

# A Telecommunications Development: Analysis and Models

Dragan Bogojević and Slobodan Lazović

**Abstract:** This paper presents one approach of analyzing telecommunications development in developing European countries and Yugoslavia. Global parameter, which represents telecommunications information penetration, is introduced and calculated. Differences in telecommunications among the European countries are analyzed. According to the current development level, one model, potentially adequate for developing European countries and Yugoslavia is given. Proposals for national information infrastructure development in Yugoslavia are described.

**Keywords:** Telecommunications, models, telecommunicatins development, telecommunication information penetration, information communications market.

## 1 Introduction

Although development toward the Global Information Society (GIS) indicates acceleration of this process, experiences of developed and so-called developing countries or countries in transition are very different over the last decade. Target trends in developed countries are focused on services and applications, while developing countries primarily discuss networks, physical infrastructures and low penetration rate.

Accelerating development of telecommunications sector, national information infrastructures (NII) and access networks (AN) in the developing countries have been a key issue for more than a decade [1, 2], and [3]. However, the problem still exists. Evidently and based on international statistics

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D. Bogojević is with VF Holding a. d., Cvetna 4, 11080 Zemun (e-mail: draganb@vf.co.yu). S. Lazović is with Faculty of Traffic and Transportation Engineering, Vojvode Stepe 305, 11000 Beograd.

[4], risk of creating information rich (developed countries) and information poor societies (developing countries) has risen within the last five years. European developing countries have met common and specific development problems. Most critical common problems are economical and investment inferiority and information infrastructure undevelopment. Also, every country has its own specific development problems, especially Yugoslavia.

Our research [5, 6, 7, 8] proposes an approach to resolve the above problems, both generally for European developing countries, and specifically, regarding telecommunication sector development in Yugoslavia.

In [5] one approach in solving telecommunications developing problem is proposed. Global model for developed countries and national model for developing countries are identified. Analyzing telecommunications in European countries, strong correlation between regional belonging (Western Europe, Central and Eastern Europe, Southeastern Europe) and economical, market and telecommunications development [6] are found. A proposal of telecommunications development model for European developing countries is given in [7]. According to the previous research, which includes analysis of Yugoslav telecommunications model in period 1992-2000 [5], and quantification based on international statistics, in [8] a proposal of telecommunications developing model for Yugoslavia is given. In this paper an approach of analyzing telecommunications information penetration in Yugoslavia is described.

## 2 Analysis of Telecommunications Development

In this paper telecommunications development is analyzed as penetration of fixed telephony network, mobile telephony networks, cable TV networks, PCs and Internet toward end users. We introduced new parameter: telecommunication information penetration TIP, and pcTIP measured per 100 inhabitants. Development level of telecommunications information penetration (TIP/pcTIP) is treated like sum of penetration indicators in fixed telephone networks (main lines MTL/pcMTL), mobile telephony networks (mobile subscribers Mob/pcMob), cable TV networks (cable TV subscribers CaTV/pcCaTV), number of PCs per 100 inhabitants (PC/pcPC) and Internet users (Int/pcInt).

$$TIP = MTL + Mob + CaTV + PC + Int \quad (1)$$

$$pcTIP = pcMTL + pcMob + pcCaTV + pcPC + pcInt \quad (2)$$

First, we analyzed telecommunications development within the period

of ten years, from 1990 to 1999:

$$pcTIP = f(t) \quad (3)$$

$$pcTIP(t) = pcMTL(t) + pcMob(t) + pcCaTV(t) + pcPC(t) + pcInt(t) \quad (4)$$

$$t = [1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999]$$

From the geographic and economic aspects, European countries are classified into three groups-regions: Western Europe (WE); Central and Eastern Europe (CEE); and Southeastern Europe (SEE). Earlier, CEE and SEE countries were often politically referred to Eastern European (EE) countries.

