THE ROLE OF THE TPA-70 GATEWAY-NETWORK IN PROMOTING TRANSBORDER DATA FLOW OF SCIENTIFIC INFORMATION IN AN INTERNATIONAL SETTING

A. Labadi
I. Sebestyen

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

ABSTRACT

This paper describes the recently developed "TPA-70 gateway-network" of the International Institute for Applied Systems Analysis (IIASA) in Austria, and of the Institute for Computerization and Automation of the Hungarian Academy of Sciences (SZTAKI) in Hungary, and its promoting role in the on-line exchange of scientific information among national and international institutes and organizations. It presents a short overview of the major categories of transborder data flows relevant to IIASA's work, and how the gateway-network handles them. Finally, some operational and technical aspects of this East-West network of gateways are discussed.

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1. INTRODUCTION

There is no single definition of the term "Transborder Data Flow". This phenomenon is described in many documents, in very broad terms, as the movement of information across national borders for subsequent processing and storage in automated data systems [1]. This paper follows a considerably narrower definition. The authors regard only on-line computerized information flow over national borders as Transborder Data Flow; basically the flow of computerized data as handled by the TPA-70 gateway-network, which is run by the Computer Communications Services Group of the International Institute for Applied Systems Analysis (IIASA) and by the Computer Center of the Institute for Computerization and Automation of the Hungarian Academy of Sciences (SZTAKI).

There are many different categories of Transborder Data Flow: the Electronic Fund Transfer of the SWIFT network; the air passenger reservation data of the SITA network; observed meteorological data on the network of national meteorological institutes; news on the network of news agencies such as Reuters; corporate data on the private networks of multinationals such as IBM, Philips or Unilever; technical and economic data on private time-sharing networks such as CYBERNET or the I.P. Sharp Network; scientific, technical, economical, and legal information on EURONET, TYMNET, and TELENET. Through the international links of IIASA in Laxenburg, Austria, information relating primarily to the Institute and its research activities are transmitted. The major categories of IIASA's Transborder Data Flow activities are shown in Figure 1.

Name of Category	Example
Service of scientific time sharing centers	Computational Services of e.g., CNUCE (Italy) or SZTAKI (Hungary) for IIASA; or services of the IIASA VAX 11/780 and PDP 11/70 computers to external collaborators.
Service of data base centers (mainly in the field of science and technology)	Data Bank Services of e.g., Lockheed (USA), ESA (Italy), IAEA (UN), SZTAKI (Hungary) for IIASA; or usage of IIASA private data bases by external collaborators.
Electronic message sending and computerized teleconferencing	For writing joint manuscripts, preparing joint conferences, management of joint projects on e.g., the EIES system (US) or on the PDP 11/70 of IIASA by the TELECTR System.
Bulk (file) transfer of scientific data for remote handling	e.g., IIASA's large global energy models were partly installed at the IBM computers of CNUCE (Italy) or scientific data files loaded from Moscow to IIASA for batch processing on the internal IIASA computers.

Figure 1. Major categories of IIASA's Transborder Data Flow Activities.

