DYNAMIC MODELING FOR "INTERNET TELEPHONY" MANAGEMENT

Habib Sedehi
HELP Auditing Informatico
Via Antonio D'Achiardi, 31
00158 Rome (ITALY)

E-mail Sedehi@help.it

Nicolò Vaccaro
Università degli Studi di Palermo
Facoltà di Economia e Commercio
PALERMO (ITALY)

E-mail nvaccaro@tin.it

Abstract:

Voice over Internet Protocol (*VoIP*), i.e. the possibility to dispatch "**VOICE"** through *Internet*, constitutes a serious menace to the Telecommunication Operator consolidated business. Indeed the possibility to dispatch an international telephone call paying the price of a local call incites private and business users to use more and more *Internet telephony,* shrinking present profit margins. The complexity of the problem and the opportunity to understand and analyze it from a systemic point of view, is a stimulating challenge.

The aim of this work is to provide the Telecommunication Operator, with a tool, which supports management *strategic decisions* in transforming *VoIP* from a menace to a new business opportunity. In particular it consists in developing a System Dynamics simulation model estimating the Internet telephony "*erosion effect*" on corporate profit margins, in order to determine the size of menace and, as a consequence, to plan corrective actions.

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1. Introduction

1.1. General aspects of Internet Protocol Telephony

The convergence of network technologies and telecommunications has been taking giant steps forward in the last two years, to the extent that today Internet represents a serious threat to the greatest asset of telecommunications operators: the switched network infrastructure. Indeed, the technological evolution of the Internet network coupled with a constant improvement in the compression algorithms of voice and in transmission speed of modems has made possible the development of telephony technologies based on the transmission of IP data packages. In particular, the IP Telephony voice is converted, by means of specific software, into digital information (packages) which is routed through different architectures in to the Internet network in the same way packages containing text or images are sent. When the digital packages reach the receiver, they are reconverted, always by means of a software, into "voice" reproducible by sound diffusers (multimedia computer loudspeakers or telephone handset). Obviously, in addition to this phenomenon being remarkable from a technological point of view, it also has a great economic importance, particularly for the long – distance communications.
It must be stressed that, presently, the Internet is a "connectionless" network type, which means that destination of the "packages", at the emission time, is not traceable. In fact the routed nodes on the network depend on network traffic conditions. So the different packages follow physically different routes and are then reassembled at destination. Of course, that entails the risk that some of these packages may get lost or meet traffic problems among the network routers, thus altering the voice quality at the receiver. However, the devising of more advanced network protocols, such as RTP (Real-time Transport Protocol) and RSVP (Resource Reservation Protocol), which are able to support real–time services, as well as the potential offer of preferential and less overcrowded routes should guarantee, in a short time, the necessary quality level for voice transmission over a package – switching network.

1.2. IP telephony Architectures

Telephony via Internet can develop on three different types of architecture:

- PC TO PC: there are at least two computers at the two ends of the communication, both equipped with the same telephony software. The software compresses and transforms voice into digital packages and sends it, through Internet, to the computer of destination that reverses the process. The cost of the communication is only limited to the cost of the local connection necessary to get connected to the POP (Point of Presence) of the ISP (Internet Service Provider). So it is possible to make an international phone call and pay only for the price of the local call needed to have access to the Internet network.

- PC TO PHONE: by means of the above described procedure, a PC sends a digitized voice to a server located in a place near the one the phone call is directed to. The server automatically reaches the phone being called, through the public telephone network. With this architecture, the cost of the communication includes both the cost of the local phone call to get connected to the access provider plus the cost for the use of the server and the "termination price" from server to receiver.
- PHONE TO PHONE: a normal phone is connected, by a local call, to a gateway (server) which

in to Internet. Another gateway receives the packages, transforms them into voice and delivers them, through the switched telephone network, to receiver. The cost of the communication includes both the costs to get connected to/from the gateway and the price for the use of servers.

