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PROGRESS AND PLANS OF THE HUNGARIAN INFORMATION INFRASTRUCTURE NETWORK FOR RESEARCH AND DEVELOPMENT

CONSULTANT'S REPORT

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EXECUTIVE SUMMARY

This report, based on visits to some of the IIF institutions, discusses progress achieved since the author's last visit in 1990 and considers IIF's plans for the future, especially in relation to proposed funds from the PHARE programme.

Noteworthy features of the developments over the past three years have been the establishment of a widespread communications network handling a variety of protocols, the creation of a large pool of expertise in institutions throughout the country and the extent of the data cabling installed on campuses.

The PHARE equipment installed hitherto is appropriate for the needs of the community and the plans to establish more regional/disciplinary centres based on the earlier model are sound.

Recommendations are made concerning the rigidity of the PHARE/EC procurement process and its deleterious effects on the IIF programme. The hope is also expressed that PHARE may be able to increase its share of IIF funding from the present level of less than 10%.

1. INTRODUCTION

1.1. 1992 saw the conclusion of Phase I of a project, partly funded through PHARE at a cost of about 700 KECU, to support Hungary's Information Infrastructure Programme IIF. Phase II starting in 1993 is worth about 800 KECU and is part of a scheme worth 2.5 MECU to extend COSINE activities and the associated IXI and European Multi-Protocol Backbone (EMPB) networks to several East European countries.

1.2. This assistance should be viewed in the context of the overall funding for the IIF programme. The Hungarians themselves are contributing 200 Mfts annually through the National Committee for Technological Development (OMFB), the Academy of Sciences, the National Science Foundation and the Ministry for Education and Culture. In addition, there is a loan from the World Bank of some $6M over three years.

1.3. I have been familiar with the programme to develop the Hungarian academic community's Information Technology infrastructure since its inception in the mid-1980's. Towards the end of 1992, I was asked by the OMFB to write a report on the status of the project and the plans for the coming phase, as well as to make recommendations for future actions.

1.4. I was in Hungary in mid-February 1993 and had discussions with managers and technical experts coordinating the IIF programme. As an essential part of the trip, visits were organised to regional centres at Veszprém and Pécs and meetings were held with staff at the Computer and Automation Research Institute of the Hungarian Academy of Sciences (SZTAKI), the Eötvös Loránd University (ELTE) and the Budapest Technical University (BME).

1.5. Prior to my visit, I was provided with some background material but most of what I needed was given to me while I was in Hungary. In addition, it has been useful to refer to a document written by Professor Steve Wilbur and me after a similar consultancy visit in 1990 *[1]*.

1.6. The present report begins with some impressions of the progress made and subsequent sections deal with the main building blocks of the project. Within each section are a summary description of what I found, an indication of development plans and my comments or recommendations. There are also sections concerning PHARE support — including the proposal for the next tranche of equipment — and organisational aspects.

1.7. For convenience, a summary of the conclusions and recommendations is given in the last section.

1.8. Summaries of what I learnt at the institutions I visited are given in an Appendix.

1.9. I have interpreted my brief rather liberally in the hope that my observations on aspects beyond the immediate scope of the PHARE programme will be of use to the Commission, the OMFB, the IIF and the wider Hungarian academic community.

2. GENERAL IMPRESSIONS

2.1. Particularly important objectives of the IIF programme have been the establishment of a widespread communications network and the creation of a pool of expertise able to ensure the effective exploitation of modern computing facilities. Both these goals are well on the way to being attained.

2.2. I have been especially impressed by the advances made in the cabling of campuses. All the places visited have completed the wiring of nearly all their buildings with Ethernet. In many cases, optical fibres have been laid to connect separate buildings. Where sites are more than 1 km apart, plans are in place to lay such cables.

2.3. Another notable phenomenon has been the huge proliferation of PCs over the past couple of years to the point where, as in more advanced countries, no firm information is available about the total numbers in a particular institution. Of course, such an explosion is not without its support and communications problems but at this stage there is no doubting the importance of providing as many PCs for staff and students as budgets will allow.

2.4. At all the sites visited, the staff I met were well-versed in the principles of the relevant underlying communications technologies (X.25, Ethernet, repeaters, bridges, routers etc.). They also understood protocol issues including OSI and the TCP/IP-based stacks. Concrete experience in the operation of large local area networks is also being accumulated.

2.5. The equipment funded through PHARE comprising Unix servers, workstations and X-terminals has now been installed. In some institutions, it is all in one room while at others the decision has been taken to distribute it among several faculties and departments. There has been insufficient time for the growth of a real user base for the workstations. This is an issue which needs to be addressed in the forthcoming phase of the IIF programme and is considered further later in this report.

2.6. Electronic mail is the most pervasive of the user services. This application accounts for a high proportion of the intra-site, inter-site and international traffic. The variety of email systems in operation is large with the attendant problems of interworking and support. This topic was the subject of much discussion with the email experts at SZTAKI. Many options are available but considerably more investigation will be needed to arrive at a feasible resolution.

