CASE STUDY: SIMULATION OF THE CALL CENTER ENVIRONMENT FOR COMPARING COMPETING CALL ROUTING TECHNOLOGIES FOR BUSINESS CASE ROI PROJECTION

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ABSTRACT

This paper describes how simulation was used for business case benefits and return on investment (ROI) projection for the procurement and rollout of a new call routing technology to 25 call centers. With investment costs of about 17 million dollars and annual operating costs of about 8 million for the new technology, we needed to determine if the technology would provide enough cost savings and cost avoidance (through reduced trunk costs, increased agent productivity, and ability to service more calls) to warrant its nationwide implementation.

We constructed a model of the existing call center environment consisting of 25 call centers where calls were distributed to the sites based on a system of percentage allocation routing; for example, the telephone network provider directs calls to each site based on the number of agents scheduled. We then modeled the same call system dynamics and intricacies under the new call routing system where calls are distributed based on longest available agent. Subsequently, we conducted average day simulations with light and heavy volumes and other "what if" laboratory analyses and experiments to facilitate planning decisions required to be documented and substantiated in the business case.

1 INTRODUCTION

What is a business case? What are the major principles and purpose of doing an ROI analysis? What are the problems of doing an ROI analysis?

A business case is a proposal for an investment initiative to satisfy business and functional requirements. It is also a management decision tool that supports the following three primary objectives:

1) Justify the investment to decision makers,

2) Establish the baseline to monitor, measure, and evaluate the investment, and

3) Provide a justification to oversight for funding the investment throughout its life cycle.

The business case justifies the initiative by demonstrating how the investment satisfies guidelines established by the Office of Management and Budget (OMB), Department of Treasury, recent legislative acts, as well as guidance from the General Accounting Office. This justification requires linking the investment to a strategic plan; analyzing the process costs, and conducting analyses in the areas of costs, benefits, and risk.

The business case assesses the current processes and documents how the work is being accomplished today. It explains what the proposed capital asset would improve and how the asset would accomplish the improvement in terms of performance metrics. This documentation creates a baseline with which to evaluate the investment.

One of the OBM guidelines requires that the investment demonstrate a positive ROI. ROI is defined as

$$ROI = Benefits \div Investment, \text{ or}$$

the present value (PV) of the benefits divided by the PV of the investment. ROI is the ratio between the benefits and the investment that indicates the return on each dollar invested. For example, an ROI of 3.1 translates as getting $3.10 in return for every dollar invested in the initiative. Business cases recognize and address the following types of benefits:

1) The new system realizes savings in the recurring cost to operate and maintain it as compared to the existing system.

2) The new system allows users to accomplish a given amount of work at a lower cost than when using the current system.

3) The new system increases the amount of revenue that the organization can attain.

Although the terminology is straightforward, the difficulty in computing ROI is determining what constitutes the *total benefits (savings)* and what constitutes *total investment*, and then accurately quantifying those measures.

The nature of our problem

Our specific task was to develop a business case with an ROI projection for the procurement and rollout of a new call routing sytem to 25 call centers. The organization had been using the telephone network provider (e.g., AT&T) to route incoming calls to 25 call centers based on site-specific, predefined percentages, derived by the Customer Service organization, and based on the number of agents scheduled to answer incoming calls at each site. The new technology being considered was the GeoTel Intelligent Call Router (ICR)™.

Under the ICR™, hardware and software is installed at each call center that communicates with a central router system. The router continually receives, from the call centers, real-time status updates such as the number of agents currently available to handle the calls, the number of calls currently in queue at each site, and average wait time. When the telephone network provider receives an incoming call from a customer, the network provider queries the router on where (e.g., to what call center) to send the call. The router responds to the network provider on where to send the call based on call scripting and the current status information from the call sites.

Fees are assessed by the network provider for communicating with the router. The total investment cost for the 25-site installation would be about 17 million dollars and annual operating costs would be about 8 million dollars for the new technology. We needed to determine if the technology would provide enough cost savings and cost avoidance (through reduced trunk costs, increased agent productivity, and ability to service more calls) to warrant its nationwide implementation.

The remainder of this paper is as follows:

- Section 2 describes a prototype evaluation of the new technology and the problems experienced when trying to use the prototype results for the business case ROI analysis.

- Section 3 provides a description of the simulation approach and implemenation as well as the advantages of using simulation for ROI analysis.

- Section 4 briefly summarizes the results of the simulation.

- Section 5 provides conclusions.

