Romanian national computer network for research and higher education

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Abstract

This paper reviews the current status of the Romanian National Computer Network for Research and Higher Education (RNC), services provided and user community in the first stage of the development. Some lessons learned during this phase are considered. Then, future plans for the second phase of development are briefly described with emphasis on the development of a national backbone and a metropolitan network for Bucharest.

1 Introduction

RNC represents a national project aimed to build the Romanian National Computer Network for Research and Higher Education. It started in 1992, being funded by the Ministry of Research and Technology and the Ministry of Education [1], [2] with the main objective to build the data communications infrastructure and to provide modern and efficient services for scientific and technical information exchange between Romanian scientists and their colleagues all over the world.

2 Early Initiatives

2.1 Experimental Packet-Switched Network

During 1980's the Research Institute for Informatics (ICI) in cooperation with the Ministry of Communication has developed a packet-switched computer network that had 18 operational nodes in 1989, spread all over the country. The nodes were installed at PTT sites and it was planned to become a public data network. Several industrial enterprises were connected to this network, mainly those belonging to Ministry of Electronics and Electrotechnics. Some application layer services were developed: remote login, file transfer, virtual device, remote command execution. Due to poor hardware and software reliability, this project was given up in 1990. However, it had a major role in forming highly qualified network specialists and technicians.

2.2 Dial-up Connectivity

Soon after the political changes in 1989, several cooperation agreements were established between Romanian research institutes and universities on one hand and Western European Research Networks, on the other hand, to provide access to the international scientific networks. The immediate technical solution to provide such connection was via dial-up links, using simple protocols like terminal emulation or UUCP protocols. The most remarkable project in this period was the Pilot E-mail System set up at Politechnica University of Bucharest in cooperation with the Technical University of Darmstadt, using a dial up X.25 link [5].

2.3 EARN Connectivity

At the beginning of 1990's, EARN (European Academic and Research Network) had a leading role in connecting the Central and Eastern European countries to the international networks via the Austrian Academic Computer Network (ACONET). Most of the Central and Eastern European countries have a direct link to Vienna University [3].

Romania became full EARN member in 1992 and in December 1992, the Romanian National Gateway Node to EARN (ROEARN.BITNET) became operational, being connected by a 9.6 kbps leased line to AEARN node located at Vienna University. The main aspect that is to be underlined is the use of tcp/ip protocol for the link Bucharest-Vienna and NJE traffic for EARN/BITNET connection was carried over tcp/ip. The use of tcp/ip protocol from the very beginning was essential since this allowed also the Internet connectivity to be provided very soon [4].

Taking into account several years of experience in networking and also the communications infrastructure existing between ICI site and the PTT telephone exchange, the Romanian National Commission for Informatics (a governmental body) took the decision that the Romanian National Gateway Node for EARN be located at ICI.

Very soon after those, other research institutes and Universities were connected to ROEARN node:

- Institute for Atomic Physics, Magurele (ROIFA.BITNET);
- Polytechnical University of Bucharest (ROIPB.BITNET);
- Technical University of Timisoara (ROUTT.BITNET);
- CEPES - The European Center for Higher Education (CEPES.BITNET), a division of UNESCO, aiming at the development of university training in Europe;
- Institute for Mathematics of Romanian Academy (ROIMAR).

All the nodes in the first phase were based on Digital equipment: VAX machines, DECRouters and DEC terminal servers (Figure 1). The configuration for ROEARN node was as follows:

- Hardware
  - ◊ PC Router with KA9Q software for the connection to Vienna node via a 9.6 kbps leased line, using tcp/ip protocol;
  - ◊ Micro-VAX 3100/20 with 20 MB RAM, 600 MB hard disk, Ethernet interface, 4 asynchronous serial interfaces;
  - ◊ DEC Server 90 with 8 asynchronous lines allowing the connection of 8 terminals;
  - ◊ DECRouter 250 with 8 synchronous/asynchronous lines allowing the connection of 8 nodes in the country using DDCMP protocol;
- Software
  - ◊ VMS operating system
  - ◊ DECNET software
  - ◊ JNET for NJE access to EARN/BITNET;
  - ◊ VMS Ultrix Connection for tcp/ip access to Internet;
  - ◊ KERMIT for file transfer via terminal emulation access points;
  - ◊ MX Mailer for BITNET and Internet e-mail, listserv and filesever.