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2.7. As in other countries, the traditional model of the computer centre as the sole repository of significant computing power and expertise has all but vanished. The sheer volume of PCs has meant that faculties and departments have had to become much more self-reliant for support. Consequently, an indeterminate but undoubtedly large amount of staff effort is being devoted to this activity with possibly uneven results.

2.8. There are opportunities here for rationalisation and economies of scale. Thankfully, it has been recognised everywhere that the operation of large campus networks can only be done effectively by a single central team rather than by uncoordinated groups dispersed throughout an institution.

2.9. The IIF programme has led to the evolution of a large community of experts. It is most important that common solutions be devised and applied to common problems thereby minimising the risk of duplication.

2.10. The regular IIF newsletter is a useful medium for the cohesion of the community, members of which contribute progress reports on their local activities. There are also more detailed technical articles of significance to the community as a whole.

2.11. It is gratifying to note that the IIF has adopted from the UK the idea of an annual "Networkshop" attended by representatives from almost every participating organisation. With an attendance in 1992 in excess of 400, this now appears to be even more popular than its UK counterpart. The Proceedings of the 1992 Miskolc Conference *[2]* exemplify the breadth of users' applications benefiting from the IIF programme.

3. DATA NETWORKS

3.1. Wide area networks

3.1.1. There appears to be good connectivity among the participating regional centres via the public X.25 network of Please Kft (the public packet-switching subsidiary of MATAV; the principal Hungarian carrier). The X.25 technology is a combination of switches developed as part of the IIF programme by SZTAKI (maximum capacity 300 packets/s) and Siemens switches based on old PDP-11 systems with Z80 line cards.

3.1.2. Under a special tariffing contract between Please and IIF. standard rates are charged for data volumes up to a threshold of 10 Mega-segments per month above which costs are proportional to the inverse logarithm of the volume (eg. a traffic volume of 100 times the threshold costs only twice as much). The volume-dependent costs are borne centrally by the IIF programme while institutions pay for the rental of the subscriber lines.

3.1.3. The most serious problem is the low throughput of the switches and the inadequate speed of many of the subscriber links which can be as low as 9.6 kbits/sec. This, coupled with error-prone analogue circuitry, constitutes a severe limitation on the traffic which can be carried. It is understood that Please Kft has plans to offer 64 kbps digital access lines to an upgraded X.25 network based on more modern Siemens equipment.

3.1.4. In common with its counterparts throughout Europe, the Hungarian academic community is intent on developing a separate IP-based network (HBONE) to be operated initially by institutions themselves. The network is to comprise up to

15 routers in institutions interconnected by leased lines running first at 9.6 kbps with data compression and later at 64 kbps. Seven of the sites are already equipped.

3.1.5. This step is essential if Hungary is to remain in line with the rest of Europe. However, the staff resources required to operate such a network should not be underestimated. Network management issues are considered further below.

3.1.6. Although 64 Kbps represents a significant increase in bandwidth, the rapid growth of the user population together with the emergence of applications such as visualisation and multimedia will result in huge traffic volumes. Demands for bandwidth of the order of 100 Mbps between sites will not be long in coming.

3.1.7. If possible, Hungary should bypass any provision of low-speed ISDN and move directly to broadband B-ISDN. This advice is based on the experience of other countries where the advantages of ISDN have not been clear and consequently the take-up has been disappointing. There may be opportunities here for collaboration between carriers and the IIF community in areas such as high speed communications and the exploration of technologies such as ATM switching.

3.2. International links

3.2.1. The links between Hungary and the rest of Europe have become quite complex. This is an aspect which has developed considerably over the past few years. Parallel 64 kbps links to Vienna from SZTAKI and from the Budapest Economics University (BKE) provide primary and fallback international paths. The link from SZTAKI is funded through the IIF programme while the cost of the link from BKE is borne by the Austrian Government and IBM (as part of their support for a donated 3090/170 computer).

3.2.2. There are also 64 kbps links from SZTAKI and the Budapest Technical University to IXI: the European academic X.25 network.

3.2.3. Hungary's access to the European IP EBONE network is obtained via the Austrian IP network. Included in the Austrian Government's contribution to the BKE line costs is Hungary's subscription to the EBONE. This same link also carries traffic to and from the InterNet. The connection to Europanet, the new European Multi-Protocol Backbone network (EMPB), is via Berne.

3.2.4. Here again the restricted bandwidth of 64 kbps constrains the performance for users all over Hungary. During my trip, I myself found it impossible to use a host in the UK interactively because of the long character echo times. There is an urgent need to increase the bandwidth of Hungary's international links whilst preserving the resilience offered by multiple connections.

3.2.5. I am concerned at the vulnerability of the arrangements for the funding of these international links. To rely on the munificence of a foreign government and a multinational computer vendor for such a vital part of the community's infrastructure seems risky and I feel that steps should be taken to reduce this dependence.