WE countries have had a continual evolutionary development in knowledge based economy (KBE), information communications technology (ICT) market and telecommunications development, in the period 1992-2001. In contrast nevertheless, CEE and especially SEE countries failed to grow. Due to the economical differences, most of the SEE countries are absolutely inferior in view of the national income, ICT market and information infrastructure. Statistics show that 12 WE countries have had ICT expenditures per capita (pcICT) more than 1,000€ [9], while 12 SEE and CEE countries GDP per capita (pcGDP) less than 3,000€ [10]. ICT market of EE countries represents only 7% of ICT market of WE countries [9].

The pcTIP parameter for each European country, average for Europe, CEE, SEE and WE regions, in the period 1990-1999, are calculated. Results for Europe and regions WE, CEE and SEE are given in Fig. 1.

The results show that development level of European Information Infrastructure (EII) and telecommunications information penetration in WE on the one hand, and CEE and SEE on the other hand is very different. In 1997, on the average, every WE citizen had elementary telecom or IT access ( $pcTIP \geq 100$ ); in CEE every third; in SEE every fourth. In the period 1990-1999, differences were larger toward the end of the period than at the beginning. In addition, we analyzed the structure of pcTIP parameters in CEE and SEE. The dominant indicators were main telephone lines and mobile subscribers, while the number of PCs and Internet users was considered as a minor indicator. Evidently, over the last five years, problems and risks of creating a society of information rich (WE) and information poor (CEE, especially SEE) occurred in the development of GII-GIS infrastructure.

The positions of individual countries in European regions are also very different. In this paper we analyzed a group of 10 countries with populations between 8 and 11 million, called *g10*: Austria, Belarus, Belgium, Bul-

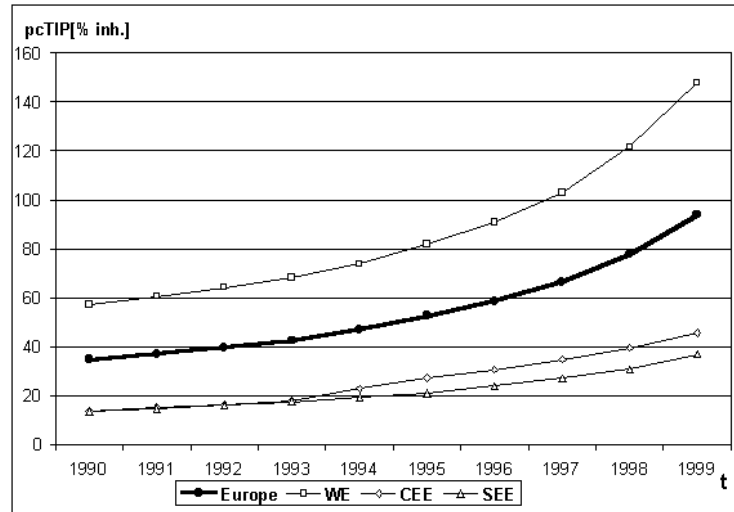


Fig. 1. Telecommunications development, Europe, 1990-1999.

garia, Czech Republic, Greece, Hungary, Portugal, Sweden and Yugoslavia. Telecommunications development for g10 group, measured by pcTIP in the period 1990 - 1999, is shown in Fig. 2.