As mentioned above, the international link was carrying tcp/ip and NJE over tcp/ip traffic. The other nodes (ROIFA, ROIPB, ROUTT, CEPES) were connected to ROEARN node by DECNET (DDCMP protocol) and the NJE traffic was carried over DECNET. The MX public domain software was used for SMTP e-mail over JNET.

ROIMAR node was connected by DECNET and the MX mailer was used for SMTP e-mail over DECNET.

To give access to more users, dial-up access points were set up. Simply using a PC with a dial-up modem and a terminal emulation software (BITCOM, TELIX, PROCOMM, KERMIT, etc.), users from research institutes and universities can have access to the international networks.

The nodes located in Bucharest could very soon be connected by leased line. Those in the country could not afford the cost of a long distance leased line. For these institutions, a dial-up access point was installed, allowing DECNET connectivity and NJE over DECNET. The NJE protocol has the advantage that messages are transferred entirely hop by hop and it is not necessary that the final destination be connected all the time. For instance, messages with ROUTT destination arrive at ROEARN node and they are stored there on the disk until the ROUTT node comes up and takes all its messages.

Setting up the connection for EARN/BITNET was a major step for the Romanian National Computer Network for Research and Higher Education. Besides the communication among people within the academic community, it was the first time when scientists from main research institutes had on line access to the public information servers provided by the international scientific networks. The diversity of services was tremendous for the Romanian research community that were very much isolated until 1990.

The services provided during this stage were:

- exchanging electronic mail and files;
- interactive messages via JNET;
- news via LISTSERV (mail distribution lists);
- access to public domain and shareware software via TRICKLE;

2.4 Internet Connectivity

Exploring the network services it became very soon clear that the future of networking for research community is Internet. So, only in few months after the setting up of EARN connection, in March 1993, Romania got full Internet connectivity. With the kind assistance of INTERNIC, RIPE (Reseaux IP Europeenne) and Vienna University, the .ro top level domain was registered. People from all over

the world helped with running secondary nameservers for .ro domain.

The primary nameserver for .ro top level domain is ns.ici.ro (192.162.16.21) and secondary nameservers are running on:

- ns1.univie.ac.at (131.130.1.11)
- ns.eu.net (192.16.202.11)
- sunic.sunet.se (192.36.125.2)
- ns.uu.net (137.39.1.3)
- sparky.arl.mil (128.63.48.200)
- ns.eunet.co.at (192.92.138.35)

Establishing full Internet connectivity was the second major step for developing RNC. New services (telnet, ftp, archie, gopher, wais, netfind, www) were discovered, and these had a great impact not only on the activity of researcher but also on the activity of students and even high school people.