2 CALL ROUTING PROTOTYPE RESULTS: WHY WE DID NOT USE THEM

Since the new call routing technology was such a large investment, it was decided to install and test an ICR prototype on a limited, trial basis to test its call routing technology as an alternative to the current system of percent allocation routing. The prototype was well conceived—sites receiving calls under the existing system were identified for a baseline comparison to nine sites selected to receive calls routed under the ICR system. We would collect data and evaluate performance measures comparing the ICR sites to the baseline sites. We intended to use the results of the prototype for the business case in order to calculate cost savings and cost avoidance for the new investment. However, several factors had an impact on the comparative analysis of the two competing routing methodologies and made the prototype results unusable for the business case:

- The prototype operated with low call volumes (about 15 percent of the normal call volume) during a nonpeak calling period. As a result, it would have been impossible to extrapolate what would happen during a full-scale implementation of the ICR during peak calling periods.

- At least during the period that the prototype was being tested, it was determined that unique implementations of management practices at the different call centers were having a significant impact on productivity and thus skewing the results of the comparison between ICR and percentage allocation routing.

- During the period of prototype testing, major script changes were being evaluated. For example, changing the routing algorithm from "most available agents" to "longest available agent." Major script changes would, to some extent, render previous prototype results obsolete.

The following graphs illustrate how management practices at the different call centers impacted the results of the comparison between the two competing routing technologies. The figures show performance measures for the three lines of business (i.e., product lines X, Y, and Z) that were included in the prototype. Overall, the baseline sites receiving calls under percent allocation outperformed the sites receiving calls under ICR (Figure 1). Further analysis showed that the baseline sites outperformed the ICR prototype sites *when all sites received calls by percent allocation* (Figure 2). When evaluated against themselves (as opposed to being compared to other sites), sites consistently performed better when using ICR than when using percent allocation (Figure 3).

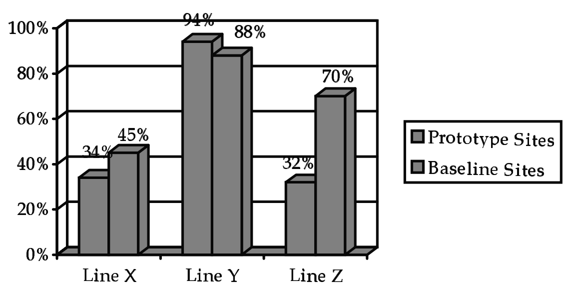

Figure 1: Service Level Comparison: Prototype Sites Using ICR vs. Baseline Sites Using Percent Allocation

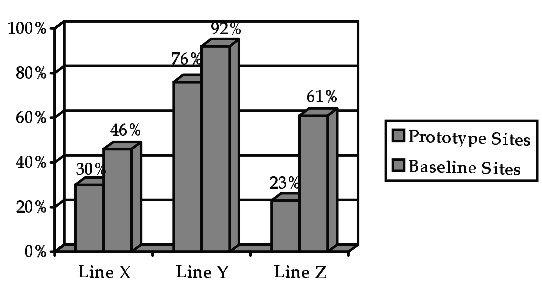

Figure 2: Service Level Comparison: Prototype Sites Using Percent Allocation vs. Baseline Sites Using Percent Allocation

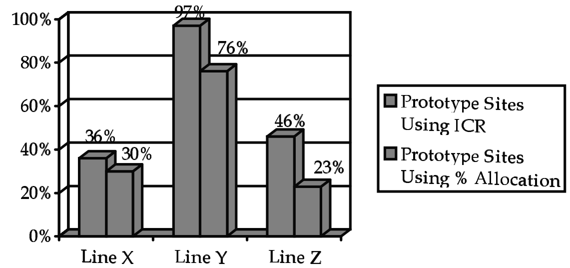

Figure 3: Service Level Comparison: Prototype Sites Using ICR vs. Prototype Sites Using Percent Allocation

Given the results of the prototype, it was decided to use modeling and simulation to provide a means to perform a comparative analysis of the two competing routing methodologies without the noncontrolling variables (i.e., management practices, agent skills) that would skew the results.

3 MODELING AND SIMULATION

3.1 Advantages

We decided on a modeling and simulation approach because of the advantages that the technology offered:

- Simulation provides a controlled environment for evaluating performance. For example, when we run two simulations, one for percent allocation and one for ICR, we can create equal conditions for each simulation run: the same volume of calls, same call arrival pattern, same number of agents to handle calls, same average handle time, etc. In addition, factors such as site outages, hardware failures, or trunk failure, which influence performance in real life can be controlled or eliminated with modeling.

- Changes can be made easily to the model to reflect ICR script changes and results evaluated quickly.

- It is cost effective to model the entire Customer Service call center environment. Due to cost considerations as well as risk factors, the prototype was only fielded at nine sites and only applied to one product line at each site.

