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System Dynamics in Telecommunications - a Case Study

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Abstract

We have used System Dynamics for a telecom business case. In this paper we briefly describe the case. We discuss our experiences, both as to the results and the process. Some observations of general interest are presented.

Introduction

Telecommunications are developing rapidly. For telecom operators the changes mean a necessity to make decisions on very flimsy grounds, decisions that often involve large sums of money. One change that is of current interest is that of GPRS, General Packet Radio Service, a new high-speed, packet-based transmission technology. GPRS is a fundamental change compared to the way mobile telephony works today. It means among other things that subscribers can have permanent mobile access to their network and always be connected, just like with fixed access today. It also paves the way for IP telephony.

We have as consultants investigated the consequences of GPRS on behalf of a telecom operator, by means of Systems Dynamics. Our process closely followed the one described by Vennix [1]. A group was formed, consisting of Kipling consultants and people from the operator staff. As part of the process an ithink model was built. The visible outcome of the work were the model simulations results together with the findings from the discussions during the construction of the model.

The case

The operator wanted to know how to act on the GPRS change. Specifically, they were concerned with what price alternative to choose, and if and when they would have to add capacity to their network. Both these factors would have an important influence on the company's economic result.

We had access to key persons within the company. However, due to time constraints only a limited number of them could participate in the working group put together. Others were interviewed to gather information. We also had a time limit. The whole process was to be finished within two months.

The process

Since time was limited we chose to start working in the group directly, without any preceding information gathering. The group consisted of about eight persons, but frequently not more than five were present at the same time. We started by selecting the competitive power of the company as the key variable. A loop diagram was then constructed with the group, aiming at identifying all the

relevant variables. This loop diagram was transformed into an ithink computer model. Quantifying the variables took time, and was difficult in many cases. An idea of the complexity of the model can be gained from Fig. 1. There are ten different sectors. Four of them represent different types of customers, three the network with its traffic, one the price and two sectors covered economic aspects. Simulations were performed with the model.

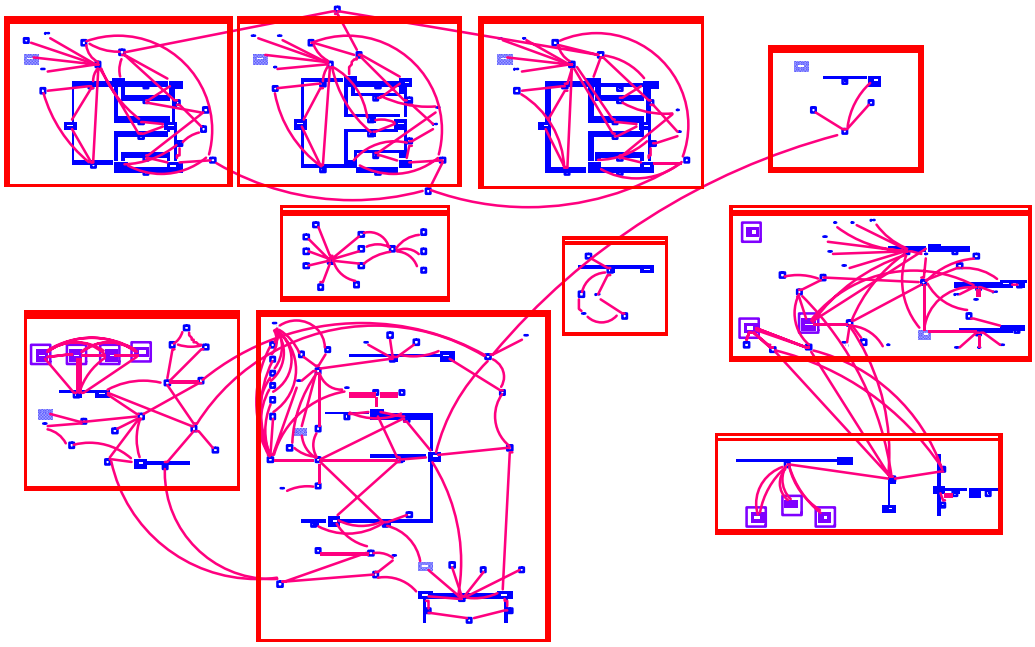

Fig. 1. Overview of the complete model.