Establishing a full Internet connectivity had also

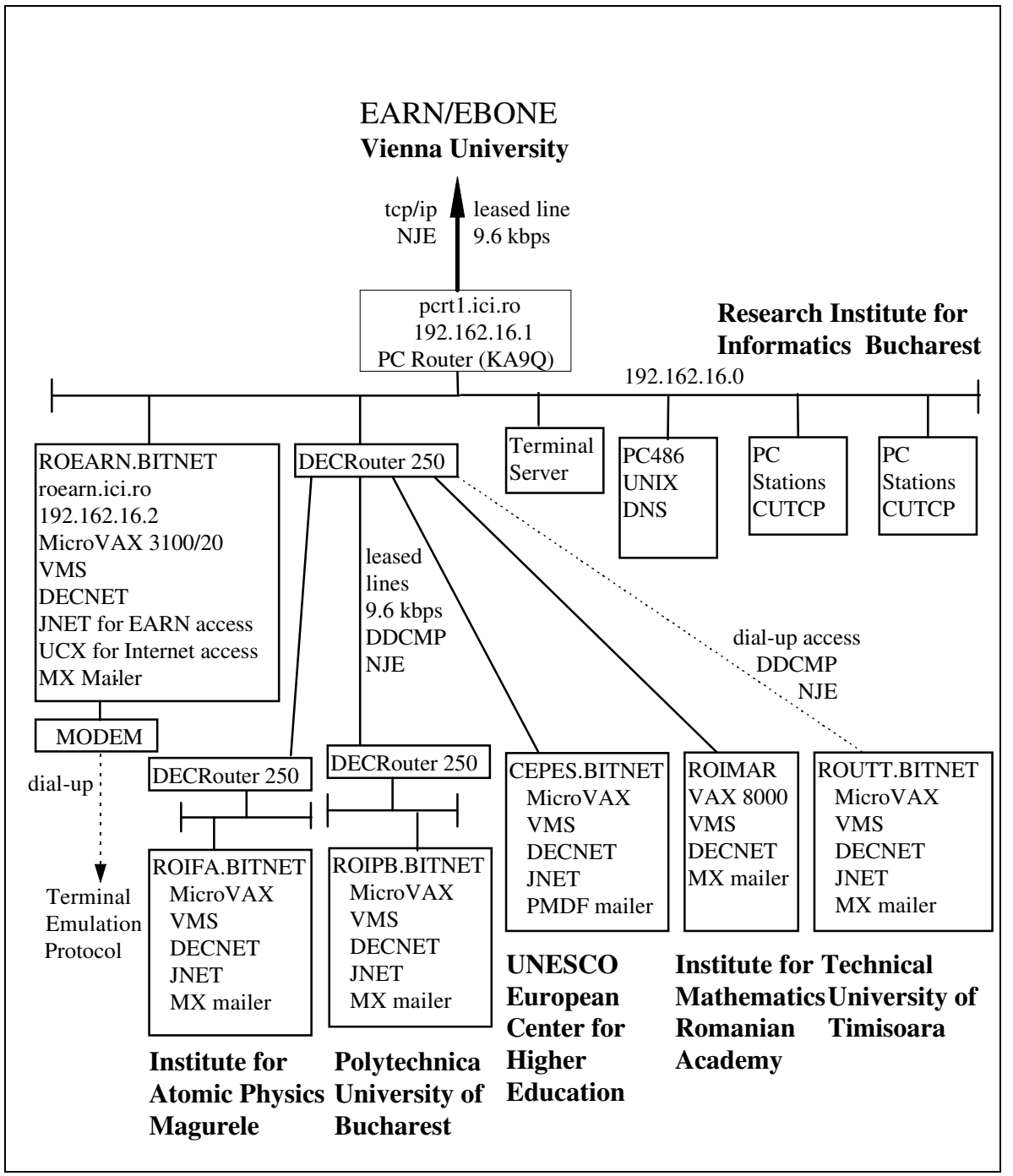

Figure 1. ROEARN node configuration in the first phase

increased the speed of network development of RNC from two points of view:

1. The number of people wishing to have network access increased very rapidly;
2. The equipment needed for Internet access was less expensive than for EARN/BITNET access. The cheapest equipment for EARN/BITNET access was a micro-VAX with VMS and JNET software, which was rather expensive for Romanian users. Internet access was possible using a PC 386/486 station with KA9Q or CUTCP/NCSA software from public domain, which was much cheaper than a micro-VAX.

3 Current Status

After getting full Internet connectivity, the Internet extended very rapidly in Romania. Low cost solutions were used to give access to a large number of users.

3.1 International Node

The international node is located at ICI (Research Institute for Informatics) in Bucharest and its hardware configuration includes: routers, servers, terminal servers and data communications equipment (modems, satellite communications equipment).

The RNC is connected to the world by two international links:

- Bucharest - Vienna , which is a 64 kbps satellite line, used for connection to EBONE via ACONET and carries tcp/ip and NJE over tcp/ip traffic;
- Bucharest - Amsterdam, which is a 9.6K terrestrial leased line, used for connection to EUROPANET via PTT Telecom Netherlands, carrying tcp/ip over X.25 traffic.

RNC has also a 9.6 kbps terrestrial line between Bucharest and Chisinau, used to provide access for the academic network of Moldova Republic.

Since the network grew up gradually, several types of routers are being used: CISCO, Telebit, DECRouter and PCRouters (with KA9Q or Linux software).

The international router is a CISCO AGS/+ router with the following technical specifications:

- 5 serial interfaces;
- one Ethernet interface
- 16 Mbytes RAM
- non volatile memory for storing configuration;
- flash eprom memory;
- exterior routing protocols: BGP4, EGP;
- interior routing protocols: RIP, HELLO, IGRP, OSPF;
- physical level: IEEE 802.3 Ethernet, V.35, RS232;
- line protocols: HDLC, LAPB, PPP;
- software;
- tftp to load and save configuration;
- SNMP management;
- syslog logging facility;
- IP accounting;
- packet filtering options for incoming and outgoing packets.