3.3. Metropolitan Area Networks

3.3.1. An FDDI network connects the Budapest Economics University (BKE), the Budapest Technical University (BME) and two campuses of the Eötvös Loránd University (ELTE). This appears to have been established at low cost with assistance from Digital and will undoubtedly be of importance in the future. Valuable experience is undoubtedly being gained in the establishment and operation of high-

speed MANs. However, there did not seem to be any major application areas or volumes of traffic currently requiring such bandwidth.

3.3.2. There are plans for a second ring connecting the Technical University, the Horticultural University (KÉE) and the State Administration College (AIF). These institutions together with BME and BKE constitute the University Union of Budapest (UUB). The two FDDI rings are intended to form the basis of an integrated UUB voice and data communications system.

3.3.3. FDDI rings are also being established in Debrecen and Szeged.

3.4. Local area networks

3.4.1. As mentioned earlier, I was impressed by the extent of the LAN cabling installed over the past few years in the institutions I visited. I should however remark that the quality and appearance of the ducting have been variable and there are some particularly unsightly examples.

3.4.2. This is all thick or thin Ethernet cable with some fibre-optic segments between buildings or campuses. It may be appropriate in the near future to consider more flexible schemes such as structured wiring with Unshielded Twisted Pair (UTP) cable. This can be used today in "Ethernet" mode but could in the future operate in the 100 Mbps region with different technologies such as CDDI. The difference in cost between UTP and conventional Ethernet does not appear to be prohibitive.

3.4.3. In general, such LANs are interconnected via bridges and there is a risk that the total network may become so complex as to be unmanageable. One of the problems of rapid growth is insufficient time to plan a more rational solution. However, it will not be possible to neglect this, once institutional networks exceed a certain number of segments. Otherwise there will be serious problems of security, traffic congestion and the inability to handle the increasing variety of protocols.

3.4.4. Unfortunately, the only way of avoiding such difficulties is through the use of routers which are still rather expensive and available only from a limited range of US suppliers.

3.5. Network Operations and Management

3.5.1. The strategic and day-to-day importance of an institution's local area network cannot be stressed too strongly. This vital part of the infrastructure will play a fundamental rôle in the evolution of information-based services which are after all the lifeblood of an academic organisation. For this reason, it is important that the network be planned and operated by a group fully accountable to the institution's governing body. I make this point because I suspect that, in some of the places I visited, those responsible for the network constituted somewhat free-floating groups of experts with little official status.

3.5.2. Several institutions are making use of sophisticated network management packages to control their local networks. These are in general based on the Simple Network Management Protocol (SNMP) which, although not ratified internationally, is certainly an industry standard. Digital have made their DECmcc system available to at least one institution (BME). ELTE is experimenting with Cabletron's Spectrum network management product in collaboration with the Technical University of Vienna.

3.5.3. This accumulation of experience in the use of network management tools is valuable since they are likely to be required at every site. However, they are

expensive and a project has been established to select a standard package for the whole IIF community with the objective of benefiting from a bulk purchasing arrangement negotiated with the chosen supplier.

3.5.4. The operation of wide area networks including HBONE will require strong central coordination and well-defined responsibilities for the various parts of the distributed operations team. I detected signs of unilateral decisions being taken with respect to the management of vital parts of the wide area network and its international gateways. A proliferation of such *ad hoc* arrangements would be a recipe for disaster.

4. SERVICES AND PROTOCOLS

4.1. International and *de facto* standards

4.1.1. In our earlier report *[1]*, we warned of the dangers inherent in excessive reliance on proprietary networking facilities such as IBM's NJE as implemented for EARN/Bitnet. However, there is no doubting the richness of the facilities which EARN offers especially when it comes to the effective utilisation of slow and expensive leased lines or high-cost public packet-switched networks. EARN/Bitnet traffic in Europe now runs predominantly over IP or X.25 links. The network offers built-in facilities for a high degree of multiplexing together with store-and-forward and list serving for the distribution of mail to a large number of local recipients. This helps to reduce traffic on the costly wide-area network.

4.1.2. I remain concerned at the proliferation of protocols (such as TCP/IP, DECNET, Novell) though this was perhaps only to be expected given the expansion of business opportunities in Hungary over the past three years. The consequences of this will be manifold and will include demands for staffing resources to support the increased diversity as well as costly conversion facilities to permit interworking among different protocols.

4.1.3. The prognosis for the adoption of the pure OSI protocol stack (including FTAM, VTP and JTP) is by no means clear. The significant effort expended by vendors in implementing some of the OSI protocols will inevitably be reflected in the prices of the resultant products. This contrasts with the very low cost (zero in some cases) of acquiring implementations of TCP/IP-based protocols such as telnet, ftp and SMTP.

