages the establishment and monitoring of milestones for evaluating options resulting from managerial flexibility, and provides an ongoing framework within which learning from past successful and unsuccessful projects can be used to improve future decisions.

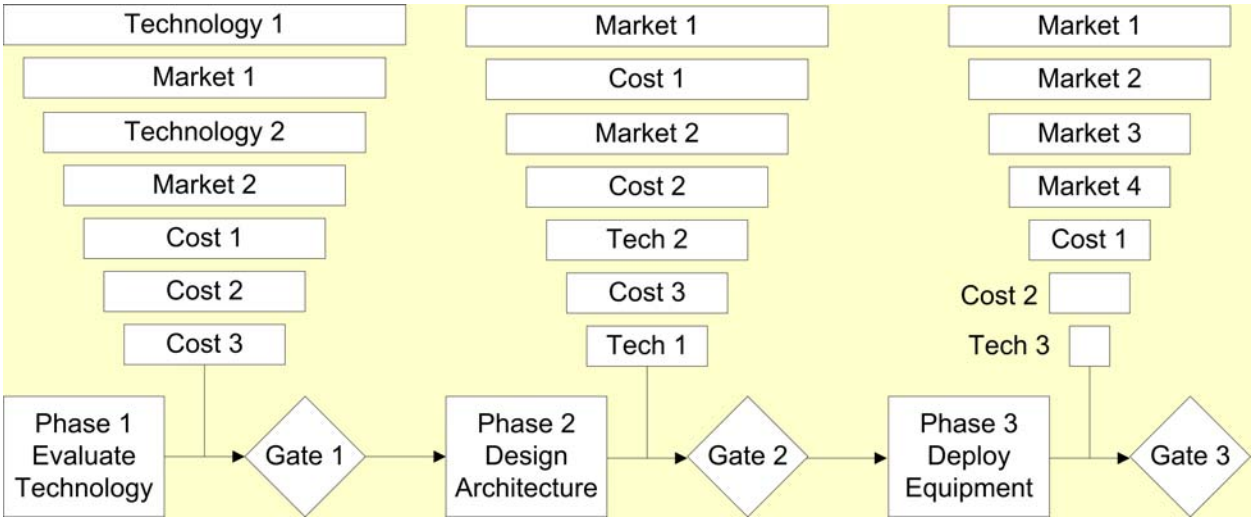

Figure 2: Representation of the various phases of a generic decision problem in telecommunications network management. The real options valuation tool is used at each decision phase to quantify uncertainties, and measure their impact on expected net present value. By adapting models to changing business conditions or decisions that have been made, the ROV tool helps to facilitate corporate memory and fosters consistency in decision making over time.

3 COMPARISON TO REAL OPTIONS ANALYSIS TOOLKIT

The ROV tool described in this paper approaches the valuation of real options from a different perspective than does Decisioneering's Real Options Analysis Toolkit (ROAT). The ROV tool developed for Sprint and Nortel Networks uses simulation of the underlying observable variables with Crystal Ball and evaluation of the decision alternatives using OptQuest. ROAT uses recombining binomial or trinomial lattices that are based on the volatility and the number of discretization steps specified by the analyst for the stochastic process assumed to be generating the value of the underlying real assets. ROAT is an appealing tool to those analysts trained in finance who are comfortable obtaining approximate solutions to the Black-Scholes options pricing formula using lattice representations.

4 CONCLUSION

This paper describes an approach to the valuation of managerial flexibility that is itself highly flexible in its ability to support managerial decisions in a wide variety of situations involving real options. The greatest benefits from using the ROV tool come to users when the tool is adopted for making decisions on a companywide basis. Using the structured approach of the ROV tool for decision making helps to ensure consistency in decision making and to facilitate corporate memory and learning.

The ROV tool can be used for strategic planning, comparing products offered by different vendors, or supplement the use of existing financial models for estimating return on invested capital. With endorsement and commitment from top management, its use adds tremendous value to existing decision-making processes and provides an ongoing framework that can be used to improve future decisions.

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