1.3. Objectives of the analysis

The complexity of the phenomenon just described as well as its effects on the economic performances represents, in our opinion, a good reason, to analyze the problem from a systemic point of view through System Dynamics Methodology. In particular we assumed as object of our investigation a Telecom Operator who, besides operating in the telephony traditional business, is also present on Internet market as a connectivity provider. The analysis basically aims describing the effects that the development of IP telephony platforms will bring out on corporate economic results, by supposing slight tariff maneuvers as a short-term instrument of intervention. Indeed, a cut in international telephone tariffs (within the sustainability limits deriving from the impact on the other subsystems) at a time when the Internet telephony phenomenon is in an embryonic phase would make it possible, in our opinion, to slow down the increase of users of this new technology. That is looked as a short–term strategy able to postpone the impact of Internet telephony on corporate revenues in order to review current business models and quickly adjust them to the ones emerging in the new scenarios.

We particularly thank Dr. Sandro Bosso, Telecom Operator expert, for his cooperation in supporting this study. He offered, with high professionally, his knowledge in the field of Internet telephony.

2. Model

The model is divided into four areas:

a) Internet Telephony Users
b) Effects of Internet Telephony on Internet Strategic Business Area
c) Substitution of PSTN (Public Switched Telephone Network) traffic with VON (Voice Over the Net) traffic
d) Integration of PSTN traffic with VON traffic

Here below follows an analysis of each area.

3. Internet Telephony Users

In this area we are going to examine the dynamics of Internet Telephony user growth. We first of all have to precise that the model distinguishes two classes of users:

- Residential End-user (home)
- Small and Medium Business (office)

Within each of these classes a further distinction is made between:

- Internet Telephony Users PC to PC and PC to Phone
- Internet Telephony Users Phone to Phone

So we have the following four user typologies:

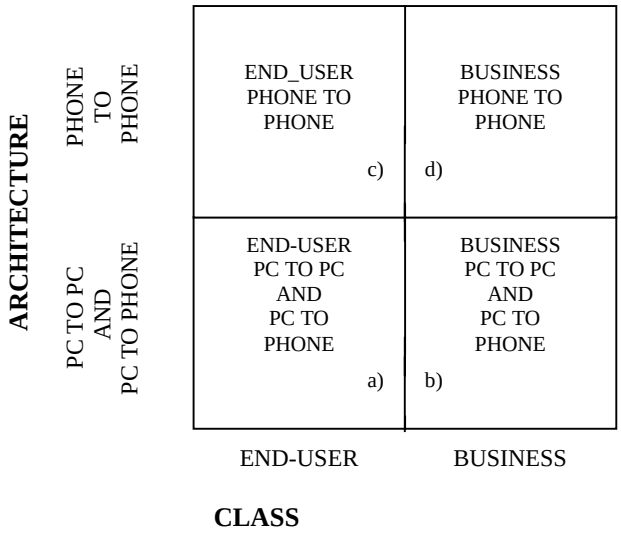

Fig. 1

3.1. End-user and Business Users: PC TO PC and PC TO PHONE

The dynamics of growth of the Internet Telephony users listed in boxes *a* and *b* of the matrix in Fig.1 is represented by the following cause – effect diagram:

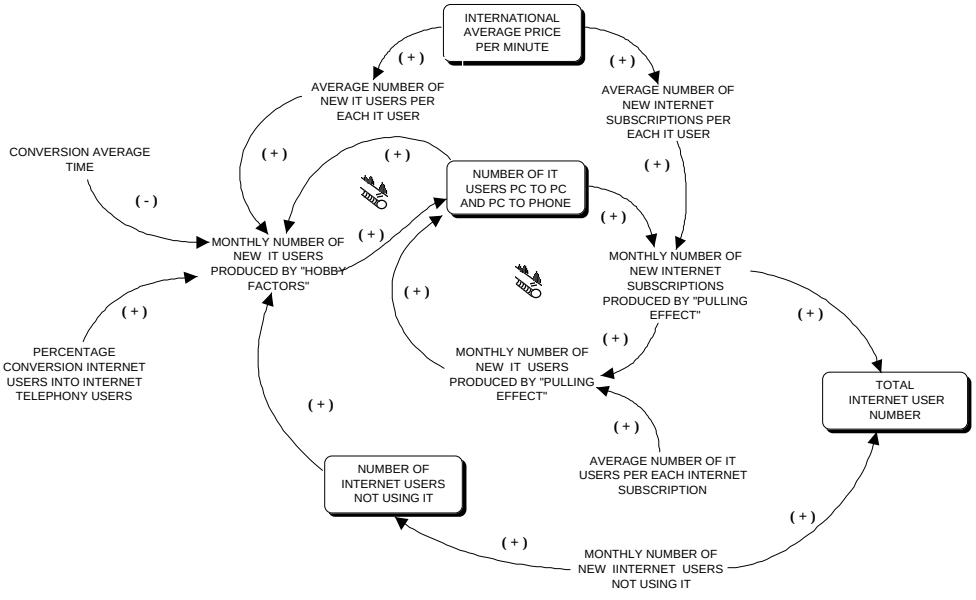

Fig. 2

The "Number of IT [1] users PC to PC and PC to Phone" depends on:

- the number of new IT users generated by hobby factors
- the number of new IT users generated by pulling effect

The former consist of those users who already have a multi-media PC, an access to Internet and a telephony software and decide to try out this new technology. The periodical flow of these new users is governed by:

a) Purely play factors: i.e. part of the WEB users, after some time spent in getting acquainted with the network, begin delighting in discovering the potentialities of Internet telephony;
b) Advantage factors: the play aspects are also complemented by a search for possible savings in extra–urban calls. The greater the advantage in calling via Internet, the wider the spread of Internet telephony.
c) Spread of IT: i.e. its spread and popularity causes a positive feedback loop which, at least during the simulation period (the period during which Internet Telephony potential market has not been brought forth yet), will generate an exponential growth of its users.

The "monthly number of new IT users produced by the pulling effect" represents, in the other hand, those users who make a high volume of international calls and subscribe to the Internet network exclusively motivated by the need to use it in order to make their phone calls. Such a variable depends on the product of the "monthly number of new Internet subscriptions generated by the pulling effect" and the "average number of IT users for each subscription". The reason lies in the fact that for each "new subscription" there are many "new IT users". The dynamics of the "monthly number of new Internet subscriptions generated by pulling effect» variable depends on the advantages IT offers and its spread. In fact, the higher is the rate of an international call, through the PSTN, and the greater is the popularity of Internet telephony, the greater will be the propelling effect in terms of new subscriptions.

3.1. Residential and Business Users: Phone to Phone

The evolutionary dynamics of the Internet telephony users using the Phone to Phone architecture (boxes *c* and *d* in figure 1) is shown in the following cause-effect diagram:

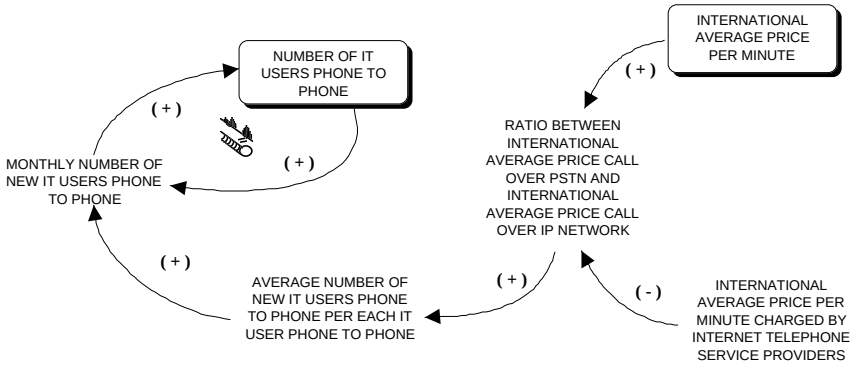

Fig. 3

The "number of IT users Phone to Phone" as well depends both on the spread of the Internet telephony platform usage and on a factor of advantage expressed by the ratio between the international average tariff per minute of a phone call made through the PSTN and the average international tariff per minute charged by the Internet Telephone Service Providers offering telephone services in Phone to Phone architecture.