At present, there are two European backbone networks: EBONE and EUROPANET. As shown in Figure 2, the CISCO AGS/+ router is connected to both of these European backbone networks:

- to EBONE via the 64 kbps satellite link between Bucharest and Vienna;
- to EUROPANET via the 9.6 kbps terrestrial leased line between Bucharest and Amsterdam.

The routing protocol used for the international links is BGP4, allowing a load balancing between the two international links, and also, in case of failure of an international link, all the traffic is routed via the other international link. This function is very important for providing high quality service to RNC users.

The RNC nodes are connected to the international node either by CISCO routers or by other kind of routers: Telebit, DECRouter, PCRouters. The connection of CISCO-based nodes is done either directly to the international router (having at present 3 serial interfaces for this purpose) or to some other CISCO 2501 routers (as shown in Figure 2), the data transmission speed being between 9.6 kbps and 128 kbps.

The connection of Politechnica University (PUB) has at present some particularities. At PUB site there is at present an X.25 switch which is connected to EUROPANET node located at ICI and the traffic for PUB is routed via EUROPANET

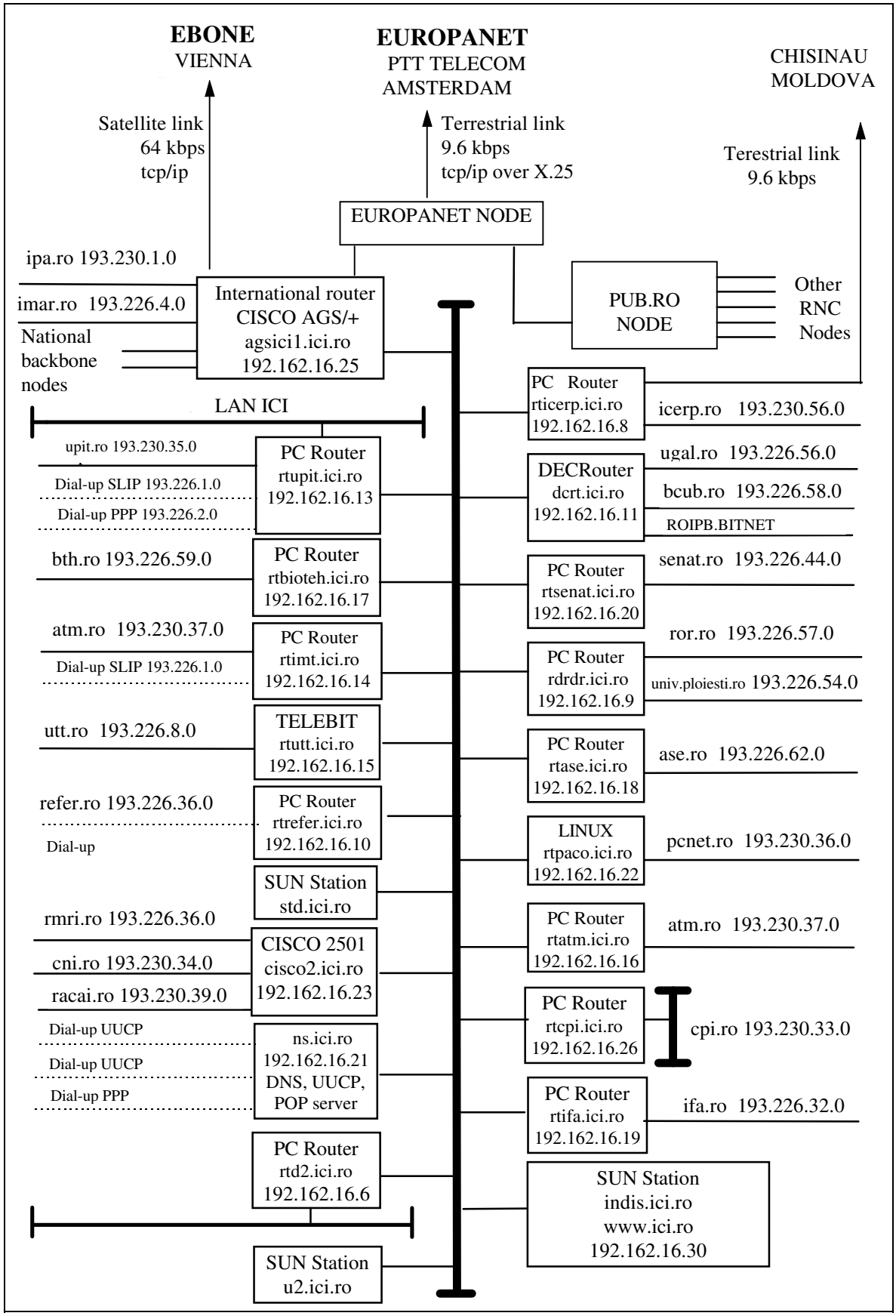

Figure 2. Current configuration of the international node (April 25, 1995)

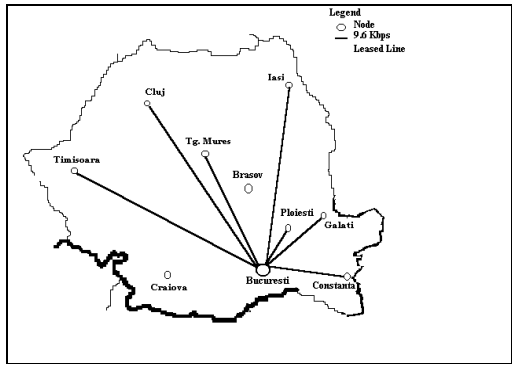

Figure 3. Current national backbone topology

using tcp/ip over X.25. Some other universities are directly connected to PUB. Plans exist to switch very soon the direct connection of PUB from the EUROPANET node to the international CISCO router located at ICI and using also a CISCO route at PUB site. This will allow the use of both international links for all the RNC traffic.

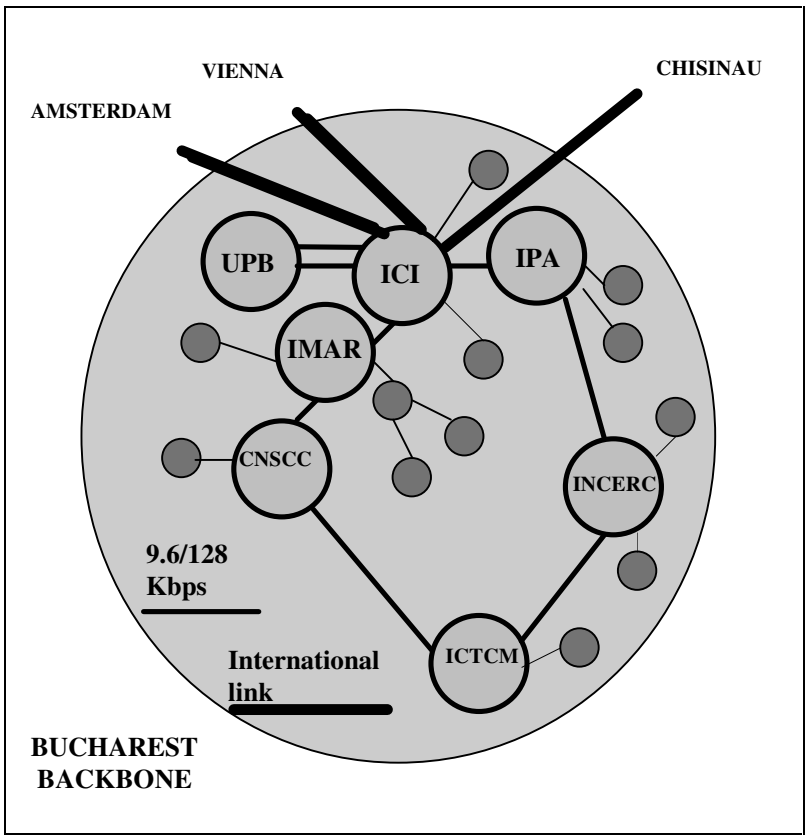

Figure 4. Bucharest backbone network configuration

3.2 Topological Configuration

The current configuration is a star like configuration, as shown in Figure 3, connecting 8 main cities to Bucharest node, by 9.6 kbps leased lines.

A particular case is in Bucharest where a large number of research institutes and universities are concentrated. The basic idea was to create a reliable environment for network community. The Physical support to do this is the Bucharest Backbone (BB) network shown in Figure 4.