- Extrapolation is supportable because of the ability to simulate light and heavy volume days by changing a minimal number of model inputs.

- Simulation and modeling provides an easy way to control other influencing factors to conduct sensitivity analysis. Consider these example questions. What happens when call volume is higher than expected? What happens when agent adherence to schedule is worse than expected? What happens when the percentage of calls handled entirely by automation increases? Each question can be analyzed by modifying inputs to the model and running a simulation.

3.2 Approach

One of the first steps in building the model was to decide which tools we would use to support its development and implementation. We narrowed our options to two products, Arena® Call Center—a discrete event simulation tool—and the GeoTel ICR Lab System—a real-time emulator—and then performed a detailed product comparison. At the end of the evaluation, Arena Call Center was selected as the tool to support our model. Arena Call Center is a Pentium-based simulation tool with built-in software constructs for modeling call centers and reporting features tailored for measuring the effectiveness of modeled call centers. Arena Call Center can be used in conjunction with standard Arena constructs (a widely-used, general purpose simulation tool) to generate models of specific call center architectures. The obvious advantage to using Arena Call Center is that it reduces development time for the model because the developer does not have to write scripts for many functions that are common to any call center model, such as generating incoming calls and seizing trunks.

Because Arena Call Center uses discrete event simulation techniques, a large number of simulations can be performed at the busy hour, busy day, and even seasonal level at faster than real-time. This capability was a primary consideration in our selection because of our need to obtain results that could be annualized for ROI analysis.

3.2.1 Defining Modeling and Simulation Objectives

A concurrent task that influenced our tool selection, was defining what we needed and expected to get as part of our results. We identified the following simulation objectives:

- Provide a cost comparison of two competing technologies.

- Provide objective measures of call routing performance that could be represented in terms of cost.

- Provide results that could be annualized for ROI analysis.

These three objectives drove many of the subsequent decisions that would affect the modeling effort.

Under the prototype, Customer Service identified six performance measures that would be the basis for comparing the prototype sites receiving calls under ICR, and baseline sites receiving calls under percent allocation. Those performance measures are listed in the first column of Figure 4. By nature, these performance measures are indicators of service qualitity and efficiency. In our model, we mapped the performance indicators to cost factors that could be used in an ROI analysis (Figure 4). We subsequently developed the formula for operational cost on a per-call basis (Figure 5).

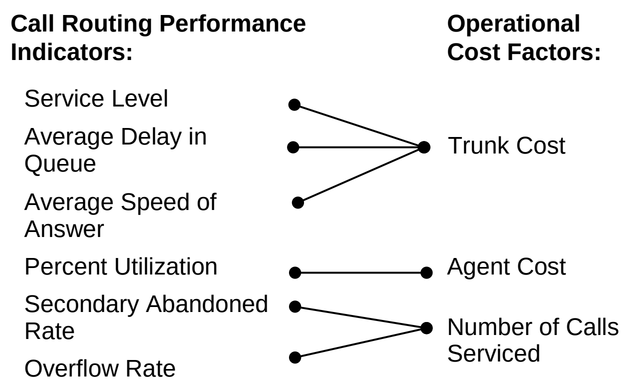

Figure 4: Mapping of Call Routing Performance Indicators to Cost Factors

$$\text{Operational Cost} = \frac{\text{Trunk Cost} + \text{Busy Agent Cost}}{\text{Calls Serviced}}$$

Figure 5: Operational Trunk and Agent Cost

One of the appealing features about the Arena Call Center tool, was that it produced agent cost as “scheduled agent cost” and “busy agent cost” where busy agent cost reflected the time that the agents actually spent on the phones, thus eliminating idle time. This was significant to us because in our environment, agents had other tasks (such as processing mail) to occupy their idle time and the busy agent measure provided a means to separate call processing activity with other duties.

3.2.2 Basic Simulation Process

Building a model entails developing flowchart-style scripts that depict the current and proposed call routing process. The process is illustrated at a high level in Figure 6. The model generates streams of arriving calls that are held by the network provider. The network provider routes the calls to one of 25 call centers according to the designated routing process. When at the call center, calls are assigned to trunk lines and routed through the center to agents who will eventually service the calls.