4.1.4. There is much to be said at this stage for the adoption of a hybrid regime with the TCP/IP-based set supplemented by OSI X.400 and X.500 over TCP/IP. This is very much in accordance with the IIF's thinking. However, it should be noted that the worldwide growth of X.400 usage appears to be rather slow and there are no strong reasons why its adoption should be of particular urgency in Hungary.

4.1.5. X.25 and the associated X.29 terminal access protocol will continue to be required so long as any of the IIF institutions rely on public data network facilities for their wide-area connectivity.

4.2. Electronic mail

4.2.1. Electronic mail remains one of the most important facilities provided to the community by the IIF infrastructure. The variety of mechanisms used is truly enormous with consequent implications for long-term support and maintenance. Interworking among the various protocols is provided either by convertors/gateways at particular sites or by a series of such convertors/gateways at SZTAKI. It is not

possible to specify a standard solution to this problem — each site will have to work out its own way of reducing the burden.

4.2.2. SZTAKI staff are responsible for implementing and running major national and international mail services including:—

— the ELLA system (with its related bulletin board and database facilities)
— a central VMS mail gateway (with the option of similar gateways at other sites)
— the Hungarian nodes of EARN and EUnet
— an X.400 PRMD for the IIF community

4.2.3. An overriding objective within IIF is that there should be no protocol obstacles to email communications among members of the community and with the rest of the world. SZTAKI is very much concerned with email gateways which convert among the different addressing schemes and protocols of the various mail systems.

4.2.4. The ELLA system also provides email services for several institutions which do not have mail servers of their own and there are facilities for remote users with PCs or simple terminals to access email in a user-friendly way either by dial-up or by X.29 connections. ELLA offers a Hungarian user interface and handles the Hungarian accented character set.

4.2.5. ELLA runs on a IBM mainframe under VM and there are plans to port the ELLA system to a Unix box. I understand the motive for such a step but wonder whether the perpetuation of the homegrown ELLA system, despite the undoubted richness of its facilities, is not storing up serious problems for the future.

4.2.6. Alternatives may result in a disruption of service to some users but this might be outweighed by the longer term benefits. Among the solutions I discussed with the Hungarians was the public domain POP package for servers with its associated NUPop interface for PC clients. POP runs over IP (or its serial line version SLIP for dial-up links).

4.3. Information services

4.3.1. The IIF community has recently become an active participant in the international Paradise project to coordinate X.500 directory services. This will allow information about individuals (such as their telephone numbers) to be stored in a distributed database accessible from anywhere on the global academic network. Through work at SZTAKI, steps are also being taken to implement structured information services based on the Gopher system.

4.3.2. A natural by-product of the IIF's connection to the Internet is access to bulletin boards such as Usenet News and to distributed software libraries such as Archie.

4.3.3. Of course, there continue to be a large number of PCs which are not yet directly connected to IP networks. For such equipment, access to facilities like Usenet News, Archie and Gopher can be achieved by simple terminal access to an appropriate server in X.29 terminal mode.

4.3.4. I was not able to study library systems in any depth. However, I noted that at least one institution has developed its own fully integrated library system which handles bibliographic databases, the library catalogue, reservations and loan records. Some institutions have purchased commercial products which make full use of the local LAN to provide library access from any system on the network. There may be

case for a coordinated approach towards library packages with the aim of securing a financially attractive bulk deal for the whole community from an appropriate supplier.

4.4. Administrative computing

4.4.1. In only one of the organisations I visited was any mention made of computing for administrative and finance departments. Experience elsewhere suggests that moves towards a market economy lead to departmental autonomy with consequent demands for access to centrally held information especially finance and student records.

4.4.2. The danger of a too rigid separation between academic and administrative computing is that different dedicated networks get set up to meet the different needs. Consideration should therefore be given to mechanisms for integrating all information services onto the same network.

4.4.3. There are technical solutions to meet concerns about the security of financial and other restricted information such as personal data.

5. PHARE SUPPORT

5.1. Existing equipment

5.1.1. The model of the typical regional centre proposed in the earlier bid for PHARE assistance comprised Unix workstations, servers and X-terminals. The server was also to act as an email hub and a primary Domain Name Server (DNS). The objective was to provide a basic infrastructure at each site upon which significant extensions and additional services could be built.

5.1.2. The success of this strategy was evident from the places I visited. However, delays in the procurement process have meant that the equipment purchased with the PHARE money has only recently been installed. Thus whilst services such as email and DNS are fully operational, there has been insufficient time for the establishment of a large user community for the workstations and X-terminals.

5.1.3. Regional centres have taken different approaches towards the physical placement of their equipment. Some sites have set up all their equipment in a single "cluster" in one department while others have chosen to distribute the workstations and X-terminals among a number of user departments.

5.1.4. Summaries of the position in the centres I visited are given in the Appendix.

5.2. The forthcoming procurement

5.2.1. The plans for Phase II PHARE support *[3]* call for equipment to establish more regional centres along similar lines. Each centre would comprise a server, workstations, X-terminals and router facilities. This bid is made in parallel with a larger proposal for finance from the World Bank to provide similar equipment for another set of regional centres.

