PART I. A PROPOSAL FOR THE DEVELOPMENT OF
COMPUTER NETWORKING FACILITIES AT IIASA

and

PART II. IIASA NETWORK PROJECT

J. H. Sexton

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A PROPOSAL FOR THE DEVELOPMENT OF
COMPUTER NETWORKING FACILITIES AT
IIASA

As a result of meetings with Computer Institutions in Hungary and Czechoslovakia, it has become clear that there exists a concrete opportunity to establish the basis of a Computer Network available as a direct communication resource to IIASA Scientists.

That there is a need for Data Communication facilities has become increasingly obvious, as a direct result of the difficulties experienced in exchanging information between IIASA and the NMO's, and between the NMO's themselves.

In accordance with the aims of the project to improve and facilitate cooperation between IIASA and Home Institutions a proposal for a preliminary computer network has been drawn-up, which will enable IIASA projects to make pilot studies in cooperation with remote centres. It will also provide the necessary experience to expand and improve such communication. The latter is important to the decentralisation of IIASA research and to the widening of its sphere of influence.

The proposal is one for joint participation with the Computer and Automation Institute in Budapest, and the United Nations Computing Research Centre in Bratislava. The costs would be shared equally between all three participants, and each would supply computer time and the necessary man power.

In order that the completion of the first phase of this work should coincide with the planned IFIP-IIASA conference in September, a timetable has been drawn-up for a starting date of the 1st April. It is emphasized however, that the present proposal is purely provisional, and open to modification. When draft proposals have been made by all three parties a meeting will be convened to agree a final form for the proposal.

The technical details of the proposal now follow:-

PROPOSAL FOR AN EMBRYO COMPUTER NETWORK

The essence of the proposal is to connect together three computer centres as shown in the diagram:-
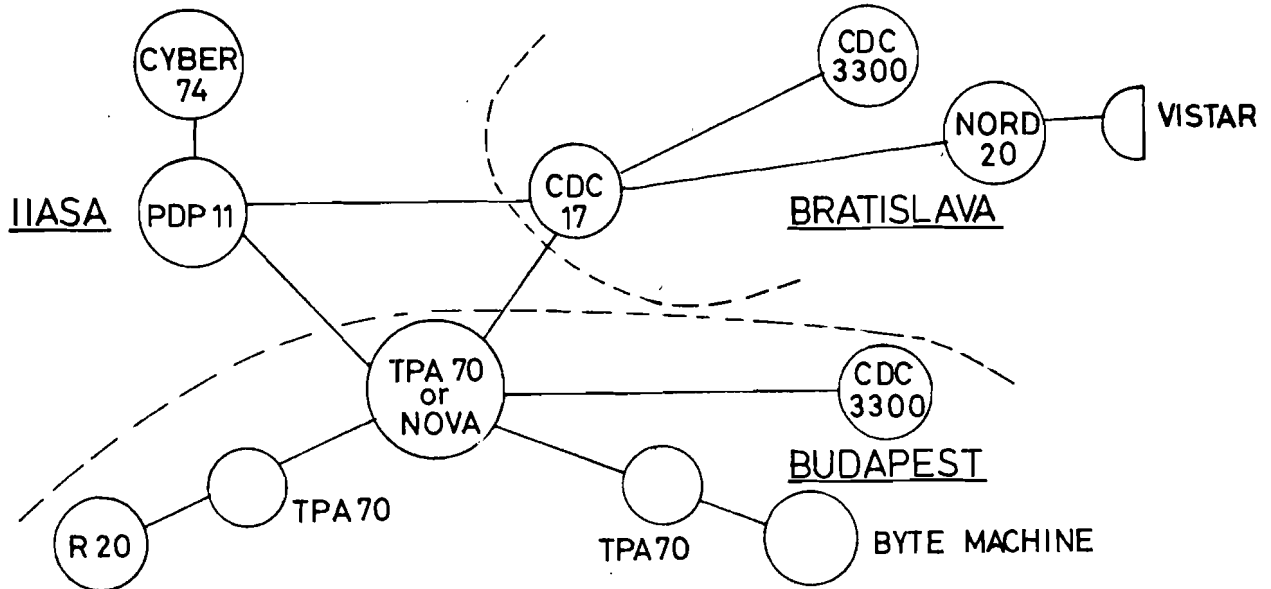
The exact arrangement at Budapest would be decided in course of the project. It might, for example, be unnecessary to use 3 TPA-70s, their function might be included in 2 machines or even only one. Part of the study would be to decide these questions as a result of measurements of possible maximum throughput.

