Proceedings of the 2003 Winter Simulation Conference
S. Chick, P. J. Sánchez, D. Ferrin, and D. J. Morrice, eds.

OPTIMIZATION OF A TELECOMMUNICATIONS BILLING SYSTEM

Mark Schouwenaar

BestSys
59 Currie Street
St. Catharines, Ontario L2M 5M9, CANADA

Eleazer Martin

BestSys
Hasleveien 10
N-0504 Oslo, NORWAY

ABSTRACT

To remain competitive in a turbulent and rapidly evolving market, telecommunication companies have found it necessary to invest large sums of money on the latest technologies and IT infrastructure. These investments have been a serious drain on the financial resources of these companies who are now seeking ways to pare costs and regain their financial footing. This new reality is increasingly forcing companies to focus on improving processes in order to increase profitability. Process simulation is proving to be a useful tool in helping these companies attain higher levels of efficiency in business critical processes by revealing inefficiencies and redesigning processes. This paper seeks to illustrate the method used to obtain substantial savings in the billing system of Telenor (Norway's largest telecom company), through the use of simulation.

1 INTRODUCTION

1.1 Telenor

Telenor, with its headquarters in Oslo, the capital of Norway, is Norway's largest telecommunications company. It has operations within the fixed line, mobile and broadband segments as well as other activities in Norway and abroad. Turnover for the fiscal year 2002 was NOK 48.8 billion or approximately USD 6.7 billion (Telenor 2003).

With its 1.7 million subscriber fixed line market share of around 70% as well as its 15 million subscribers for all services combined, Telenor holds a dominant position in the Norwegian telecommunication market.

1.2 The Project

Telenor's billing system for fixed line subscribers and traffic, KOF (a Norwegian acronym for Customer, Order, Invoice), is comprised of two subsystems:

- KOF1: billing for small business clients
- KOF2: billing for residential customers.

KOF1 has 323,000 customers segmented into 13 monthly Billing Cycles or Bill Cycles (BC) and 9 quarterly ones. Annual operating cost was NOK 62 million. KOF2 has 1.8 million customers spread over 52 quarterly BC's and 19 monthly BC's. KOF2's annual operating cost was NOK 113 million (Telenor 2002).

Those subscribers allocated to the monthly BC's receive monthly invoices; those in the quarterly receive invoices 4 times a year and Urgent Billing Cycles are used for extraordinary invoicing such as termination of subscription.

As will be discussed in greater depth later, the amount of subscribers in each BC is not even and can vary from as low as 2,500 to as high as 45,000.

This paper will describe the use of discrete event simulation in:

1. The identification of key cost drivers
2. Invoice production costing
3. Optimizing invoice production.

2 BACKGROUND

2.1 The Industry and Telenor

The collapse of the dot.com bubble in the US has had ramifications. In its aftermath, many analysts have questioned the wisdom of massive investments by telecommunications companies the world over, especially in the mobile segment. This coupled with the record-breaking losses in large European telecommunication companies like Deutsche Telekom and France Telecom has dried up capital for further investment. Instead the focus is now on the bottom line and in cost cutting measures including manpower reductions.

Towards the end of 2001, Telenor initiated an extensive, comprehensive long term cost cutting program called Delta 4. To achieve these significant cost reductions Delta 4 has been focusing on improving the efficiency and productivity of existing processes and systems.

Simulation is increasingly demonstrating itself to be a valuable and powerful tool in achieving the necessary levels of efficiency at Telenor.

2.2 Challenges – The Billing System

Telenor's billing system (KOF) is rather complex and expensive to run. It also interfaces with several other subsystems. This inter-dependency and complexity makes it difficult to study and improve the system without the aid of a proven methodology, such as simulation.

The major challenges in analyzing Telenor's billing system are:

1. The study and analysis of each major cost driver
2. Find methods by which to cut costs. Determining which activities are most expensive and/or inefficient and, therefore, offer the greatest potential for improvement.