5.2.2. The equipment specified appears to be appropriate though I have suggested to the Hungarians that consideration should be given to the inclusion of a laser printer in each configuration. This would ensure that each centre could

immediately offer a complete service to its users without reliance on other sources for the provision of such an important output medium.

5.2.3. Some suppliers' implementations of X.400 are inadequate in that they have poor user interfaces and conform to the earlier 1984 specification of the protocol. I therefore endorse the IIF's insistence on the provision of the ISODE OSI package on the servers. This would also ensure the availability of an X.500 implementation.

5.2.4. I heard complaints about a lack of documentation with the Phase I equipment. This appears to have arisen because of an omission in the contract. My strong advice for the forthcoming phase is to list every single piece of hardware, software and documentation that is to be delivered and to make this a formal part of the contract. Experience proves that, although this might seem like hard work, it is well worth the effort.

5.3. Applications software packages

5.3.1. The provision of modern Unix workstation facilities remains an important objective in its own right if Hungarian academic users are to be on a par with their counterparts in other countries. However, the lesson to be learnt from the IBM-compatible PC and the Apple Mac is that the mass market for a particular technology only really develops as a repertoire of useful applications packages becomes available.

5.3.2. Negotiations with DEC on a campus licence for their software are in their final stages with the result that DEC software will be almost free to any user. A further consequence may be that a DEC station at each PHARE site could be used for network management.

5.3.3. Unfortunately, third-party applications software was not part of the earlier procurement. Thus, apart from the DEC software, only a limited range of mainly public domain packages is available on the systems. Commercial packages are costly and it is unlikely that Hungarian institutions would accord them high priority from their own limited foreign currency budgets. Consideration should therefore be given to a reservation funds for applications software within the Phase II budget. The range of applications available on tendered equipment should also be one of the criteria in the evaluation of bids.

5.3.4. Because of the high cost of software, it would be worth establishing a mechanism whereby bulk deals could be negotiated with software vendors on behalf of the whole IIF community. In the UK, the Combined Higher Education Software Team (CHEST) carries out just such a function for our academic community.

5.4. Procurement procedures

5.4.1. During my visit, widespread concern was expressed about the effects on the IIF programme of the extended timescales of the procurement process. A major sticking point appears to have been the requirement to prove that at least 90% of the equipment to be purchased originated from an EEC or PHARE-supported country.

5.4.2. This stipulation has been extremely difficult to interpret and the wisdom of its literal application remains questionable. It is ironic that, just when the COCOM restrictions are being relaxed for countries like Hungary, they should now be facing a different set of procurement constraints.

5.4.3. As I understand it, an important objective of the PHARE programme is to provide a stimulus for Hungary to overcome several decades of technical isolation and backwardness. This requires them rapidly to acquire experience of the best equipment which is already available to their counterparts in the more advanced countries.

5.4.4. Without exception, the leading computer manufacturers and software vendors are multi-national, with significant operations in all the advanced countries. The subjection of each tendered item to rigorous analysis to determine the origins and associated percentages of its component parts is resulting in delays which the Hungarians can ill afford.

5.4.5. It is not clear whether systems and applications software are covered by the procurement rules. Inclusion of the former would eliminate all Unix systems while inclusion of the latter would eliminate almost any system because of the huge volume of software originating from the USA.

5.4.6. To put matters into perspective, it is worth remembering that the extent of the proposed PHARE assistance is less than 10% of the overall IIF budget (including the World Bank contribution). The Hungarians have wisely chosen to combine the PHARE and WOrld Bank funds so as to streamline the procurement process. It would be very unfortunate if, as a result of the EC rules, they were to be thwarted in this objective and forced to initiate multiple procurements against the PHARE and World Bank funds separately.

5.4.7. It is therefore to be hoped that a somewhat less rigid approach will be adopted towards the forthcoming procurements funded through PHARE. It would also be desirable if PHARE funds could be used to purchase equipment such as routers for which there are no suitable products of European-origin.

5.5. Funding

5.5.1. One of the objectives of support from PHARE is to put sites into a strong position to bid for much larger funds from elsewhere including their own institutions. Earlier sections have mentioned examples of the extent to which this has been successful such as the degree to which many IIF institutions have installed data cabling throughout their premises and the rapid growth in the size of the pool of network experts.

5.5.2. The competition within Hungary for equipment in the next phase of the IIF programme attracted over 100 bids of which only 12 could be funded from the PHARE budget. It is therefore clear that the level of EEC funding is insufficient and the EEC should consider increasing its contribution significantly in the longer term.