2. STATUS OF IIASA'S EXTERNAL COMPUTER COMMUNICATION LINKS

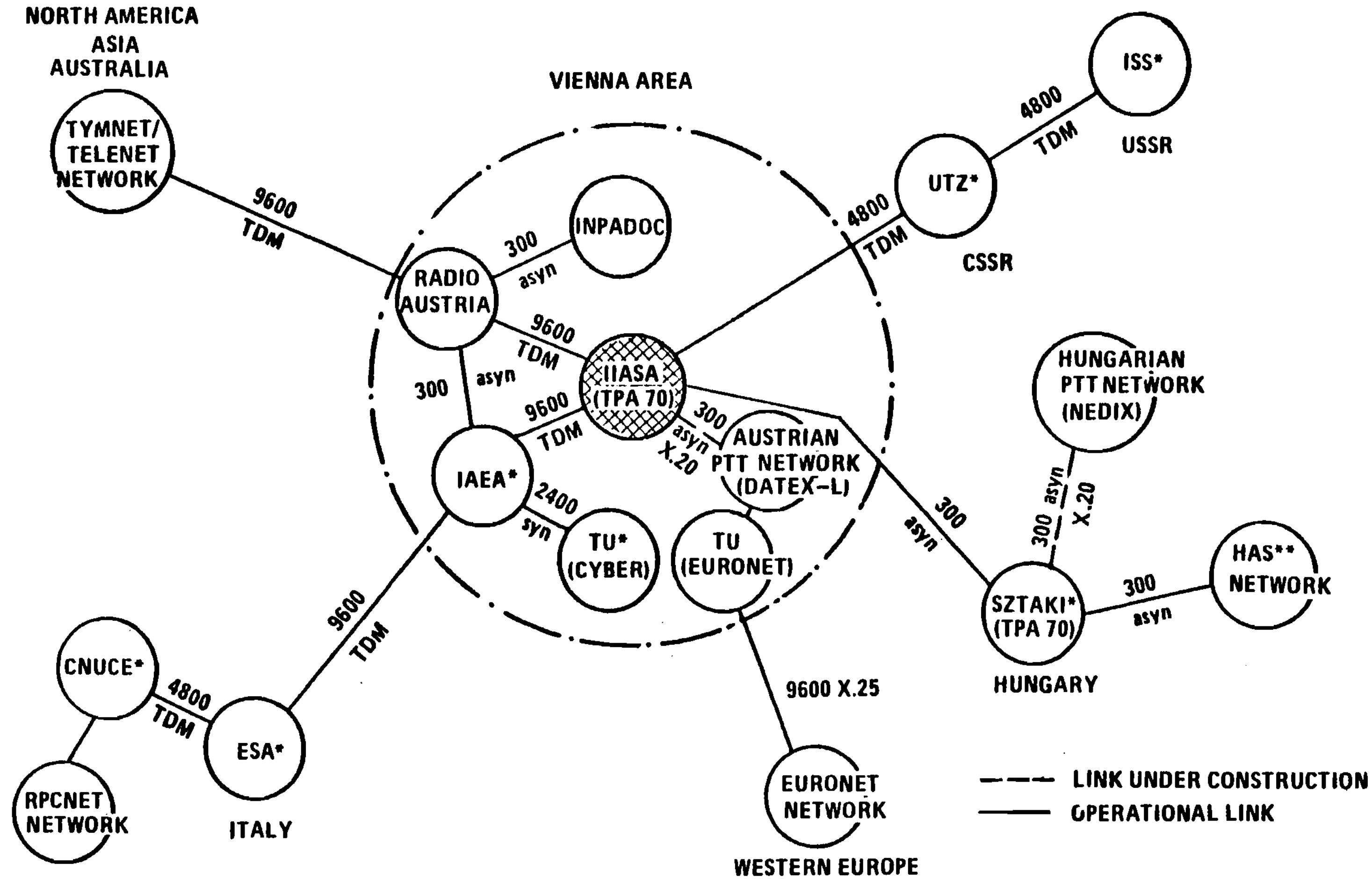
The Computer Communications Services department of IIASA is responsible for providing the telecommunication infrastructure necessary for the above transborder data flow. The basic philosophy of the services provided by this department is described length in earlier papers [2], [3]; the activities of the Institute with regard to the transborder data flow category of electronic message sending and computerized teleconferencing are described in [4]. The present status of IIASA's external computer links through dedicated lines is shown in Figure 2. Compared with figures on the same subject as shown in papers [3], [4], a major step forward has been the installation of the second TPA-70 node (based on the Hungarian made minicomputer TPA-70) at the Institute for Computerization and Automation of the Hungarian Academy of Sciences (SZTAKI) in Budapest. This node is also linked to the computer network of the Hungarian Academy of Sciences, and through it to the IBM 3031 computer of the Academy where work is being carried out on the water quality models of IIASA's Resources and Environment Area. In addition, the on-line bibliographical data base being installed under STAIRS on "Mass Communication Research" compiled by the Central European Mass Communication Research Documentation Centre (CECOM) in Krakow Poland might be of considerable interest to IIASA.

The next important step forward at the TPA-70 node in Budapest will be the connection of the node to the Hungarian Circuit Switching PTT-network NEDIX, which was brought into operation early in 1981. Through NEDIX it is hoped to establish additional direct computer connections with IIASA's cooperating scientific institutions in Hungary.