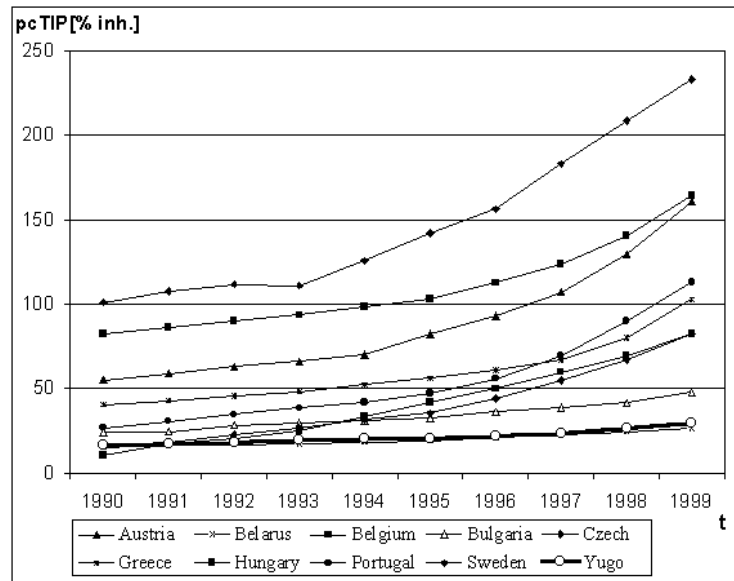


Fig. 2. Telecommunication development, g10 group of European countries, 1990-1999.

Telecommunications development is very unequal. Measured by pcTIP, Sweden has the most developed telecommunications, followed by Belgium and Austria, then Portugal and Greece (all countries belong to WE). Czech Republic, Hungary and partially Bulgaria have achieved evident improvement from starting positions. Yugoslavia and Belarus have the worst results.

The partial development in fixed telephony networks, mobile telephony networks, cable television networks, PC penetration and development of Internet, is also analyzed. The results for g10 group of countries are shown in Fig. 3, Fig. 4, Fig. 5, Fig. 6 and Fig. 7, respectively.

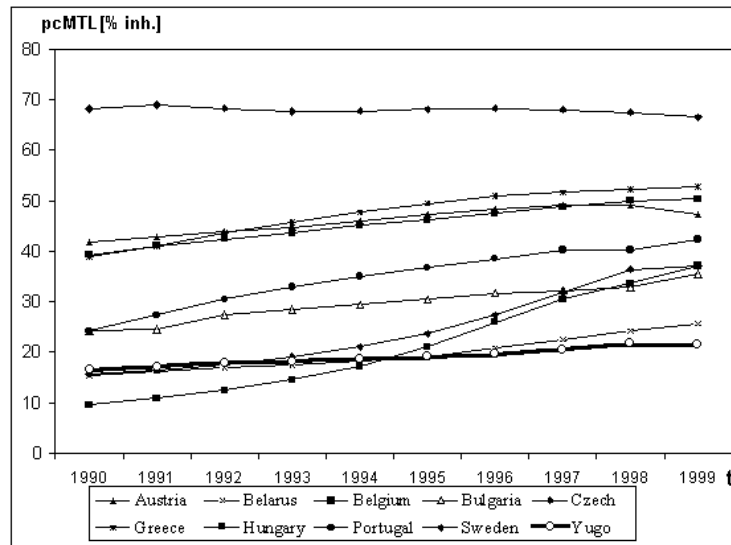


Fig. 3. Fixed telephony development, g10 group of European countries, 1990-1999.

Telecommunications development of fixed, mobile, cable television networks is also very disparate. The most evident (revolutionary) growth was in the expansion of mobile telephony and Internet, especially in the period 1995-1999. Rapid (but evolutionary) growth achieved in fixed telephony and CaTV.

Telecommunications development in Yugoslavia is unsatisfactory compared with g10. Regarding the number of fixed telephony subscribers (pcMTL) Yugoslavia is on 10th position; mobile subscribers (pcMob) on 8th position (better than Bulgaria and Belarus), CaTV subscribers (pcCaTV) on 7-10th position (together with Greece and Belarus), PC penetration (pcPC) on 9th position (better than Belarus); Internet users (pcInt) on 9th position (better