6. PROJECT ORGANISATION

6.1. Current arrangements

6.1.1. The IIF management structure comprises:

— a Supervisory Board responsible for overall policy issues, with senior members of the funding bodies; OMFB, the Academy of Science, the National Science Foundation and the Ministry for Public Education;

— a Steering Committee responsible for the development of the programme, with technical experts representing the funding bodies:

— a Technical Committee concerned with implementation details, with experts from participating organisations;

— an Appiications Committee, with over 400 members from all the IIF institutions representing the interests of the users and coordinating their activities.

6.1.2. The Technical and Applications Committees report to the Steering Committee. There is a Programme Coordination Office, currently within the SZTAKI organisation, which is responsible for the day-do-day management of the project including the handling of contracts etc.

6.2. The user tender

6.2.1. One of the aims of Phase II is to establish new regional and disciplinary centres or to enhance existing ones. Sites were selected by a bidding process which began with the specification of a user tender *[4]*. This single tender covered both the PHARE and World Bank funds

6.2.2. Respondents had to guarantee to meet certain conditions such as the provision of LAN and WAN access to the acquired systems and had to prove their ability to serve large communities of users both inside and outside their institutions. Of course, in addition to specifying what equipment they required, they also had to indicate the proposed application areas.

6.2.3. Bids were shortlisted by the Applications Committee and the final selection was made by three referees (two from the Applications Committee and one from the Technical Committee). Borderline cases were considered by the full Technical Committee and recommendations were then made to the full Applications Committee. A final ordered list was submitted for approval to the Steering Committee which made some small changes in the rankings and the amounts of money to be allocated.

6.2.4. The selection criteria were:

— the importance of the application area
— the quality of the technical description of the application
— the ability of the institution to fulfil the rôle of a regional or disciplinary centre
— the state of the institution's technical and infrastructural development

6.2.5. Successful institutions have been invited to participate in the procurement of the equipment.

6.2.6. This open approach towards the direct involvement of end-user sites has been a characteristic of the whole IIF programme since its inception. It has undoubtedly shaped the cooperative spirit which I detected during my visit.

6.3. HUNGARNET

6.3.1. The earlier somewhat loose affiliation of institutions to the IIF programme has recently been formalised with the establishment of HUNGARNET (the Hungarian Academic and Research Network Association). This is a not-for-profit legal entity with about 300 signatories, including governmental and non-governmental bodies, research laboratories and factories.

6.3.2. Its purpose is to represent and assist member institutions within the framework of the IIF programme. An important change brought about by the creation of the new organisation is the greater flexibility for the programme to seek members,

sponsorship and funds from outside the academic community and even from other countries.

6.3.3. HUNGARNET will represent Hungary in international bodies such as RARE, EARN and RIPE.

6.3.4. HUNGARNET is to join the ISODE consortium, one consequence of which will be that ISODE will be freely available for all HUNGARNET equipment.

6.3.5. Similar steps to create umbrella organisations for national academic networking programmes have been taken in other countries eg. DFN in Germany and UKERNA in the United Kingdom. The establishment of HUNGARNET is a welcome development.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Principal features of the developments over the past three years have been the establishment of a widespread communications network handling a variety of protocols, the creation of a large pool of expertise in institutions throughout the country and the advances made in the cabling of campuses.

7.2. A large amount of staff effort is being devoted to supporting the rapidly expanding number of PCs in departments. There are opportunities for rationalisation and economies of scale possibly by setting up central PC support teams in each institution.

7.3. The IIF programme has led to the evolution of a large community of experts. It is most important that common solutions be devised and applied to common problems thereby minimising the risk of duplication.

7.4. The regular IIF newsletter and the regular Networkshops are important vehicles for the cohesion of the community, the dissemination of information and enlarging the pool of experts.

7.5. The proposed establishment of the IP-based HBONE network is essential if Hungary is to remain in line with the rest of Europe. However, the staff resources required to operate such a network should not be underestimated.

7.6. If possible, Hungary should bypass any provision of low-speed ISDN and move directly to broadband B-ISDN. There may be opportunities for collaboration between carriers and the IIF community in areas such as high speed communications and the exploration of technologies such as ATM switching.

7.7. There is an urgent need to increase the bandwidth of Hungary's international links whilst preserving the resilience offered by multiple connections.

7.8. Steps should be taken to put the funding of the international links onto a more stable footing, independent of foreign governments and equipment vendors.

7.9. There are many examples where the quality and appearance of ducting for local area networks are unsatisfactory.

7.10. Consideration should be given to structured wiring for local area networks using Unshielded Twisted Pair (UTP) cable.

7.11. Once LANs exceed a certain size, routers yield significant benefits over bridges in terms of security, traffic volumes and the handling of diverse protocols.

7.12. Local area networks should be planned and operated by groups fully accountable to each institution's governing body.

7.13. There would be advantages in adopting a standard network management package for the whole IIF community through a bulk purchasing arrangement.

7.14. The operation of wide area networks including HBONE will require strong central coordination and well-defined responsibilities for the various parts of the distributed operations team. There is a danger of unilateral decisions being taken with respect to the management of vital parts of the wide area network and its international gateways.