The missing link--which, in fact, effects a gap in the development of IIASA's external links--is a connection to EURONET which has some specifically Western European databases relevant to IIASA's research. It can only be hoped that some fruitful results will soon emerge from the negotiations between the European Commission and the State of Austria--at least allowing IIASA to become a user of this network.

Figure 2. IIASA'S EXTERNAL COMPUTER COMMUNICATION CONNECTIONS THROUGH DEDICATED LINES

(STATUS AUGUST 1981)



* Collaborating research institutes of IIASA in the field of computer communications

** Network of the Hungarian Academy of Sciences

Another current problem for IIASA is that the planned EURONET connection to Austria will, also for technical reasons, be basically one-way (from EURONET to Austria) not allowing the connection of Austrian hosts, such as IIASA or IAEA to EURONET. Because of this burden the Western European coverage of our computer communication infrastructure is less developed than it actually could be. The final solution to this problem can only be gradually be brought about; i.e., when the individual national PTT networks are interconnected, a long step by step process, due to start soon, which will take place over the next couple of years.

3. THE MAIN FUNCTIONS OF THE TPA-70 GATEWAY-NETWORK

The principle technical description of IIASA's computer communication infrastructure is described in more detail in [3] and [5].

It is basically a mixed system built on node computers performing the usual network functions (switching, routing, multiplexing, flow control, code conversion etc.) and on Time Division Multiplexers (TDM s) . The actual implementation is very much dependent on the technical and financial capability of our partners and of course of IIASA itself. Therefore, the link to the International Atomic Energy Agency (IAEA) and European Space Agency (ESA) was practically conceived as the extension of the private network of the European Space Agency "ESANET", built on TDM s ; thus on this link IIASA had to adopt the same TDM based technology. A similar case was that of the Radio Austria (TYMNET/TELENET) and the Prague-Moscow line. It is, however, planned to replace the TDM technology gradually; the connection to ESA and Radio Austria through packet switching is already under preparation by all parties and the control of the Prague-Moscow line will be taken over by a Czechoslovak made minicomputer CM 4, which was donated to IIASA by its Czechoslovak NMO in 1980. The connection to Hungary was planned from the beginning to be built on Hungarian made TPA-70 node computers. It is worth drawing attention to the fact that the present model of the TPA-70 at IIASA was originally donated to the Institute by CDC and controlled a very early version of the Hungarian made graphical display GD-71. In 1977 when the first plans were made to implement a gateway system for IIASA it was decided, for reasons of economy, to upgrade the original TPA-70 hardware configuration. The enhancement of the system was started in 1978 and is still continuing in accordance with the needs of the growing gateway traffic. At present this rather old TPA-70 hardware--which was built almost a decade ago--performs all major network functions of IIASA with reliability of over 97%. From the software point of view, which will be discussed later at length, the first node version described in [5] was basically one-node oriented. However, after the installation of a second TPA-70 node computer in Budapest, circuit switching network software was put into operation (Figure 5), which will eventually be superseded by packet switching network software supporting X.25. An experimental version of this software is already running, but some further test runs and some additional "value-added" features (such as statistical record generating, direct messaging, monitoring etc.) have to be built in.

The main system functions of the TPA-70 nodes are listed in Figure 3. It mainly performs the usual network control functions plus some specific "value-added" functions which were required to improve the quality of the gateway service. Thus, additional features for remote training and monitoring, for control of authorization (who may access what ?) and for direct exchange of short messages between users of the TPA-70 gateway-network had to be built in. From the "semantics" point of view a short overview of the kind of services the TPA-70 gateway network is actually used for is given in Figure 4. It can be seen that the Institute's connections are primarily used for supporting the research work of IIASA. In addition to this, they allow a form of third party traffic between other international organizations and partner organizations of the Institute, in cases where no other way of connection is possible. Thus, for example, the Hungarian Liaison Office of INIS/AGRIS at the International Atomic Energy Agency can be switched from their terminal in Budapest through the gateway network to the IAEA center in Vienna. This switching function will be discontinued as soon as the appropriate Hungarian and Austrian PTT networks would be interconnected, since it is not the function of IIASA to take over the role of national PTTs in international networking. Another aspect of the provisional