4. Effects of Internet Telephony on Internet Strategic Business Area

As we previously pointed out, Internet telephony generates a propelling effect appearing as an increasing demand for access to Internet. Furthermore, we wrote that the company considered for our investigation is also present in the Internet market as an access provider. So, taking that into account, we can easily infer that the propelling effect of Internet telephony entails an increase in the sale of subscriptions offered by our company proportionality to its market share. In addition, we should bear in mind that the sale of additional subscriptions has effects, for each following year, in terms of potentiality of renewal. The dynamics of the dimensions under consideration may be easily understood by observing the following cause-effect diagram:

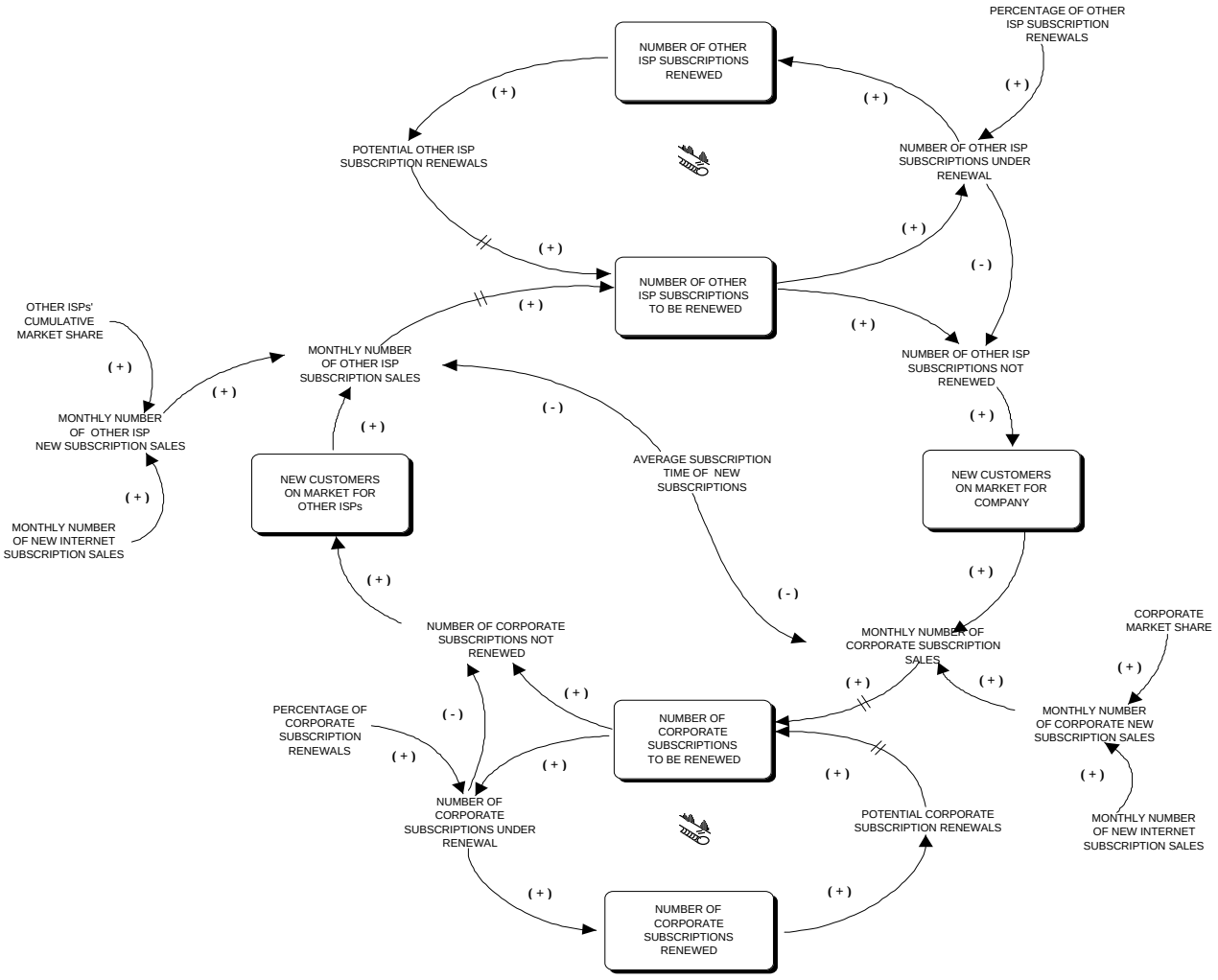

Fig. 4

The Internet Telephony propelling effect is represented by the "monthly number of new Internet subscription sales" variable, which expresses the greater number of new Internet subscriptions, sold thanks to IT. Such a propelling effect generates an increase in sales of subscriptions offered both by the company under analysis ("monthly number of corporate subscription sales"), proportional to its market share, and by the competing Internet Service Providers ("monthly number of other ISP subscription sales") proportional to the remaining cumulative market share. There should be observed that the sale of additional Internet subscriptions determines an annual reiteration of revenues from subscriptions' renewal and that subscriptions not renewed become new selling opportunities by the competitors [2] ("new customers on market for company" and "new customers on market for other ISPs").

5. Substitution and integration of PSTN traffic with VON traffic

Internet telephony users make two types of phone calls over the IP network:

- *Substitutive calls*