7.15. The prognosis for the adoption of the pure OSI protocol stack (including FTAM, VTP and JTP) is by no means clear. There is much to be said at this stage for the adoption of a hybrid regime with the TCP/IP-based set supplemented by OSI X.400 and X.500 over TCP/IP. However, the worldwide growth of X.400 usage appears to be rather slow and there are no strong reasons why its adoption should be of particular urgency in Hungary.

7.16. The variety of mechanisms used for electronic mail is very large, with consequent implications for long-term support and maintenance. It is not possible to specify a standard solution to this problem — each site will have to work out its own way of reducing the burden.

7.17. Although the reasons for porting the ELLA system to a Unix box are appreciated, consideration should be given to phasing it out so as to avoid the burden of long-term support and maintenance.

7.18. There may be case for a coordinated approach towards library packages with the aim of securing a financially attractive bulk deal for the whole community from an appropriate supplier.

7.19. Consideration should be given to mechanisms for integrating academic and administrative computing onto the same local networks in institutions.

7.20. Delays in the procurement process have meant that there has been insufficient time for the establishment of a large user community for the workstations and X-terminals. Regional centres have taken different approaches towards the physical placement of their equipment. Some sites have set up all their equipment in a single "cluster" in one department while others have chosen to distribute the workstations and X-terminals among a number of user departments.

7.21. Provision of the ISODE package should form part of the forthcoming procurement contract to ensure adequate implementations of X.400 and X.500.

7.22. It is recommended that the contract should list every single piece of hardware, software and documentation to be delivered to avoid problems such as missing documentation.

7.23. Consideration should be given to a reservation of funds for applications software within the Phase II budget. The range of applications available on tendered equipment should also be one of the criteria in the evaluation of bids.

7.24. Because of the high cost of software, it would be worth establishing a mechanism whereby bulk deals could be negotiated with software vendors on behalf of the whole IIF community.

7.25. The extent of the proposed PHARE assistance is less than 10% of the overall IIF budget. It would be unfortunate if a very rigid interpretation of the EC procurement rules were to cause significant delays and to force separate procurements for the PHARE and World Bank funds.

7.26. It would also be desirable if PHARE funds could be used to purchase equipment such as routers for which there is no suitable product of European-origin.

7.27. The level of EEC funding is insufficient to meet the emerging needs of the IIF community. Consideration should therefore be given increasing the contribution significantly in the longer term.

7.28. The establishment of HUNGARNET is a welcome development in putting the collaboration among IIF institutions onto a more formal footing and increasing its flexibility to seek wider commercial and international partnerships.

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VISITS

A1. THE UNIVERSITY OF VESZPRÉM

A1.1. The leading rôle in the provision of computing services has been taken by the Department of Information Technology and Automation, which has specialist interests in process control, signal processing, robotics and measurement theory.

A1.2. By September, they plan to complete the laying of cable between buildings on their campus with optical fibre running in Ethernet mode. Cable installation and the provision of Ethernet components have been the responsibility of a local firm.

A1.3. As a regional centre, the department already has connections with the Chemical Research Institute of the Hungarian Academy of Sciences and the County Library. It is intended to establish links with a heart hospital at Balatonfüred (20 kms away) and to nearby institutes of Toxicology, Pedagogy and Immunology. The department advises these organisations on the use of email, bulletin boards, ftp and telnet and also assists in the IT aspects of research proposals.

A1.4. Connections to the IIF network have been limited to 9.6 kbps X.25 links but they hope to have at least one 64 kbps link by the summer.

A1.5. Discussions are in progress with the local council about the possibility of a metropolitan area network connecting several academic and municipal institutions.

A1.6. The equipment funded by PHARE was installed towards the end of 1992 and most of it is in one laboratory. A VAX 5100 is the primary DNS and NIS server and acts as the email hub. In addition, it can handle about 30 simultaneous users at X-terminals and provides online documentation from its CD-ROM drive.

A1.7. The backing-up of files on the server is limited to a 95 MB streamer tape but it is hoped to upgrade this in the next phase.

A1.8. There is no printer on the Unix network, printing facilities being provided on a laser printer via a neighbouring Novell network. It is intended to acquire a high-capacity networked printer in the next phase.

A1.9. So far, most of the usage has been for public domain applications of interest to the host department.

A1.10. Most of the staff associated with the new equipment divide their time between academic and service duties. There is a network operations group of three staff.

A1.11. No systems development work of any significance is undertaken. On the applications side, ß-testing is in progress of various products such as Geographical Information Systems.

A2. PÉCS — JANUS PANNONIUS UNIVERSITY (JPTE)

A2.1. Here, much of the activity centres on the network group of four staff which has responsibility for implementing and operating the network. In addition to the equipment funded by PHARE, the group looks after some Novell servers and a

VAX 6000 system with 8 GBytes of filestore running VMS which also serves the Pollack Mihály Technical High School and the Pécs Medical School.