TPA-70 NODE

MAIN FUNCTIONS

--PROVISION OF CONCURRENT TERMINAL-HOST COMMUNICATIONS

--USER-USER COMMUNICATION

--USER-NODE OPERATOR COMMUNICATION

--MONITORING

--REMOTE TRAINING

--SAVING OF THE TRAFFIC OF ANY TERMINAL

--AUTHORIZATION CONTROL

--MAINTAINING OF A DAY-FILE(STATISTICS)

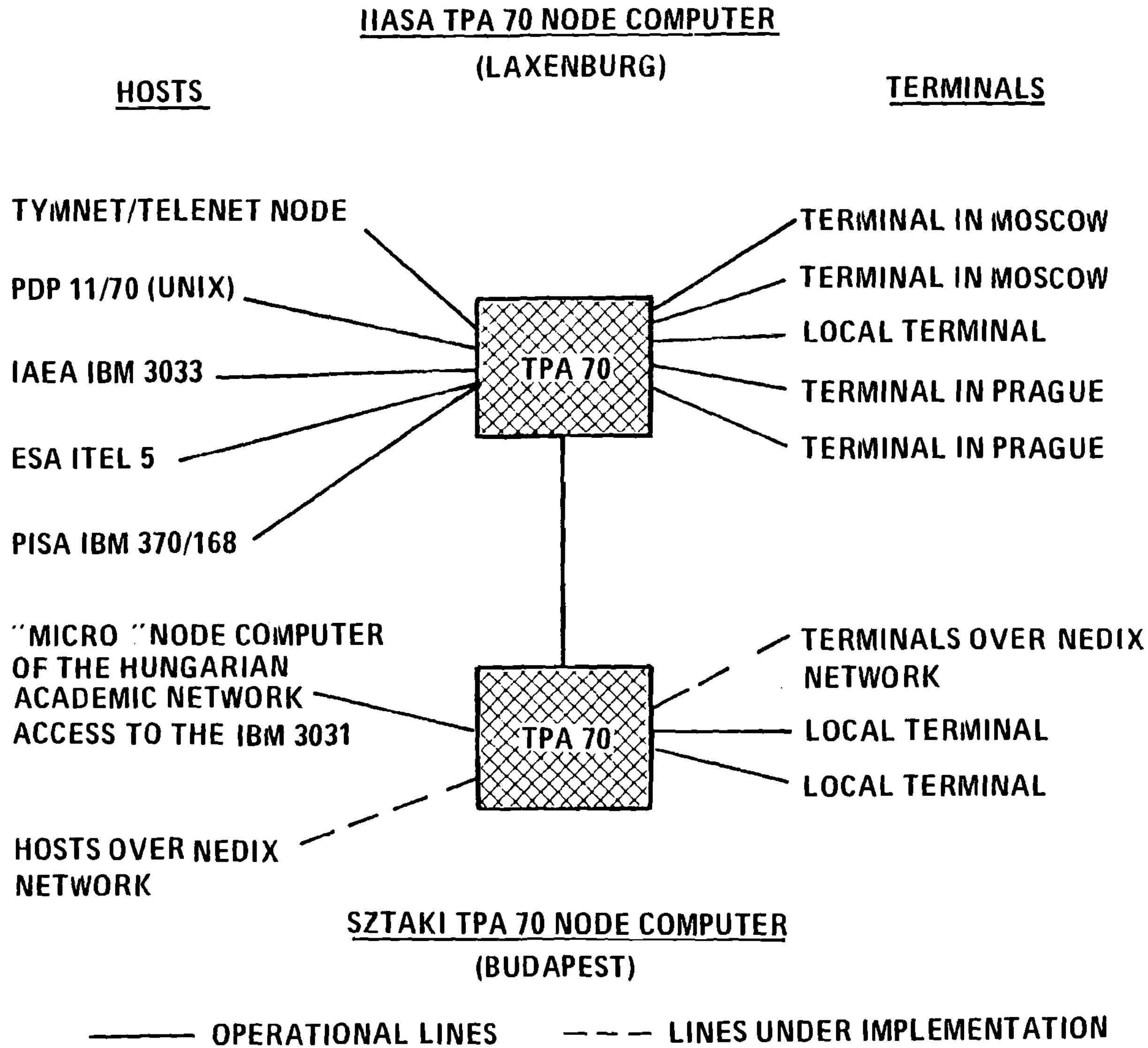
--STATUS REPORTS

Figure 3. The main functions of the TPA-70 node.