3 PROJECT OBJECTIVES

The initial project consisted of the following:

1. The breakdown of the total annual operating costs into a set of costs that could be assigned to activities – Activity Based Costing
2. Costing of monthly, quarterly and urgent invoices for both KOF1 and KOF2
3. Identifying problems areas in invoice production such as:
   - Bottlenecks
   - Individual job crashes
   - Re-running of several jobs when the invoicing is not approved.

3.1 Data Gathering and Analysis – Plan

- Map out the KOF system in detail using existing documentation and, if and where necessary, supplement this information with expert opinion. This would provide the blueprint for the model and provide a better understanding of the operations of the KOF system.
- Analyze CPU log data for each computer-based job and BC combination. This would help in obtaining a thorough understanding of how CPU time per job varies with BC size, which jobs are prone to crash, what makes them crash etc.
- The KOF system is highly automated and requires very little manual intervention. Manual intervention is routinely necessary only at the start of invoice production, to approve the BC, and the small proportion of envelops that require manual handling.

3.2 Simulation Modeling

Although much information could be gleaned by thorough and rigorous analysis of the log data, a simulation could provide the following additional benefits:

- The ability to manipulate the entire system to determine which changes will have the greatest impact on the overall cost as well as the overall cycle time.
- The study of the interaction between shared components between the two systems at the print and enveloping process – both systems used a common printing and enveloping process. For example, should an Urgent BC always pre-empt a KOF2 quarterly BC?
- Experimentation in conjunction with the KOF staff to test out strategies before implementing them.

4 EXECUTION OF THE PROJECT

4.1 Data Gathering and Analysis

The first task was to obtain system documentation. As it was fairly well documented this did not pose much of a problem. In addition, KOF staff had detailed knowledge of the system. Figure 1 shows the resulting Visio diagram, which maps out the computer-based and manual jobs, which make up KOF1.

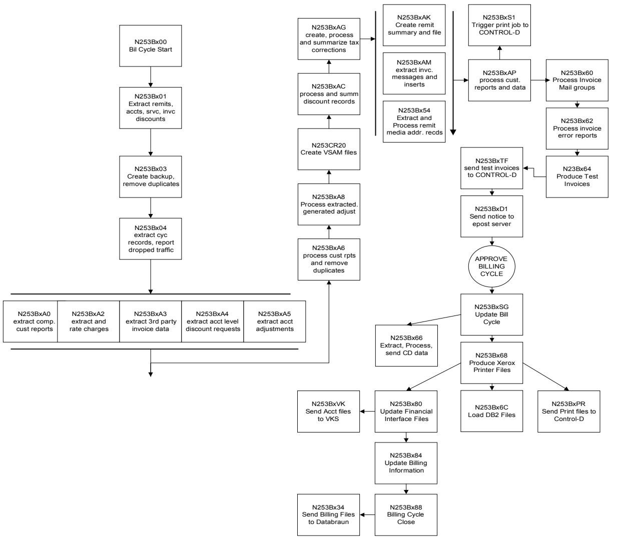

Figure 1: Process Map of KOF1 Job (Print and Enveloping Process Not Included)

A sufficient amount of historical data was extracted from the server logs by Telenor staff. BestSys then extracted only the jobs outlined in the process map above and determined the processing times for each using probability density functions (PDFs). It was determined that only a few key jobs comprised the majority of KOF's CPU processing time, and so only these key jobs had to be studied in any great detail. Figure 2 below shows how seven jobs out of 31 account for 95% of the CPU time for KOF2.

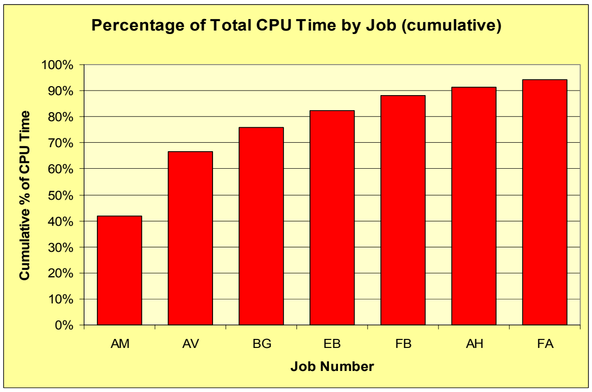

Figure 2: Cumulative Histogram of Percentage of Job Time

Analysis of the log data provided valuable insight into the actual workings of the system as explained below:

- Job crashes: When a job failed when first executed and had to be run one or more additional times before successfully completing. Often job crashes would keep running, incurring cost and causing delays until the crash could be remedied manually.
- Disapproved bill cycles: When the billing process reached a certain manual quality control point, it was sometimes found to be erroneous and was required to be rerun starting at the job which caused the first error. For some billing cycle types this happened up every fourth time.
- Parallel processing: When two ore more BCs were processed at the same job at the same time. This often resulted in inflated times for all the affected BCs, increasing processing costs for each.