The structure of a BB node is:

- CISCO 2501 router with:
  - ◊ 2MB RAM
  - ◊ 4MB EPROM-FLASH
  - ◊ Ethernet interface
  - ◊ 2 serial interfaces
- Terminal server (LANTRONIX) with 8 serial ports;
- Communication server (TATUNG) with
  - ◊ Superscalar SPARC V8, 50 MHz;
  - ◊ 32 MB RAM;
  - ◊ 2 GB HDD;
  - ◊ Streamer 2 GB (COLORADO);
- Modems (9.6/64/128 kbps).

To have a low cost, in the first phase, the BB nodes are connected in a ring configuration, but in the second phase, redundant links are added, so that a meshed configuration is obtained.

All the backbone nodes have dial-up facilities, both for UUCP protocol and for SLIP/PPP access. Increasing the number of dial-up access points, the quality of services will be improved.

3.3 Servers and Protocols Used

Servers available in the network are mainly VAX/VMS and UNIX (SCO, USL, UNIXWARE, AIX, Solaris, OSF/1, Linux) based machines. The following programs are being used for access to the network services:

- MS-DOS machines: NCSA, CUTCP, KA9Q, WAFFLE, NUPOP, Mercury for NOVELL;
- WINDOWS: WINSOCK TRUMPET, EUDORA, PEGASUS, WINAPPS, Mosaic;
- VAX/VMS machines: JNET, UCX, MX, CMUIP.

At user level services, the following protocols are used:

- TELNET;
- FTP;
- POP for e-mail communication;
- UUCP for e-mail and file transfer;
- RLOGIN.

Communities being served:

- R&D institutes;
- universities;
- libraries;
- government institutions linked to academic and research activity;
- high schools.

Resources available:

- Listserv on roearn.ici.ro;
- Mailserver on roearn.ici.ro;
- Gopher server on ulise.cs.pub.ro;
- FTP anonymous server on pub.pub.ro, stoilow.imar.ro;
- www server on www.ici.ro, tempus0.utt.ro.

Number of hosts connected to the network and estimated number of users:

- over 500 hosts registered into DNS;
- over 6000 final users;
- 26 research institutes and universities connected by leased lines;
- over 120 institutions connected by dial-up;
- around 5 Gbytes/month total traffic.

4 Plans for Future Developments

In order to improve the network connectivity for RNC users spread all over the country and to achieve a higher reliability, plans exist to add

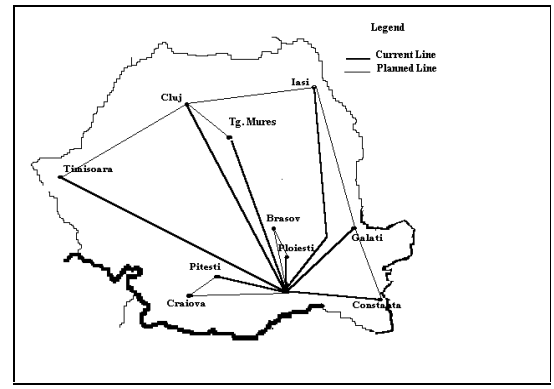

Figure 5. Planned national backbone network

redundant links within the national backbone network, as shown in Figure 5.

Future development's plans concern the following:

- Upgrade the international links to higher speeds;
- Consolidate the robustness of the national backbone network;
- Upgrade of the speed on the links within the Bucharest backbone network;
- Consolidate the user access by increasing the number of dial-up lines and providing terminal servers;
- Provide information servers (gopher, www, ftp anonymous, etc.)

5 Main Obstacles in the Development of the Network

Various kinds of obstacles were encountered since network starting in 1992 [7]. We mention some of them:

- Low speed on the international and national links;
- Poor quality of switched telephone lines;

- Poor cabling inside and outside of buildings for the connection to the public telephone networks;
- Availability of server resources and other computer and communications equipment for user access;
- Low knowledge of people in research institutes and universities about networking;
- Few access points, both for terminal and for SLIP/PPP protocols;
- Lack of human and computing resources to organize a qualified instruction of users and network administrators;
- Poor documentation in Romanian language.

6 Conclusions

The Internet and its applications, tools and services are breaking down the traditional barriers of time and distance allowing the RNC users to communicate electronically at any hour of the day with people located throughout the world.

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