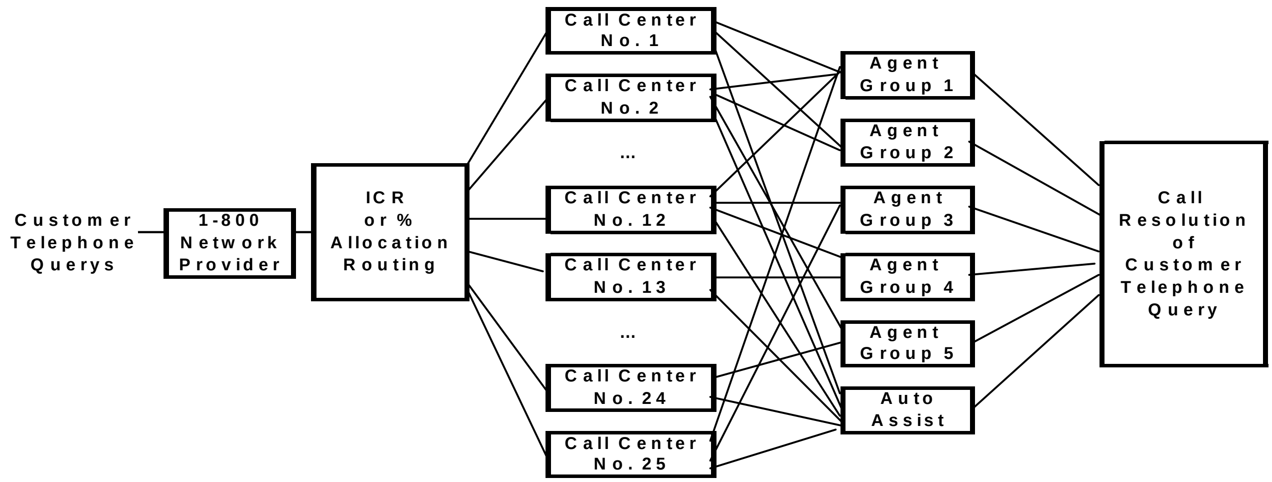

Figure 6: Basic Simulation Process

Two routing processes are modeled: (1) the network provider (e.g., AT&T) routing incoming calls to 25 call centers based on predefined percentages derived by the Customer Service organization based on the number of scheduled agents at a site, and (2) the network provider routing incoming calls by querying the GeoTel ICR on where to send the calls. The ICR receives real-time updates from the call centers on their current status and decides where to send each call based on call scripting. In our case, the scripts used longest-available agent to determine where to send the call.

There are other complicating factors that are built into the model. Calls can be blocked either at the site or network level if all trunks are busy, or if limits are exceeded based on the ratio of calls in progress to the number of agents available. When calls are routed to a site, they all go through automated call scripting to determine the type of call. Once the call type is determined, it can be processed by an automated application (without manual intervention), or it can be routed to agents belonging to skill groups who are trained to handle the call type. Because scripting can take more than one minute, calls undergo a postroute evaluation prior to being queued to an agent to determine if the call could be answered more quickly (because agents are available within a particular skill group) if sent to another call site.

We can effectively adjust the number of scheduled agents in the model by entering a shrinkage factor (determined from historical data analysis) that would manipulate the number of agents assumed to be actually available. The shrinkage factor is a trianular distribution that is illustrated in Figure 7. A distribution of 0.7 to 1.0 with a mode of 0.8 would mean that if 100 agents are scheduled at a site, any number between 70 and 100 are available to work phones, more randomly toward 80. This feature in the model turned out to be of key importance because performance measures comparing the two routing methodologies were largely driven by what shrinkage factor we used. ICR did not pay for itself when we modeled a call center enterprise with near-perfect adherence to schedule.

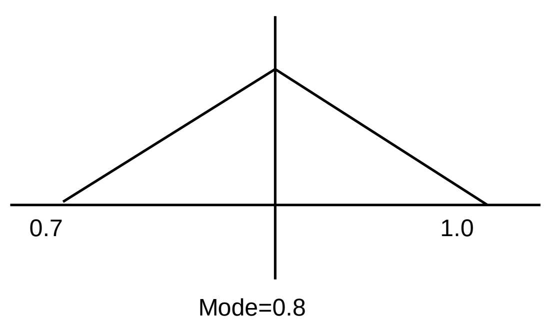

Figure 7: Triangular Distribution for Modeling Shrinkage

3.2.3 Determining Simulation Intervals to Support ROI Analysis

We needed to make a key decision on the simulation time intervals that would be used to extrapolate benefits over a ten-year period for the ROI projection. Did we want to conduct simulations and analyze results on an hourly, daily, or weekly basis? Anything longer than a week was quickly ruled out, because even with discreet event simulation, entering and running a week's worth of data, would be time-consuming and cumbersome.