Initially, quite a few pricing alternatives were suggested: time on line, pay per content, pay per megabyte, flat rate, quality of service, etc. However, after some discussion the alternatives were limited to two: flat rate and price per megabyte. The other alternatives were discarded either as impossible to use practically or as not businesslike.

In order to predict the outcome of the different alternatives the graphical functions available in ithink were used. An example is shown in Fig. 2. The curve shows the anticipated reduction in traffic volume as a function of price per megabyte. The comparison is made to the situation where the subscriber pays a flat rate only and has the right to unlimited traffic volume. This is the point to the left in the diagram, where the price is zero. The process to find this function in the group was to first determine the general shape of the curve, then to agree on the prices where the volume reduction would be 10, 50 and 90 percent, respectively, and finally to run simulations in order to ascertain a reasonable behaviour.

A similar function was set up to estimate the number of subscribers that would adopt GPRS as a function of a flat rate. Also in this case it was assumed that the price sensitivity would have a shape similar to the one in Fig. 2.

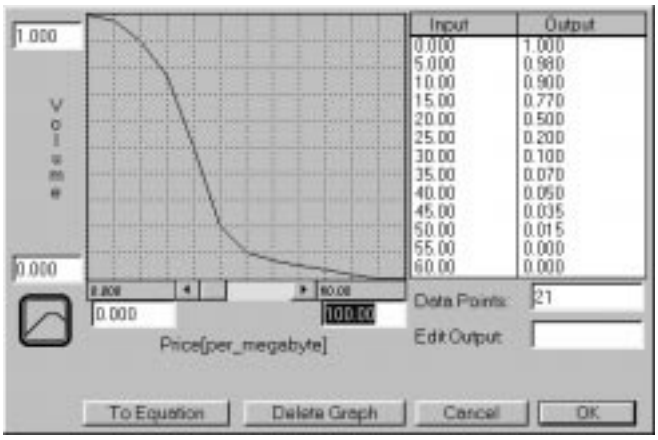

Fig. 2. Estimated reduction in traffic volume as a function of price. The price 0 means that there is a fixed price, no matter the traffic volume. Prices are in arbitrary units.

By running a number of sequential simulations it could be settled that the flat rate was superior to volume pricing. This conclusion was drawn from the simulation outputs in Fig. 3. The diagrams show the cash flow as a function of time. These diagrams were obtained by varying the volume rates with the flat rate at zero and varying the flat rates with the volume rate at zero, respectively, keeping everything else constant. The investments are the same in the two cases and start the year 2000. A heavy investment is started year 2002, continuing until 2006. Superposed on the investments are the revenues from the subscribers. As can be seen, with the "best" flat rate, a positive cash flow is reached around the beginning of year 2004, whereas this does not happen until 2006 if volume rates are applied. With the result of the simulations in hand, the result seemed obvious, as is often the case with System Dynamics. The bitrates available during the first years of GPRS are simply are not sufficient to generate high enough traffic volumes.