4.2 Simulation Modeling

With the data analysis completed, a number of questions arose for which simulation would provide the answers:

- How costly are the anomalies such as job crashes and disapprovals?
- What are the greatest overall contributors to cost?
- How can overall operating cost be reduced?

One of the greatest contributors to the overall cost was a "hidden" financial cost that was caused by the elapsed time or delay in the initiation of the invoicing process. Delays of several days were not uncommon. (Delay is defined as the time elapsed between when a BC is ready and the time invoice production starts. With such a large turnover each day lost incurs significant financial costs as it extends the payment date unnecessarily). This cost was referred to as "liquidity cost" by the KOF staff.

A simulation model based on the aforementioned process model was created using ProModel.

4.2.1 Model Basics

An entity-driven model was built with the billing cycles (BCs) created as the entities and the central CPU as a resource. Thus, the BCs would run through the various jobs, created as locations, requesting the use of the CPU.

The model was so designed to facilitate both parallel and serial processing of BC's, as appropriate.

4.2.2 Additional Functionality

The model was further refined to accommodate job crashes, disapproved BC's etc.

Job crashes were modeled quite simply using a binomial PDF in each job that experienced crashing. If, at the end of a job's execution, the PDF indicated a job crash, the BC would be rerouted back into the failed job's queue.

When a BC was disapproved it was sent back to the in-queue of the job where the problem had occurred and then was made to run through that job and all subsequent jobs once again.

To allow the model to be as versatile as possible, a total of 314 macros (variables that the user could manipulate to run experiments) were defined.

4.2.3 Statistics

To track the model's progress and results, detailed statistics were added, totaling over 900 variables, which could be both, viewed during a simulation run and also collected upon simulation completion. These included:

- CPU processing costs
- Financial cost figures
- Cycle times
- Error percentages
- Counters that track the number of BCs, invoices, etc in real time.

4.3 Experimentation

Experiments were run where the number of job crashes and disapprovals were reduced, to gauge their impact on cycle time and costs. It was found also that financial costs due to liquidity were one of the largest hidden costs in all of KOF. A reduction of the time delay to an average of 2 days reduced financial costs by 76%.

Coupling the potential savings in financial costs with several other successful experimental results, the model demonstrated potential savings of twenty percent of the entire KOF operating cost. This was obtained by:

- Reducing financial costs
- Eliminating errors which result in the BC being disapproved
- Severely curtailing the use of urgent billing cycles since they cost about 10 times more per invoice than other BC's
- Reducing print
- Reducing data storage costs.

5 FOLLOW-UP

Soon after the completion of the original project, BestSys, at the behest of the Client, continued analyzing the data in the hopes of finding further means of cutting costs and providing valuable insight to Telenor.

One interesting find was the relationship between BC size (number of subscribers) and CPU costs incurred. The relationship was non-linear at several key jobs.

5.1 The Hypothesis

Since the above-mentioned relationship was non-linear and in many cases exponential, it was reasonable to believe that an optimal BC size does exist.

A thorough analysis of the relationship for all KOF1 and KOF2 jobs was done, using regression techniques where appropriate.

5.2 The Analysis

The analysis began by extracting a fresh set of data since it had been over six months since the original data had been extracted. After preliminary data analysis was carried out to test for suitability, each KOF job was analyzed by regressing each billing cycle's CPU time against the number of customers in the billing cycle. Since there was a broad range of billing cycle sizes their scatter plots contained very few gaps and demonstrated distinct trends.