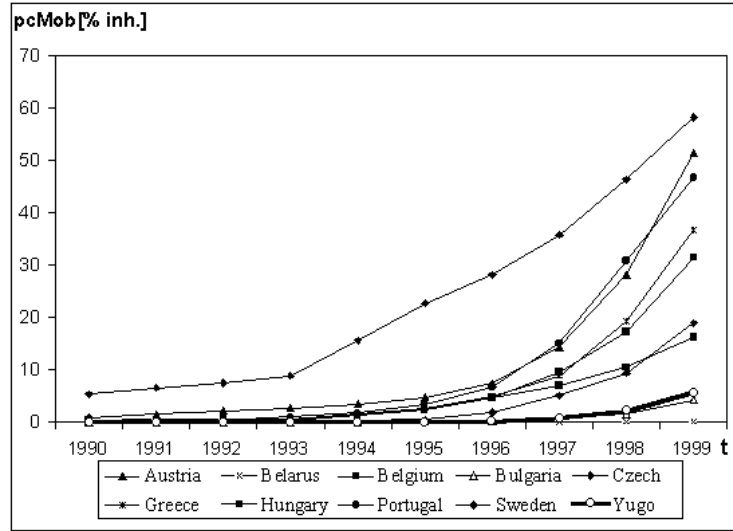


Fig. 4. Mobile telephony development, g10 group of European countries, 1990-1999.

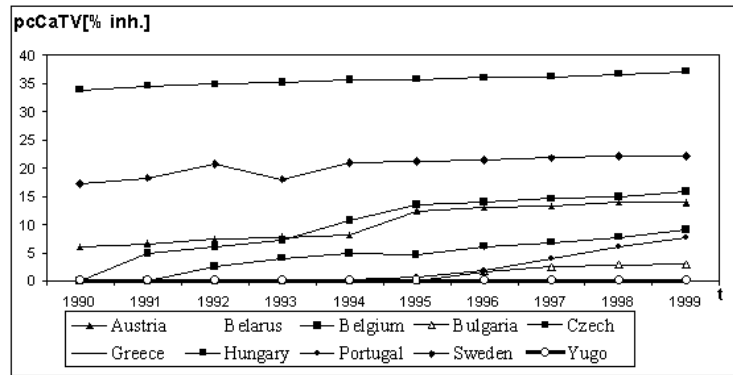


Fig. 5. Cable television development, g10 group of European countries, 1990-1999.

than Belarus). Differences between Yugoslavia and g10 group average are larger in 1999 than in 1990.

Telecommunication development as a function of time ( $pcTIP=f(t)$ ) is calculated and approximated with linear dependence. Equation for Yugoslavia in the period 1990-1999 is:

$$pcTIP_{lin} = 1,3434t + 13.954 \tag{5}$$

$$t = [1, 2, \dots, 10] \quad (R^2 = 0.9064)$$

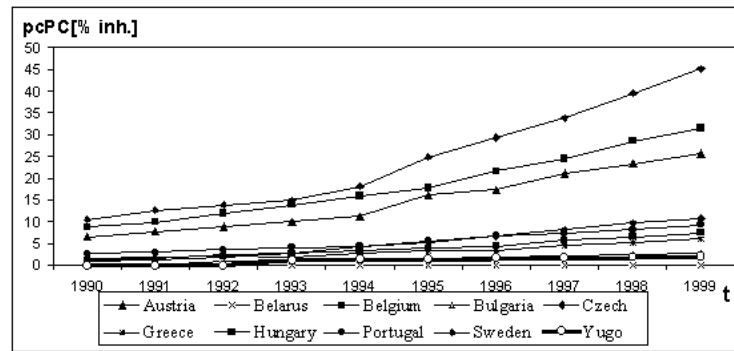


Fig. 6. PC-s penetration, *g10* group of European countries, 1990-1999.

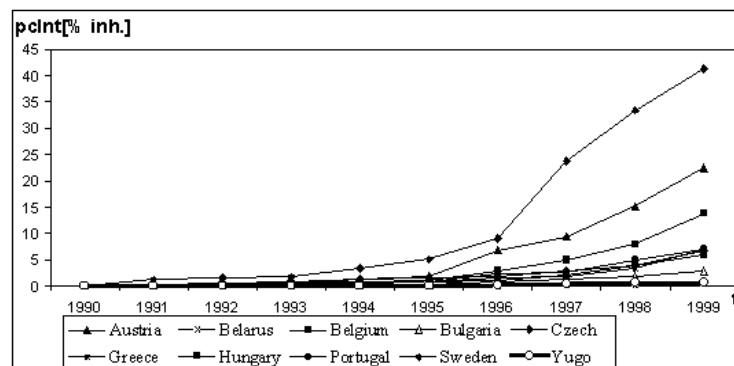


Fig. 7. Internet users development, *g10* group of European countries, 1990-1999.