Source of service / Consumer of service	IIASA	International Organizations	IIASA Partner Organization WEST	IIASA Partner Organization EAST	Scientific Service Centers (data bases, time sharing)
IIASA	—	-access to data bases -scientific computing	-access to private data bases -scientific computing -message sending	-scientific computing -access to private data bases (experimental)	-scientific computing -public data bases -message sending
International Organizations	-IIASA data bases -scientific computing -message sending	—	—	—	—
IIASA Partner Organization WEST	-IIASA data bases -scientific computing -message sending	—	—	-scientific computing -access to private data bases (experimental)	—
IIASA Partner Organization EAST	-access to IIASA data bases -scientific computing -message sending	-access to data bases of International Organizations	-scientific computing -access to private data bases -message sending	—	-scientific computing -public data bases (experimental)
Liason Offices of International Organizations	—	-access to data bases of International Organizations (experimental)	—	—	—

Figure 4. Switching function of the gateway network according to major categories of scientific application between users and providers of information services.

Figure 5. THE TPA 70 GATEWAY NETWORK



"switching-through function" is its close user group nature. IIASA only grants switching facilities to those organizations, such as UN organizations; collaborating research institutes etc., which are in close relation to the Institute. Thus it may be claimed that IIASA, and its partners, are at present the only organizations which operate the first international gateway-network carrying transborder data traffic in the field of science and research between East and West; as mentioned before, but it represents a closed user group; thus it will not and can not compete with future interconnected national data networks, which will carry transborder data traffic for a considerably broader audience.

4. SOME TECHNICAL AND OPERATIONAL ASPECTS

The present circuit switching version of the TPA-70 gateway network can only handle purely asynchronous lines. It is intended to support primarily interactive traffic. Terminals and hosts using the ASCII code set can be connected to the network with a line speed varying from 50 to 9600 baud. The network is a fully automatic one, but the operator of the nodes has the possibility to change almost any of the operational parameters at any time, if necessary, for each node separately.

The main function of the network is to provide concurrent connection for host-terminal pairs. In principle, any terminal can access any of the hosts connected to it. The connections can be fully transparent, but a certain amount of filtering and limited code conversion can also be performed. The necessary administration of the opening and closing of any connection is minimized in order to make the network as "invisible" to the users as possible. However, several features are included to provide a form of remote user support, to enable fault detection and investigation, and to ensure overall centralized control of the whole system.

One of the terminals at each node can be described as a monitoring device which can display the traffic of any other terminal through the node, having a visual copy of the terminal traffic to be monitored. With the help of terminal-to-terminal messages, instructions can be given to users in trouble using a particular system. The "Duty Officers" sitting at the monitoring devices can also issue commands to the host connected (which can also be seen by the user), thereby also providing a limited form of remote help and training.

The communications lines can run at different speeds, even when they are interconnected. In order to avoid loss of data, "flow controls" are applied.

For security reasons, a strict authorization procedure is also needed. Selectively for each terminal line, it is possible to define--at each network node separately--which hosts are permissible to access. This can be carried out automatically by default values, but can also be changed at any time--if necessary--by the console operators.

The nodes also monitor the status of the lines. In case of any major failure (e.g., loss of carrier), a warning is sent to the operator and the particular connection (if any) is terminated.

A so-called day-file is maintained by each node separately containing all commands issued by any of the terminals or the operator, as well as status reports relating to changes in the status of the lines. Information regarding the date and time of the connections, and the number of characters transferred in both directions, is also kept in the day-file.