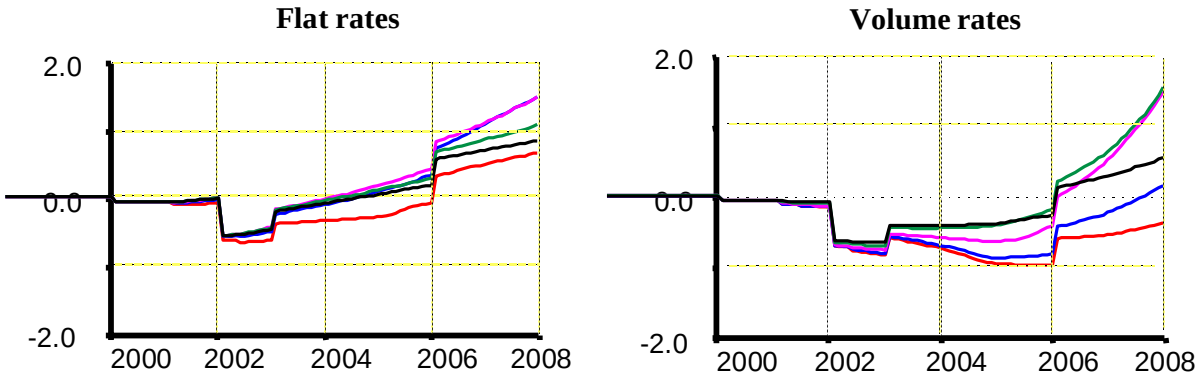

Fig. 3. Cash flows for different flat rates and volume rates. For the flat rate simulations it is assumed that the volume rate is zero and vice versa for the volume rate simulations. With flat rates a positive cash flow is reached around 2004 whereas with volume rates it takes until 2006.

The question of how the net capacity would be affected was solved only partly in the System Dynamics process. The part of the model describing the network is depicted in Fig. 4. As can be seen, an important number is the fill factor. The fill factor determines how large a part of the capacity that can be used for packet data in a circuit-switched network. This calculation was not solved by means of System Dynamics, but through a discussion illustrated in Fig. 5. If the distribution of packet data and circuit-switched traffic is the same, both for time and for geographic distribution, the fill factor can be estimated to about 50%.

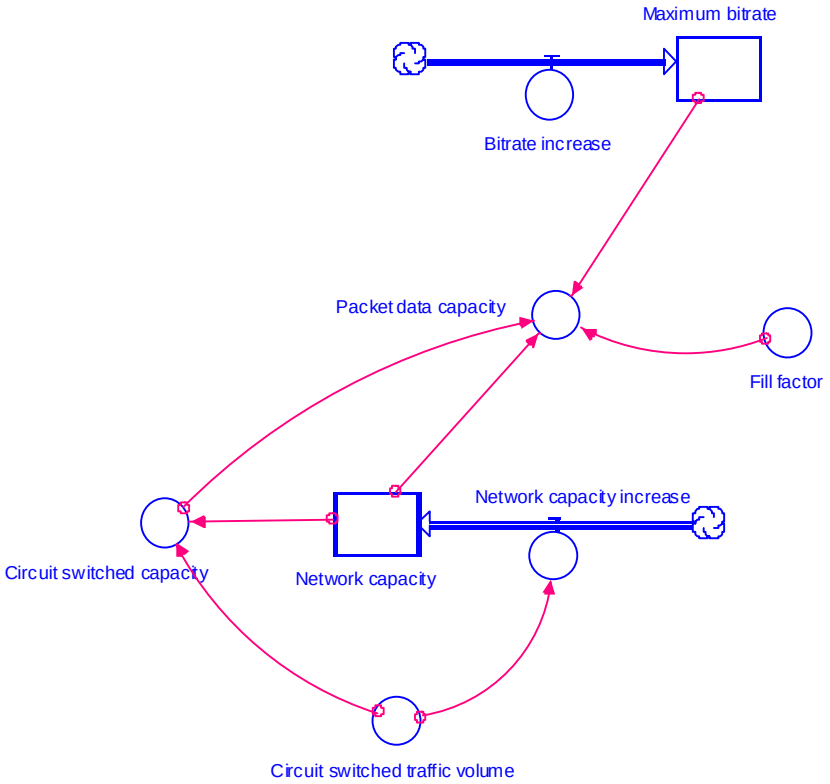

Fig. 4. The network capacity part of the ithink model. The packet data capacity is essentially the "left-over" from the circuit-switched traffic.