### 3 Proposal of the Telecommunications Development Model

A proposal of the telecommunications model for developing European countries has been investigated and introduced in [7]. The main aim of the model has been to prepare and investigate a proposal for adequate development of some aspects of telecommunications sectors in SEE countries. Specifically, for the Yugoslavian telecommunications development, the goals have been to find potential solutions for the economical, telecommunications market and penetration discontinuities in the period 1992-2001.

The proposal includes the main national elements, such as telecommunications development policy; regulation; technology; ICT market; customers; and general economy. Indicators, taken from different statistical sources like UN [10], ITU [4], OECD [11], EITO [9] and WB [12], describe development

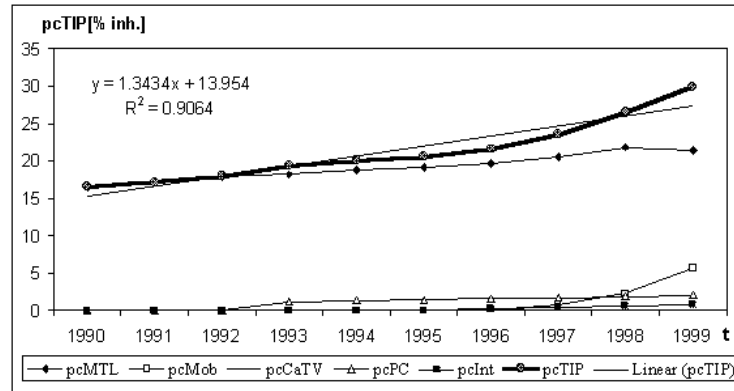


Fig. 8. Telecommunication development in Yugoslavia, 1990-1999.

level of these elements and relations among them. In total, 100 indicators are included in the model and divided into several groups: demography, economy, telephone networks, mobile and other services, operators, regulatory status, ICT market, IT penetration and R& D.

We defined the objective and basic criteria to measure success of the model implementation in developing European countries (TELad):

- Objective: accelerating telecommunication development in order to reach Global Information Society (GIS) through NII development (NIIad);
- Criteria: telecommunications information penetration (TIPad) for every end user.

$$TEL_{ad} = NII_{ad} = TIP_{ad} \quad (6)$$

$$pcTIP_{Developing\ countries} = 100 \quad (7)$$

We supposed [6] that telecommunications development level related to NII development can be defined in an adequate way according to the TIP parameter (pcTIP) and complex parameters: GDP (pcGDP), mICT (pcICT), TEH and REG:

$$TIP_{ad} = f(t, TIP_{t0}, GDP, mICT, TEH, REG) \quad (8)$$

$$pcTIP_{ad} = f(t, pcTIP_{t0}, pcGDP, pcICT, TEH, REG) \quad (9)$$



where parameters TIP and pcTIP are defined by equations (1) and (2) respectively, and

$$\begin{aligned}
 mICT &= mIT + mTT = (mITHw + mITSw + mITSe) \\
 &\quad + (mTELEq + mTELSe) \\
 pcICT &= pcIT + pcTT = mICT/Population \\
 GDP &= \sum(national\ incomes) \\
 pcGDP &= GDP/Population \\
 TEH &= \sum(telecommunication\ technologies) \\
 REG &\simeq Deregulation + Liberalization + Competition
 \end{aligned}$$

The mICT parameter represents the total ICT expenditures and the pcICT parameter represents ICT expenditures per capita. For WE countries and part of CEE, according to the [9], mICT and pcICT are calculated as a sum of expenditures for IT hardware, software and services, and telecommunications equipment and services.

GDP per capita (pcGDP) statistics were taken from UN [10], ICT market statistics (pcICT) from EITO [9], telecommunication information penetration indicators (pcMTL, pcMob, pcCaTV, pcPC, pcInt, pcTIP) from ITU [4].