5. STATISTICS

The upgraded configuration of the TPA-70 was installed at IIASA in December, 1978. The development of the TPA-70 one-node gateway was finished by May 1980. The regular experimental service of the TPA-70 node at IIASA started in July 1980 and since then the node has been in daily operation, serving the following connections: TYMNET/TELENET, IAEA, ESA,CNUCE, Technical University of Vienna, and the line to SZTAKI (Hungary). The direct connection to the Institute for Systems Studies in Moscow was established on a long term basis in January 1981, followed by the line to Czechoslovakia at the end of February 1981. After a short test period the direct leased line to Moscow was discontinued and the connection to Moscow has been taken over by the direct line to Prague where a Time Division Multiplexer provided for channeling connection to the Institute for Systems Studies in Moscow and collecting local terminal traffic.

The development of the TPA-70 gateway network was finished in July 1981 and started its daily operation in August. The aggregated statistics of the IIASA TPA-70 node for the first half of 1981 are given in Figure 6 and 7.

6. FUTURE

As already mentioned, the capabilities of the gateway network will be further developed. The next version of the network system software will include procedures for providing access according to the CCITT(X.25, PAD) recommendations. It is planned that the X.25 type of connections to Radio Austria, to the so-called "Micro" node computer of the Network of the Hungarian Academy of Sciences, and between the two TPA-70 nodes, will be put into operation in the not too distant future.