- *Additional calls*

The former is normally international phone calls taken away from the general telephone network. The volume of this substitution depends on the ratio between the average international tariff per minute and the voice reproduction quality level on Internet [3]. Whenever the ratio grows, the substitution effect increases.
In the other hand, the additional phone calls are those that are present because of the opportunities offered by Internet telephony. Indeed, the advantage in making an international phone call paying the price of a local one stimulates Internet telephony users to make more calls[4].
The dynamics of IP phone calls is represented here below:

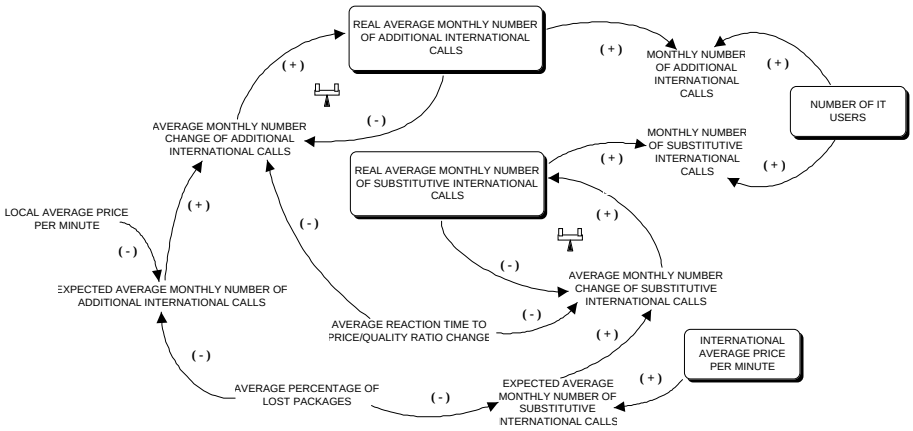

Fig. 5

Again, it should be observed how a change in the international average price per minute alters the users' propensity to use Internet to transport voice and that, after a certain lapse of time, causes a variation in the number of IP international phone calls substituting those made on the general telephone network. Likewise, the advantage in making additional calls depends on the local average price per minute maneuver.
Each substitutive phone call entails simultaneously:

1. a reduction in revenues due to a smaller volume of outgoing international traffic over the general telephone network;
2. an increase in revenues due to:

- a growth in local telephone traffic: indeed for each phone call made on IP network there is a corresponding local connection to the Internet provider server;
- additional connection times compared to the average time of a traditional international phone call.

The additional calls, instead, just produce greater revenues due to the increase of local connections.
The following diagram shows the relations just described:

[3] The voice reproduction quality is measured by the "Average Percentage of lost packages". As that percentage decreases, quality improves.