The plot in Figure 3 shows the regression line fit to a sample job in KOF 2. It shows clearly that the relationship between BC size and CPU time is non-linear especially after the BC size reaches 22,000. Although there were jobs where there was a linear relationship, jobs where no apparent relationship existed by and large they seemed to follow the pattern in Figure 3.

5.3 Results

As nearly all large jobs showed similar regression lines, the task was completed by experimenting to find the ideal billing cycle size. The regression equations for each job were entered into the model and experiments run at various billing cycle sizes.

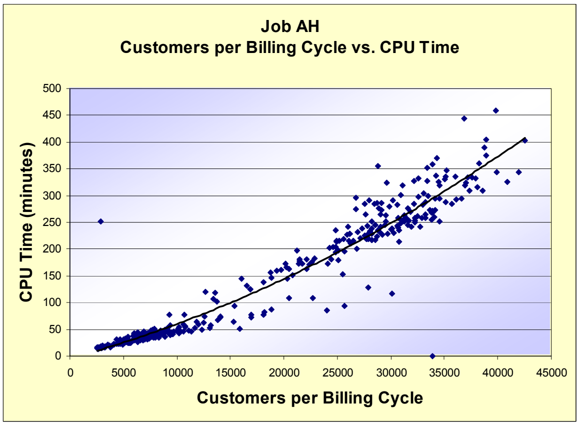

Figure 3: Sample Regression Line

ProModel's automatic analysis tool, SimRunner, was chosen to perform the experiments based on its ability to seek out the absolute ideal solution for a given parameter. The BC size range in this case was bounded at 3,000 and 44,000 invoices per BC due to a lack of empirical data beyond these bounds.

This experiment proved conclusively that an optimal BC size does exist that would minimize total CPU cost for KOF 2. Figure 4 demonstrates the trough found near 22,000 invoices per BC.

With the optimal level found, there was a theoretical savings of 17% of the total CPU processing costs against the baseline figures for KOF 2.

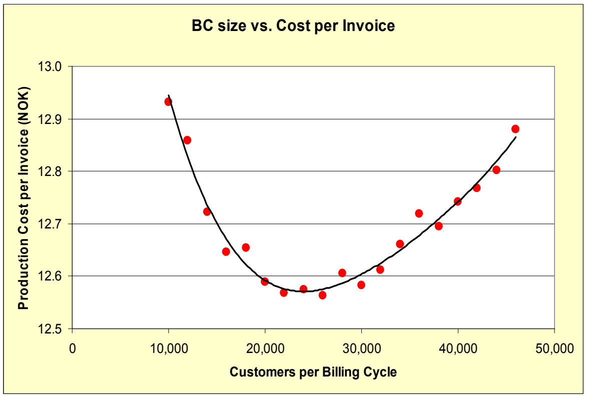

Figure 4: Optimal Billing Cycle Size

6 CONCLUSIONS

Discrete event simulation proved to be useful tool in the analysis of complex, dynamic IT systems. It also resulted in significant cost-savings for the Client and helped the Client mitigate risk by testing the system under various conditions before implementation.

At the time of writing this paper the proposed improvements to KOF are currently being implemented. A preliminary test by Telenor staff has already confirmed savings very close to those predicted by the experiments. The success of this project has resulted in several follow-up projects in Telenor which show equal potential in cost reduction.

REFERENCES

Telenor 2002. Annual Report 2001.
Telenor 2003. Annual Report 2002.

AUTHOR BIOGRAPHIES

MARK SCHOUWENAAR is a consultant with BestSys and a student of mathematics and statistics at the University of London. His work deals primarily with discrete event simulation and statistical analyses therein in the health and telecommunications sectors and has worked on several successful simulation projects with BestSys. He can be contacted by e-mail at <mark.schouwenaar@bestsys.net>.

ELEAZER MARTIN is the CEO of BestSys. He has a Masters in Business and Economics from the Norwegian School of Management and a Masters in Operational Research from Sheffield Hallam University, England. He has several years of experience in the practical applications of Operations Research and simulation. He has also worked for Accenture's (formerly Andersen Consulting) world-wide modeling and simulation group. He can be contacted by e-mail at <eleazer.martin@bestsys.net>.