Equally the Bratislava centre would be organised by the management there and each of the 3 links would be negotiated by the two parties concerned. However, it is recommended that when agreement in principle has been reached, that joint meetings of all parties concerned should be arranged.

It is further proposed that the network should be a packet switched network, and that a common packet protocol shall be agreed and implemented. The line protocols may have to be different, but wherever possible a uniform method will be used.

All software should be written in a common language, and in
a modular portable form, with the purpose of free distribution
of all products of the project between the centres. It is
necessary to define three separate functional entities in a
packet switched network. These are:-

1) <u>NODE</u>

   The purpose of a node is to perform only the switching
   function, i.e. to accept packets and to re-direct them
   according to the addressing information in the headers.
   It may be connected to any numbers of hosts and nodes.

2) <u>HOST</u>

   This is a source and/or destination of packets, and
   can only be connected to nodes.

3) <u>GATEWAY</u>

   A special case of a host, which is used to connect
   two distinct networks together. It is a host on
   both networks.

   It is possible to implement one or more of these functions
on one computer, and this will normally be necessary in order
to use the computers efficiently. The following minimal
arrangement is proposed:-

<u>AT IIASA</u>

   Host and Gateway functions
   be implemented. The Gateways
   will provide connections to
   Cyber (CDC network) and to
   Cyclades network.

AT BUDAPEST

Node and Gateway functions.
Gateway to CDC-3300.
It is recommended that the
network connecting the currently
proposed Front-End machines
should form part of the
presently proposed network
so far as protocols are
concerned.

AT BRATISLAVA

Node and Gateway functions.

It is possible that Technischer Hochschule, Vienna may
wish to participate in this project. In which case it would
be possible to include Cyber 74 directly in the network as
a Host, and to eliminate the need for a Gateway at IIASA.
This would mean that we could take advantage of the high
speed connection.

SOME DETAILS

It is recommended that line speeds not less than 2400
baud be used and that synchronous modems are employed. It
is desirable that a standard interface such as V24 be used
for the modem to computer connections. Examination should
be made of the possibilities for automatic dialling of the
connections, and of the available possibilities and costs
for connection.

PROGRAM AND TIMETABLE

STARTING DATE: 1st April 1975

1) Decisions on allocation
   of hardware, choice of modem   - 1st May 1975
   and lines. Language and
   operating systems selection.

2) Choice and implementation
   of line protocols for
   the three principal lines   } - 1st June 1975

3) Design and implementation
   of Node and Host software for
   a chosen packet structure   } - 1st August 1975
   and protocol.

4) Examination and experimental
   implementation of Host-Host
   and other higher level protocols } - September/October 1975

5) Demonstration of joint networking
   during IIASA Conference   } - September 1975

NOTES

The dates shown, are the dates by which the work should
be completed. In most cases this work can be done in parallel.
For example, the packet structures and protocols should be
discussed in detail as early as April since they have a bearing
on choice of operating systems.

For phases 3 and 4 interactive terminal test programs
should be written to enable verbal communication between the
experimenting stations.

Implementation of Gateways and other internal centre
extensions should be performed in parallel and a study should
be started at an early stage to determine what services should
be provided.

It is recommended that the work be progressed in such
a manner that any facilities which become available at any
stage are not excluded by later developments. In particular
that the use of the existing attached computer resources
continues to be available as at present from terminals.

DIVISION OF WORK AND MANPOWER

Taking into account the known resources, the following recommendation is made:-

IIASA

2 - 3 people.
Host and Gateway software
especially aspects specific to PDP-11.
Protocol design coordination.

BUDAPEST

3 - 4 people.
Line protocol implementation.
Host and Node software implementation.

BRATISLAVA

5 - 6 people.
Node and Gateway software.
Design of test and measurement
programs.

ALL PARTICIPANTS

Choice and design of system
components to be a joint
exercise.

COSTS

All costs incurred separately by each centre to be paid
by the centre involved.

Line costs: with 3 lines, it is possible for each centre
to pay for 1 line each, but costs would probably be most
simply met by the party or parties incurring them.

PERIOD OF PROJECT

1st April 1975 - 31st December 1975.
With a possibility for extension.

J.H. SEXTON
13/3/75

IIASA NETWORK PROJECT

This document is a follow up to the proposal made in March of this year in document CSN001 (attached here for reference). It will detail more accurately the program of work and a proposed new timetable. It also reports on certain aspects of the study that have been made so far and draws attention to some problem areas which require attention.