#### 4 Proposal of Yugoslavian Telecommunications Development Model

In [8] a proposal for Yugoslavian telecommunication development model is given. The model is, owing to generalization, equal to the telecommunications model for developing countries in elements and relations, but for Yugoslavia, a new concrete proposals and implementation scenario are added. Yugoslavian telecommunications development model is called Yugoslavian market model. The elements of the model: development policy, regulation, technologies, ICT market, customers and economy are described in [8]. Elements and relations of Yugoslavian market model are shown on Fig. 9.

The Yugoslavian model has a multipurpose task: to follow the trend of telecommunications development in environment (in CEE), to decrease differences from the previous period (1992-2001) for shortest possible time. It can be done with an adequate telecommunications policy and market, regulation and technology leaps. Yugoslavian telecommunications model is

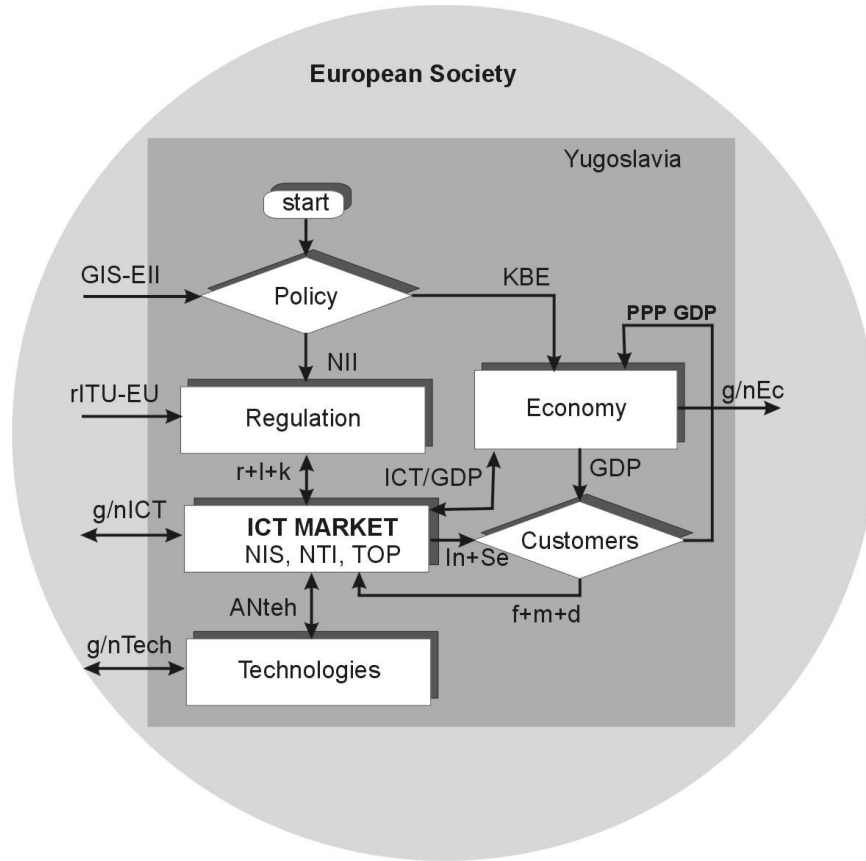


Fig. 9. Yugoslavian telecommunications development model.

based on revolutionary access; national information infrastructure development policy; national telecommunications industry concentrated on access network technologies (ANteh); regulation based on liberalization, deregulation and competition (rITU-EU and r+l+k); and supposition that rapid development of ICT market can accelerate development of the national information infrastructure.