Over the course of a year, there are times that we could anticipate high- and low-call volumes that varied significantly. In order to determine the call volumes that we would use for simulations, we conducted an analysis of the call traffic volumes for three product lines. We ultimately used monthly traffic volumes as a basis of developing average-day categories and developed a math sequence for converting average day results to annualized totals. The math sequence is depicted in Table 1.

number of trunks at each call center and the percentage of calls handled through automation.

We needed to execute the model eight times to obtain a full set of results needed for ROI computation:

- Once per average-day category for all four categories with ICR as the routing methodology
- Once per average-day category for all four categories with percent allocation as the routing methodology.

The simulation run time initially ranged between 6 minutes for category 1 and 55 minutes for category 4.

As we analyzed the simulation results, we checked for reasonableness of results within each category by comparing model results (i.e., number of abandoned calls, percentage of calls blocked, number of calls postrouted) with actual historical data for consistency.

Table 1: Traffic Analysis Across All Product Lines

Basis	**Category 1**					**Category 2**		**Category 3**		**Category 4**			**Year**
	Aug	Sep	Oct	Nov	Dec	Jan	Jul	May	Jun	Feb	Mar	Apr	**Total**
Monthly													
Calls/Month (Millions)	3.3	3.1	2.1	2.6	2.6	5.0	4.9	7.2	8.4	11.5	12.2	12.9	**75.9**
Workdays/Month	31	30	31	30	31	31	31	31	30	28	31	30	**365**
Calls/Avg Day (K)	107	103.8	67.5	88.0	84.4	160.5	158.9	233.1	281.2	411.2	393.5	429.9	**208.1**
Category													
Calls/Category (Millions)					13.8		9.9		15.7			36.6	**75.9**
Workdays/Category					153		62		61			89	**365**
Calls/Avg Day (K)					90.1		159.7		256.8			411.3	**208.1**

3.2.4 Running the Model Simulation and Analyzing Results

Once we decided on average day categories to be used for the simulation (Table 1), we specified and collected data for each simulation category. Because we knew the type of information that the model required, the data collection process took place simultaneously with the development of the model. It was interesting to note how many of the historical data elements were subject to significant change over short-time intervals; even data that might be considered fairly static, such as the

We also compared results across categories to make sure that they were reasonable (i.e., the trunk usage time increases with call volume, call blocking increases).

4 CALCULATION OF BENEFITS AND ROI PROJECTION

The modeling and simulation enabled us to estimate and compare operational cost per call under four categories of increasing call volume for each of the two routing technologies. Operational costs were calculated from Arena Call Center output using the formula contained in Figure 5. Once the operational costs were determined on a per-call basis, the costs were annualized by multiplying the operational costs by the number of calls expected per traffic-volume category per year. Initial results for annualized cost savings and avoidance (based on the four traffic categories and number of days per category) are depicted in Figure 8. Overall savings, to offset the investment and operating costs of the new technology were estimated at about 25 million dollars. The operational costs subsequently figured into the Benefits part of the equation for calculating ROI (e.g., ROI = Benefits ÷ Investment). Preliminary results obtained for ROI including sunk costs, largely based on the modeling and simulation effort, were 8.4.

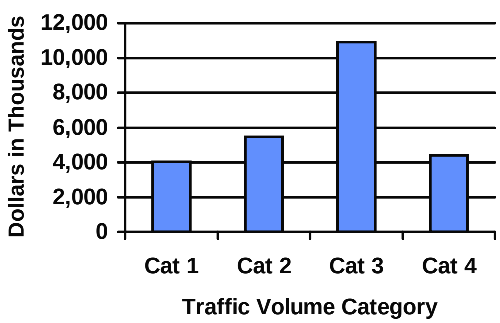

Figure 8: ICR Cost Savings and Avoidance by Traffic Category

5 CONCLUSIONS

The modeling and simulation enabled us to estimate and compare operational cost per call under four categories of increasing call volume for each routing technology. It was interesting to note that the projected savings from using ICR varied significantly depending on call volume. The simulation validated findings that had been observed on a limited basis. As a result, the government agency is now considering alternating between both routing technologies based on projected call volume.

REFERENCES

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AUTHOR BIOGRAPHIES

KATHERINE MILLER is a Senior Computer Scientist at IIT Research Institute. Mrs. Miller has over 17 years experience in the software engineering disciplines, specializing in database application development and software cost analysis. Mrs. Miller is currently supporting the Customer Service organization of a large federal agency implementing intelligent call routing capability and centralized workforce management. Mrs. Miller's engineering support includes modeling and simulation of the agency's call center environment for use in economic analysis and justification of information system investments consistent with today's congressionally mandated use of performance measures and portfolio investment techniques. Mrs. Miller received a B.S. degree in applied mathematics at Indiana University of Pennsylvania in 1982.

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