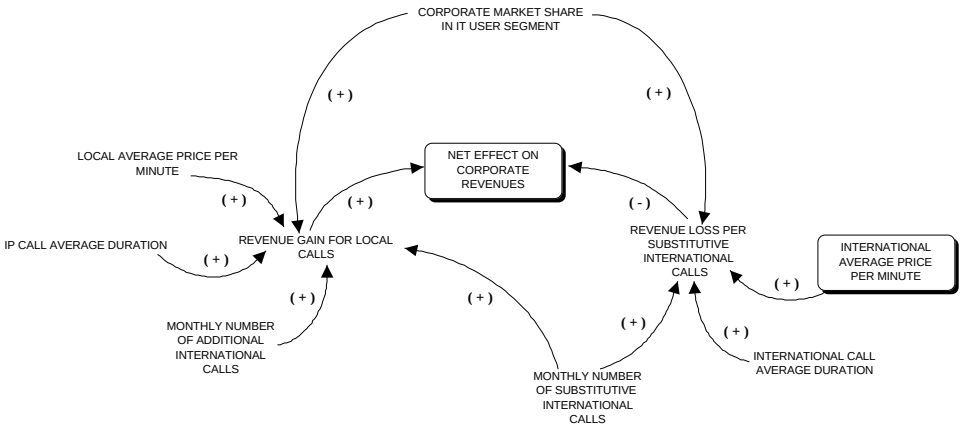

Fig. 6

It is easy to see that, in spite of the additional phone calls and time, the "net effect on corporate revenues" will be negative because of the sizeable difference between the international and local tariff.

6. Net effect on corporate revenues

The results of the previously examined areas flow into the level variable "Net effect on corporate revenues"[5]. In the absence of specific strategy policies, that variable records negative values because of an accumulation of losses in billing. However, as stated at the beginning, slight tariff maneuvers can contain the trend of those losses within sustainability margins.
The dynamics of this policy is shown in the following figure 7:

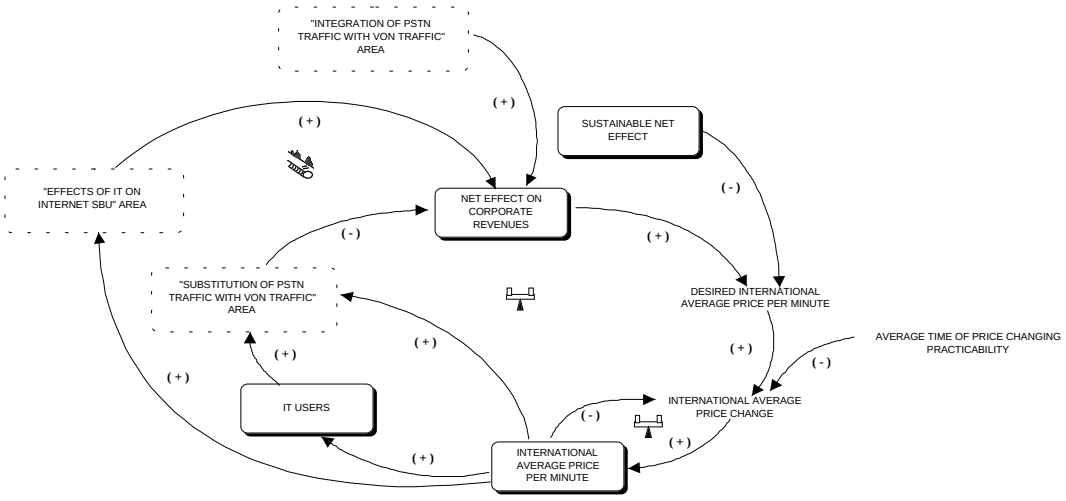

Fig. 7

[5] The model analyzes only the Internet telephony effects on corporate revenues and that is because we assume that:

- the traffic generated by Internet telephony does not saturate the productive capacity of the existing telephone

Note how, once the reduction in corporate revenues (expressed by the "Net effect on corporate revenues" variable) exceeds the sustainable one ("Sustainable net effect") it exercises a pressure toward a reduction in the international average price, thus triggering feedback mechanisms which radiate in all the areas and slow down the loss accumulation speed.