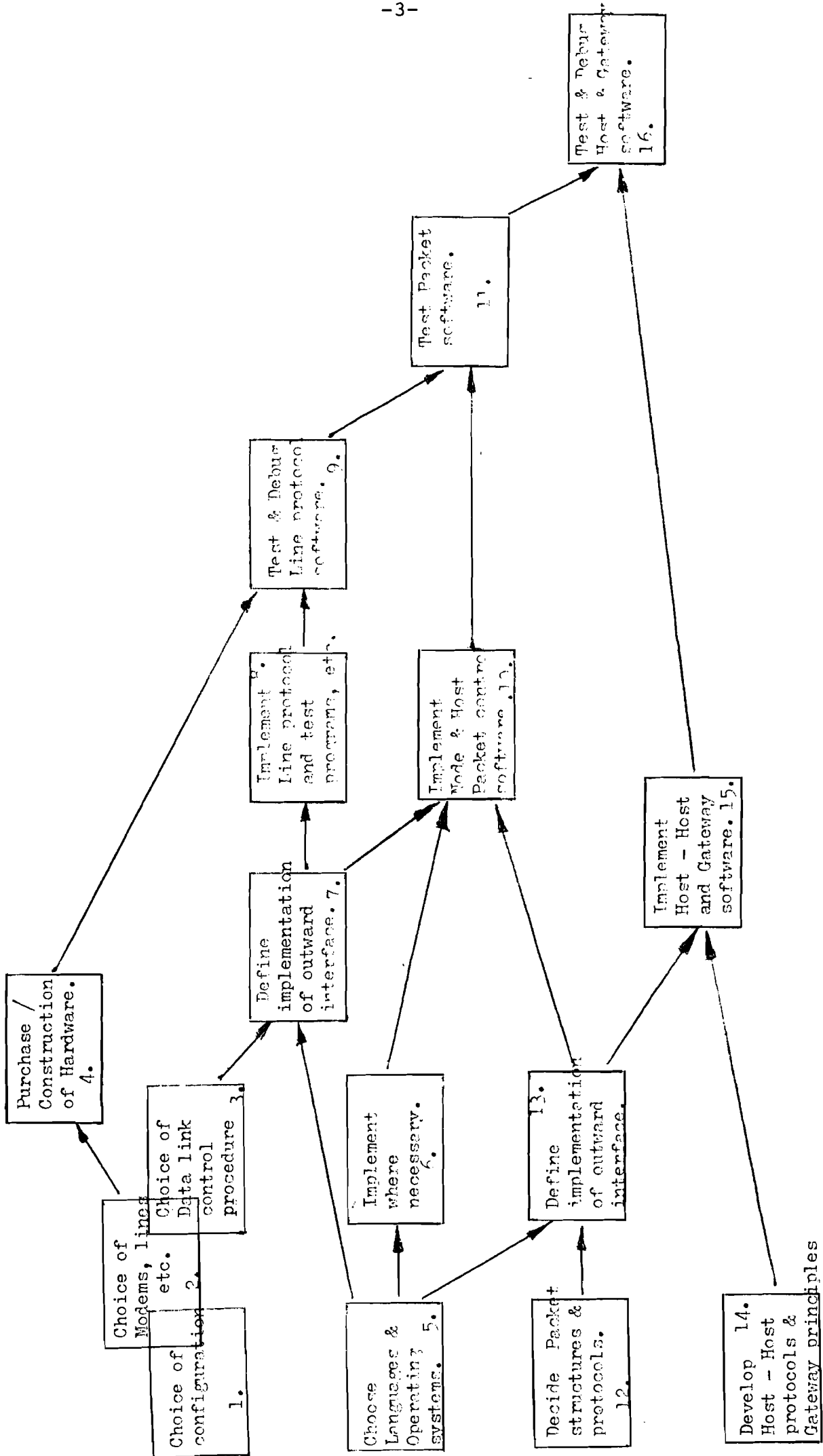John Sexton

Joint Program of Work

On a following page the steps in the program are shown
in a PERT-like diagram. Each box represents one of the tasks
to be performed and the sequence of arrows is to be understood
as meaning that items to the right can only follow the completion
of those items to the left, which are chained by arrows. Items
which are not defined as in order would be dealt with in parallel
so far as man-power permits. Each box is numbered and comments
and notes are listed below according to these numbers. It was
not possible to draw this as a conventional PERT diagram since
the time scales for several of the items depend on decisions
made as to their content. However, for each item an indication
of the range of times is given below where possible.