The telecommunications information penetration parameter in the Yugoslavian telecommunications development model, according to proposals and indicators, in period of five years, can be represented analytically with next equations and relations:

$$\begin{aligned}
 & \text{for } t_0 = 2001 \text{ and } t = [2002, 2003, 2004, 2005, 2006] \\
 & pcTIP = f(pcTIP_{t_0}, t, pcICT, POL, TEH, REG)
 \end{aligned}
 \tag{10}$$

*Policies :*

$$POL = [GIS - EII, KBE, NII]$$

*Technologies :*

$$\begin{aligned} TEH &\simeq AN_{teh} \simeq \sum (POTS, ISDN, FTTx, xDSL, WLL, \dots) \\ TEH &= AN_{teh} = \sum (POTS, ISDN, PCM) \\ &+ \sum (FTTC, ADSL, WLL) \end{aligned} \quad (11)$$

*Regulations :*

$$REG \simeq Deregulation + Liberalization + Competition$$

*ICT market :*

$$mICT_{T_{end}} \gg mICT_{T_{start}}$$

$$Yu(ICT/GDP) = WE(ICT/GDP) = 6.33\%,$$

$$\text{for } t = T_{start}.$$

$$Yu(CAGR_{ICT}) \geq CEE(CAGR_{ICT}),$$

$$\text{for } T_{start} < t \leq T_{end}.$$

$$Yu(CAGR_{TIP}) \geq CEE(CAGR_{TIP}),$$

$$\text{for } T_{start} \leq t \leq T_{end}.$$

Transformation of the Yugoslavian society into the Information Society (IS) is possible only with strong contribution and influence of national ICT market. Yugoslavian ICT market is the main element of telecommunications development. National market needs to allow interactive relations with global ICT market, and internally with national regulations, technologies and economy. For that reasons the model proposes leapfrogs in market development defined with the trend in Western Europe and targeted to development of NII. Development of ICT market, on the same level of GDP (ICT/GDP) as WE average, and structurally devoted to extension of TIP, is proposed. Compound annual growth rate (CAGR) of TIP development would to be greater or at least equal to the CEE countries.

Global ICT market trends to transform Yugoslav ICT market into a free and open market for selling products and services. Domestic telecommunications forces, marked as national innovation system (NIS), national telecommunication industry (NTI) and telecommunications operators and

providers (TOP) groups, trend to hold positions in the domestic market. They also plan to have limited but necessary access and position on global ICT market. Relation of their mutual power (g/nICT) is measured through ICT products, software and services export and import.

## 5 National Information Infrastructures Implementation Scenario

Nowadays, on the basis of telecommunications development analysis and measuring, it can be concluded that results of the Yugoslav NII development are inadequate and trend incompatible with the environment. Infrastructure leapfrogs and short time implementation scenario is recommended as a solution. The criteria in defining proposals for infrastructure leap is “real leap” necessary for keep pace with the trend of growth of NII in the CEE countries, forecasted for the period 1998-2005 [11].

- Growth of new main telephone lines (MTL) with  $CAGR_{MTL} = 10\%$ , which approximately corresponds to the trend in CEE countries for period 1990 - 1999. Additional 5% new lines could be realized from dividing the existing party (double) lines with PCM, ISDN and SDSL techniques.
- Growth of mobile telephony with the same trend as in CEE countries, with  $CAGRMob = 28.4\%$  for the period 1998-2005.
- Growth of cable TV subscribers with  $CAGRCaTV = 10\%$ , which corresponds to the doubled trends in CEE countries for the period 1998-2005.
- Growth of Internet users with the same trend as in CEE countries  $CAGR_{Int} = 25.6\%$  for the period 1998-2005.
- Growth of PC computers with  $CAGR_{PC} = 16\%$  which corresponds to the trend for the period 1997-2001 in following countries: Hungary 16.75%; Portugal 16.03%; Ireland 16%; Greece 15.18%.
- Fixed network digitalization with same trend as in CEE countries with  $CAGR\%DMTL = 14.3\%$  for the period 1998-2005.
- Growth of ISDN lines with the same trend as in CEE countries with  $CAGR_{ISDN} = 64\%$  for the period 1998-2005.
- Optical cables ducting with  $CAGR_{Fiber} = 20\%$ .