7. Model results

The figures below reproduce the time dynamics of the most significant variables of this work. Figure 8, in particular, compares the real loss in billing with the sustainable one. Note from the diagram how, during the first months, the reduction of the international average price (fig. 9) stems the revenue loss within sustainable margins. During the following months, however, the sizeable growth of Internet telephony users (fig. 10), no longer controllable through simple tariff maneuvers, causes, an out of control loss in billing, with more and more decreasing function. Figure 11 shows the function illustrating the trend of the increased monthly revenues generated by additional Internet subscription sales. In particular, the reduction of the international average tariff, by reducing the Internet telephony user growth, alters the function inclination, causing it to grow with decreasing intensity. Once the first year passes, however, the function suffers a rise due to the process of additional subscription renewals sold during the previous year. This trend repeats itself every year as each subscription lasts one year.

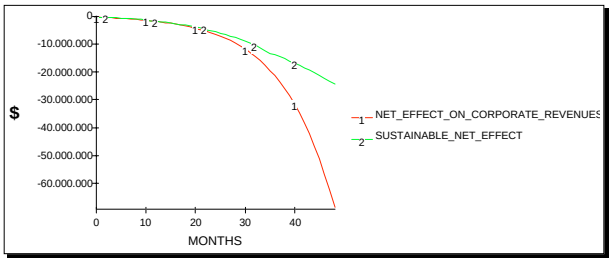

Fig.8

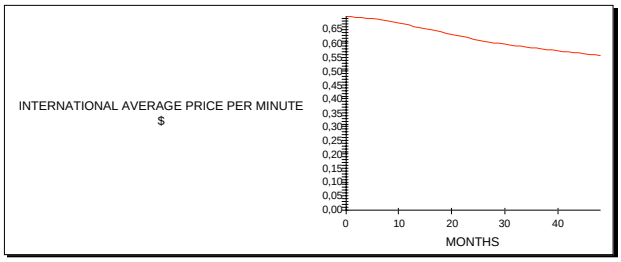

Fig.9

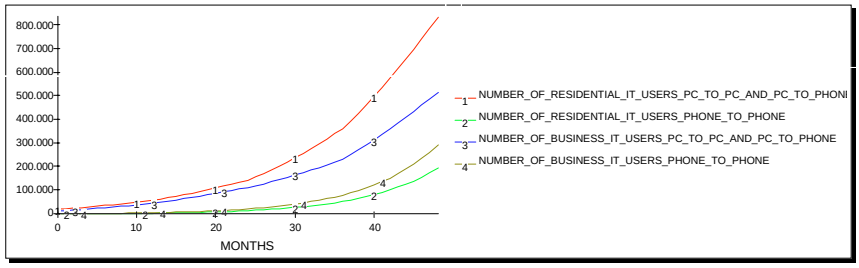

Fig.10

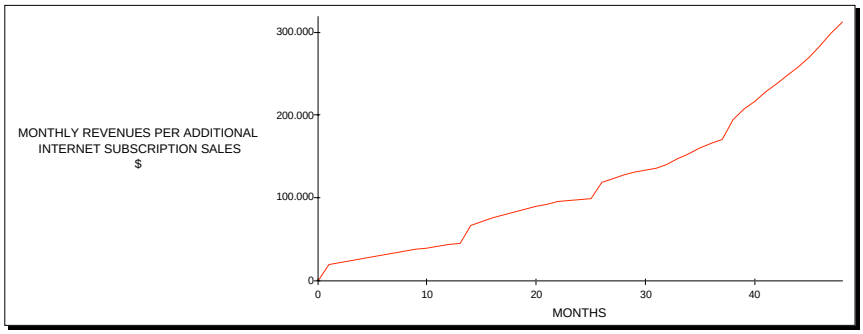

Fig.11