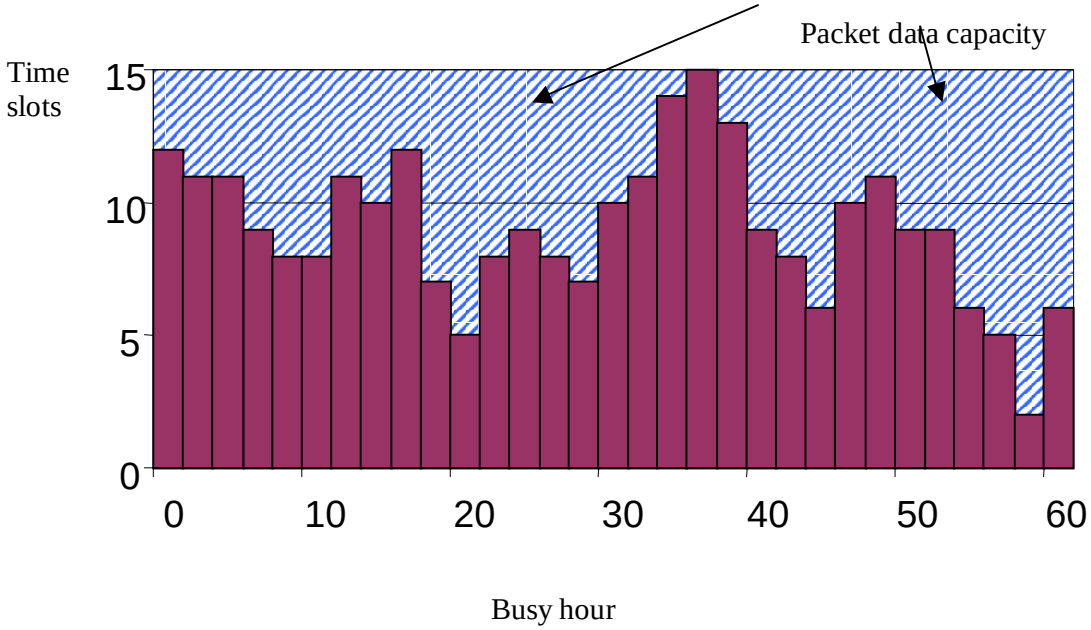

Fig. 5. General behaviour pattern of a circuit-switched network. The data are fictitious.

With this settled, it could be determined (by means of simulations) that the capacity demand would be driven by speech, i.e. circuit-switched connections, rather than packet data traffic.

As for competitive power, no conclusions could be drawn. The competitive power was talked about in terms of "the strength of the trade mark". We tried in different ways to put numbers to it, but we did not reach a quantification within the time frame given. For the simulations, we assumed that the market share of our client would remain the same.

Experiences and observations

We believe that we would have performed better as process leaders if we had started the information gathering with interviews instead of starting to work with the group immediately (cf. Ref. [2]). We would have been prepared for the difficult issues that turned up and we would have been able to direct the discussions better. We do not believe that we would have obtained an essentially different result as for the business case, but that we had done so in shorter time.

In terms of archetypes, this can be viewed as a fix-that-failed: We skipped the interviews because we were short of time. Instead we ended up spending more time with discussions in the group. We probably spent more time in total than we would have done if we had started with interviews.

The loop diagram was very big and contained many "soft" variables. This made it difficult to transform it into a computer model.

The customer requested that one output of the work be an Excel sheet that they normally use in their business cases. We decided to link our model to such a sheet. As a result, the model became unnecessarily detailed. We could not omit parts that were unnecessary for the conclusions. We believe

it would have been better to manually fit in the results of the simulations into the Excel sheet after the process instead.

In order to extract the beliefs of the group about what different price alternatives would lead to, and what reactions different prices would lead to, the graphical functions available in ithink were very useful. They allow non-exact views as input to computer models.

As observed for the network capacity, System Dynamics does not provide every answer in a process like this. This is natural, but may nevertheless be stated to prevent exaggerated expectations.

We have carried out a number of business cases, and the curves presented in Fig. 3 are common to them all. They all deal with investments of some kind, and the question from the investors is always what return they can expect on their investment, and when.

The competitive power of our client was expressed in terms of “strength of the trade mark”, which we did not succeed to quantify. The strength of the trade mark is a frequently used term, e.g. in the context of brand building. For future work it would be useful to be able to express it in well-defined numbers.

References

1. Vennix, Jac A.M., Group Model Building: Facilitating Team Learning Using System Dynamics. Wiley, UK, 1996.
2. Vennix, Jac A.M., Andersen, David F., Richardson, George P. and Rohrbaugh, John, Model Building for Group Decision Support: Issues and Alternatives in Knowledge Elicitation. In: Modeling for Learning Organizations (Eds.: Morecroft, John D.W. and Sterman, John D.). Productivity Press, Portland, 1994.