A2.2. A sum of about 20 Mfts is being invested to install Ethernet cable throughout the campus (a maximum span of 500 m).

A2.3. The PHARE equipment is distributed among a number of user departments with links back to a central server which also acts as an email hub and the DNS/NIS primary.

A2.4. The main usage of the PHARE equipment is to run public domain Unix packages including Computer-Aided Design, Natural Sciences and teacher training. The network group undertakes the basic introduction of users to the new Unix facilities.

A3. SZTAKI

A3.1. SZTAKI continues to be a focal point for IIF activities and a stimulus for technical developments in the IIF community. These aspects of its work are dealt with in the main body of the report.

A3.2. On behalf of the IIF programme, SZTAKI staff are responsible for deploying equipment funded by PHARE to act as a reference centre, to develop facilities of community-wide significance and so that assistance can be given to other centres.

A3.3. A VAX 5100 server provides access via X.29 to bulletin boards (such as Usenet News), distributed software libraries (such as Archie) and Gopher-based information services. Over 50 public users of these facilities have been registered, none of whom has their own access to IP-based services. DEC has provided SQL on this machine and, in the future, a number of databases will be mounted on it.

A3.4. Two VAX 3100 workstations and three X-terminals are extensively used by SZTAKI and IIF staff for development work and demonstrations. They are also used by students attending courses on networking organized and financed by the IIF.

A3.5. A VAX 5500 is currently used for the installation of the ISODE X.400 package. By the end of May, this will become the PRMD for HUNGARNET and the first X.400/SMTP gateway.

A4. EÖTVÖS LORÁND UNIVERSITY (ELTE)

A4.1. This is a large institution of some 11,000 students and 1500 academic staff, with 23 buildings on 9 sites. Its IT Centre has about 60 staff.

A4.2. The Network Services Group (12 staff) looks after the network and email as well as providing Facilities Management for the library. The installation of cabling and network cards for PCs is centrally controlled and standardised. Given the size of the institution, the group needs more staff specialising in hardware.

A4.3. The Computer Services Group (>40 staff) looks after computing for university finance and administration and undertakes some PC repairs. The university runs an Oracle-based student administration system jointly with the Budapest Technical University (BME).

A4.4. A newly established User Support Group (5-6 staff) has responsibility for VMS, Unix and conventional user support functions. They intend to set up courses on basic computer literacy.

A4.5. The faculties and the larger departments have local computer support staff of their own.

A4.6. Of the equipment funded by PHARE, a VAX 5100 acts as an email hub and the DNS/NIS primary. The rest of the equipment is distributed among departments. Three VAX 3100 workstations are in the Informatics Department where they are used primarily to teach Unix.

A4.7. As a Regional Centre, ELTE collaborates closely with the Budapest University of Economics (BKE), especially in an IBM initiative with both institutions. There is also cooperation with the Semmelweis Medical School and the Budapest Technical High School.

A5. BUDAPEST TECHNICAL UNIVERSITY (BME)

A5.1. Although not yet a recipient of equipment funded through PHARE, BME is scheduled to become a regional centre in the forthcoming phase.

A5.2. This is another very large university whose computing equipment already comprises some 2000 PCs, 50 to 60 Unix systems (from IBM, Sun, DEC, Hewlett Packard, Convex and Silicon Graphics) and a similar number of VAXes. There are also about 60 Novell servers.

A5.3. A World Bank loan of 30 Mfts has helped in the acquisition of several of the Unix systems including a large central server whose functions including the rôle of mail hub.

A5.4. The email gateway to SZTAKI is based on a PC. Email traffic amounts to about 10 Mbytes per day most of which is external. ISODE and the associated PP package for email are mounted on an IBM RS/6000.

A5.5. The Information Centre of 40 staff comprises three main groups — Networks, Finance and Student Records. The Networks Group has seven staff with responsibility for the very extensive campus-wide network composed of many Ethernet segments. The group also runs tutorials for the administrators of the University's Novell, VMS and Unix systems.

A5.6. The Finance Group deal with accounts and salaries on central VAX systems while the Student Records Group runs distributed Novell networks.

A5.7. As a large customer, the University has a special relationship with DEC. This extends to their hosting a DEC Support Centre staffed by DEC employees (three full-time and two part-time) who provide on-site advisory and training services for University users of DEC facilities. For its part, the University acts as a demonstration site for DEC products.

A5.8. The University has succeeded in acquiring free of charge network management products from DEC (DECmcc), Sun (SunNet) and IBM (NetView). The DEC software is being used to manage bridges, cisco routers and DEC network components using SNMP.

A5.9. BME is already linked to ELTE and the Budapest University of Economics (BKE) by an FDDI ring installed partly with assistance from DEC. There

are plans to install a second ring connecting BME and two other colleges of higher education in the Budapest area.