Items 1, 2 and 3

These can overlap to a considerable extent and they have
already been discussed and studied to a great extent. Another
section of this report lists some alternative choices and
details their advantages and disadvantages. IIASA will lead
this work, but all centres have the right to participate in
the final choice, which needs to be made in the very near
future (not more than one month) since hardware orders have
to be made.

Item 4

This includes the lease of modems and lines and the
acquisition of necessary computer-modem interfaces. Each
centre would purchase its own equipment. It may be possible

Choice of configuration. 1.

Choice of Modems, lines etc. 2.

Choice of Data link control procedure 3.

Purchase / Construction of Hardware. 4.

Choose Languages & Operating systems. 5.

Implement where necessary. 6.

Define implementation of outward interface. 7.

Implement line protocol and test programs, etc. 8.

Test & Debug Line protocol software. 9.

Implement Node & Host Packet control software. 10.

Test Packet software. 11.

Decide Packet structures & protocols. 12.

Define implementation of outward interface. 13.

Develop 14. Host - Host protocols & Gateway principles

Implement Host - Host and Gateway software. 15.

Test & Debug Host & Gateway software. 16.

PROGRAM OF WORK FOR CONSTRUCTION OF IIASA NETWORK
SHOWING SEQUENCING OF NECESSARY STAGES.

to request some hardware support from SZTAKI or Technische
Hochschule in order to construct special purpose hardware of
limited scope. As an example the HDLC line protocol requires
the insertion of a zero after every sequence of five ones and
its removal on reception. It may be possible to design and
build a few copies of such a device for the four or five
centres, using the Burroughs I.C. One or two months will be
required for this item.

Item 5

It was felt that software could be reduced by using a
common systems programming language. It would then be possible
to share the work and distribute produced modules to all
centres. However, this presupposes common interfaces and the
availability of a compiler for the chosen language. Candidates
are: PL11, C(the UNIX language). Certain basic operating
system functions are required: multiprogramming, inter-
process communication, priority scheduling system especially
for interrupt handling. This choice can take from zero to
one month depending on what is available and what choice is
made.

Item 6

Where necessary the operating system would have to be
implemented. At IIASA we would be able (and are obliged) to
run under UNIX. Compilers for the chosen language would have
to be obtained. There is a cross-compiler for PL11 that runs
on CDC 6000 series machines available from CERN or Budapest.
Range of time required from zero to three months depending on
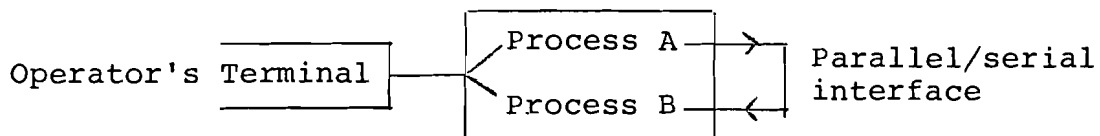decisions made at 5.

Items 7 and 8

Once the line protocol has been selected it is possible to decide the basic manner of implementation in terms of the operating system primitives and the interface to higher levels of software. By separating this definition from the rest of the implementation of the line protocol, it is then possible to start parallel implementation of packet control software and test programs before the line protocol is ready. IIASA is prepared to lead the work on item 7 but will welcome the participation of all centres.

Item 8 of course will have to be completed by at least two connected stations before final tests can be made, and it is possible that there may need to be differences between host and node implementations. Each of items 7 and 8 can be expected to require about one month for their completion.
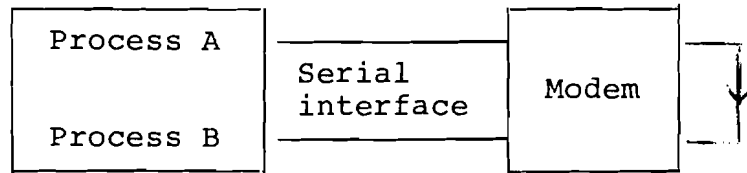
Item 9

Testing can be done partially with oneself without going through a modem, especially if multiprogramming is allowed.

```
                      ┌──────────────┐
┌──────────────────┐  │ ╱Process A───┼─→─┐  Parallel/serial
│ Operator's Terminal├──┤<            │   │  interface
└──────────────────┘  │ ╲Process B───┼─←─┘
                      └──────────────┘
```
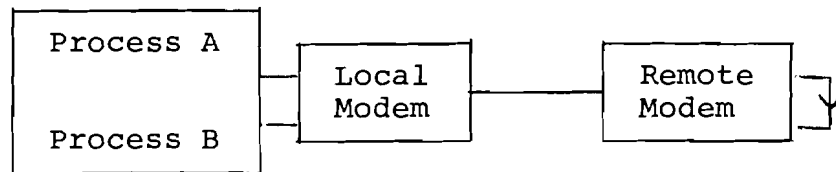
However, this cannot test the timing constraints properly. A next step could be to use local or remote loop-back (i.e. hardware echo) with modems.