We supposed that NII in developing European countries, for participating in GIS, is adequate (not optimal) when, in average, every citizen has

some kind of physical telecommunication infrastructure access, or owns a PC, or is Internet user. With the proposed implementation scenario of NII development, Yugoslavia could develop adequate telecommunications information penetration to the end users within five years. Telecommunications development  $pcTIP=100$ , started 2002 can be reached in year 2006.

$$\begin{aligned}
 pcTIP_{YU} &= 100 & T &= 5 \text{ years,} \\
 t_0 &= 2001, \\
 t &= [2002, 2003, 2004, 2005, 2006]
 \end{aligned}$$

Yugoslavian development of  $pcTIP$ ,  $pcMTL$ ,  $pcMob$ ,  $pcCaTV$ ,  $pcPC$  and  $pcInt$  is shown in Fig. 10.

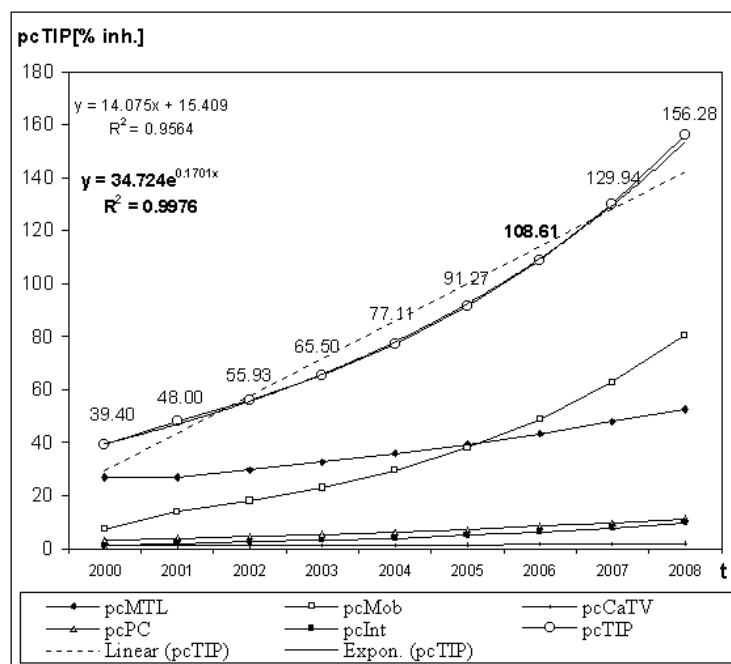


Fig. 10. Telecommunications development at Yugoslavian market model.

## 6 Conclusion

Although developments toward the information society indicates acceleration, the present data show that some European countries, grouped in CEE

and SEE are lagging behind. Current development level of the information infrastructure in developing country is, owing to limited investment possibilities and lack of foreign private sector investment, insufficient for the reduction of information gap with developed countries, and often for surviving in technology evolution.

Developing countries need to encourage investment in computer and communication technologies and in dynamic and competitive market then presently available. Much more needs to be done than in the past, in order to close the development gap and especially to ensure developing countries in trying to build their networks are investing in appropriate technologies for the information society. This renewed effort is particularly important because of the danger that the developing gap may increase as a result of WE countries rapidly building up their broadband infrastructures. The aim of developing countries should be to develop their networks as rapidly as possible so as to use the benefits from the GII-GIS.

It is clear that foreseen changes are viewed as being evolutionary rather than revolutionary, even if they are often described as an information revolution. But, if the speed of evolution is not sufficient for revolution, new approach and developing model need to be investigated [5, 7, 8]. Developing models have to include specific economic, political, cultural and social situation of every country, on one hand and on the other hand, sub-regional and European cooperation and participation in ICT market, telecommunications technology development and regulation. Leapfrogs: from obsolete to new technologies, from national to international ICT market and legislation, and feedback between global and national: technology, market and economy make a milestone of possible model for developing countries.

In this paper the problem of Yugoslavia telecommunications development level is also discussed. According to the current development level, measured by pcTIP parameter and compared with g10 group, one model, potentially adequate for Yugoslavia, is described. The main proposals, particularly for national information infrastructure development, are given.

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