Figure 6. **IIASA TPA 70 NODE**

MONTHLY TRAFFIC OF THE TERMINALS IN BUDAPEST, MOSCOW, AND PRAGUE

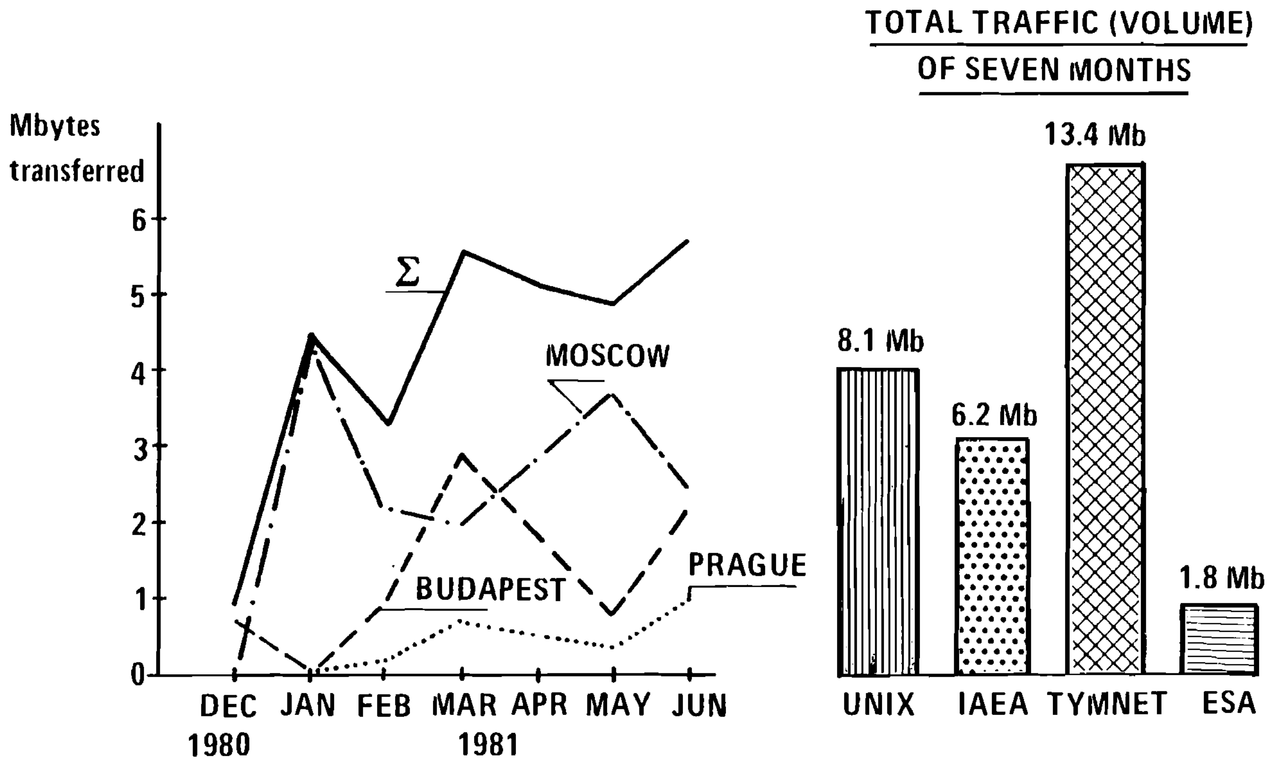
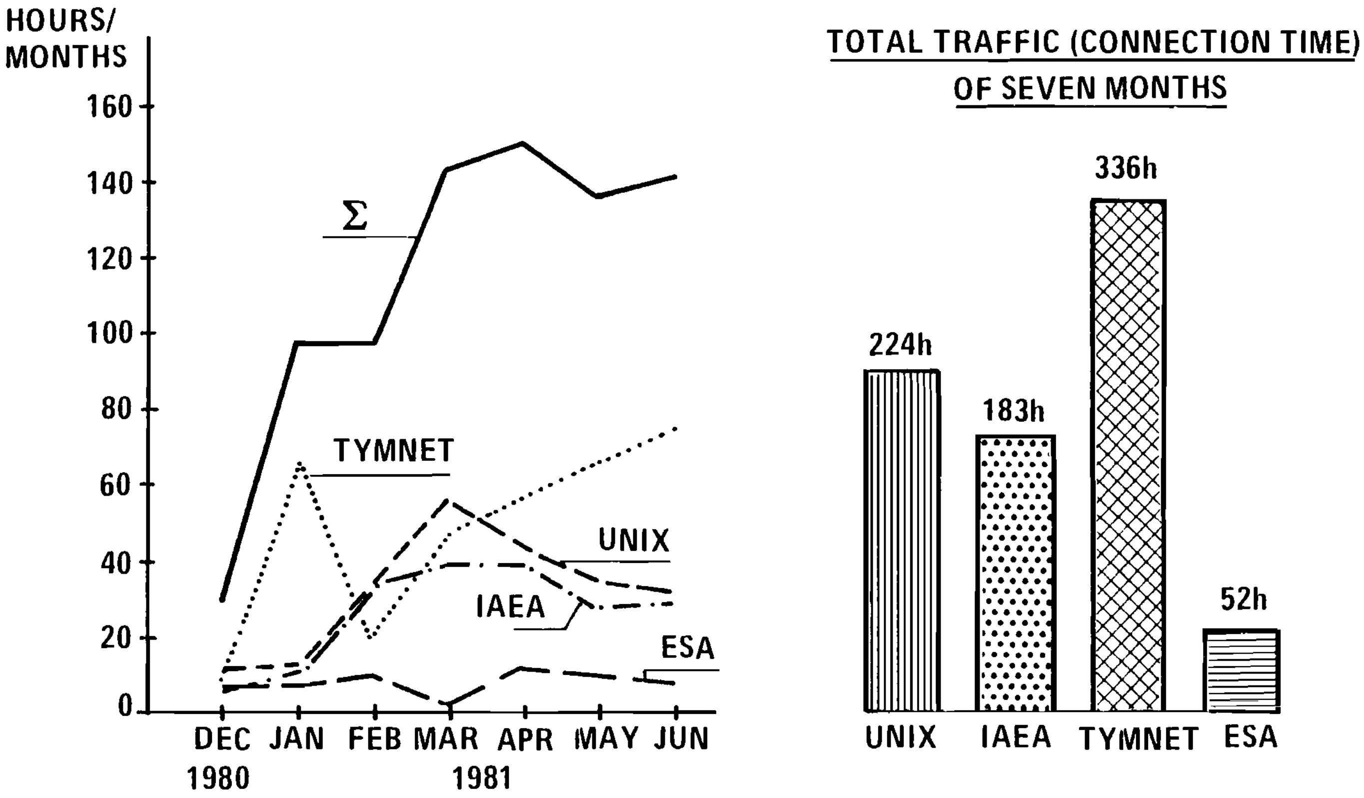


Figure 7. **IIASA TPA 70 NODE**

MONTHLY TRAFFIC OF THE TERMINALS IN BUDAPEST, MOSCOW, AND PRAGUE



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