Local Loop-Back

```
+------------------+    ----------------+-----------+  ---,
|   Process A      |                    |           |     |
|                  |   Serial          |  Modem    |    \|/
|                  |   interface       |           |
|   Process B      |    ----------------+-----------+  ---.
+------------------+                                      '
```

Remote Loop-Back

```
+------------------+    +----------+     +----------+ --,
|   Process A      |  --|  Local   |     |  Remote  |    |
|                  |    |  Modem   |-----|  Modem   |   \|/
|                  |  --|          |     |          |
|   Process B      |    +----------+     +----------+ --.
+------------------+
```

These tests would have to be done from each end and finally testing of the complete system using both computers would have to be done in cooperation. In this way one link of the network is established. Testing and debugging would overlap the implementation to some extent and it is sufficient to allow half a month for item 9.

Item 12

This can be started at the outset and IIASA would lead this work. Requires up to one month.

Item 13

Can follow as soon as the language and operating system questions have been settled. It separates the form of the interface from the remainder of the implementation much as in item 7 and for the same reason. In practice how far this is necessary depends on how far item 14 has progressed at that time.

Item 10

It would be necessary to implement the software for at least one node and one host. Items 13 and 10 will probably require about one month each.

Item 11

Represents the culmination of a large part of the effort and extensive testing including basic exploitation would take place at that stage. So it is reasonable to allocate at least one month to this. In practice item 16 could be started as soon as a reasonable degree of confidence as to the basic soundness of the rest of the system had been achieved.

Tests can be made by a host addressing packets to itself or to internal node services such as DUMP, ECHO, etc. Later Host to Host via one or more nodes would be tried.

Item 14

It is proposed to develop common Gateway principles where possible since our Network will probably involve quite a few, especially at first. This requires some cooperation but could form a principal research area for one centre. Some sort of Host-Host protocol will certainly be needed but it is felt that present techniques are unsatisfactory and a fresh look should be taken at the whole question of higher level protocols. This is a large and continuing research area in which IFIP Working Group 6.2 is involved. A two month study should allow us to define a protocol for use on the IIASA net.

Item 15

These implementations can take upward of two months. Gateways would be primarily the responsibility of individual centres. Where possible they can be avoided by including desired processors directly in the network, but in such cases it is necessary to implement network software directly on such machines. This is recommended where possible and particularly for the Technische Hochschule Cyber.

Item 16

Testing and debugging should not be a lengthy procedure but Gateways are likely to take the most time. Say one month for Host-Host and two for Gateway software.

Timing of the Project

It is clear that the biggest hold-up is likely to be the time spent on selecting and implementing compilers and operating systems. The time to implement in particular can be at most one month if it is decided to avoid any delay to item 10. However, taking into account IIASA manpower item 12 cannot start immediately and it is possible to allow two months for operating system implementation at the first site (probably Budapest) and longer elsewhere. This should dictate the level of effort and the degree of sophistication required.

The one remaining bottleneck could be the time to obtain necessary hardware and this could delay the initial testing and debugging of the line protocols.

It is clear that with the levels of effort available, the Gateway and Host-Host work will not be held up by the rest of the project and in fact can proceed at a more leisurely pace than suggested earlier.

A provisional timetable is attached which has been devised after taking into account the sequence described above, the probable manpower available and other factors such as delays due to holiday periods particularly in December. It will be seen that the pace is a more leisurely one, but the most important part of the work will still be completed within one year. The work has been divided between the centres on the basis of information provided by them to date, but suggestions for changes are welcome. It will be seen that the bulk of the work falls on IIASA and Budapest. This is because these are the only two centres that are able to go ahead immediately with manpower and computer time. It would help considerably if other centres could take on some of the load especially from October on.

PROVISIONAL

TIMETABLE AND DIVISION OF WORK FOR CONSTRUCTION OF IIASA NETWORK (1975 - 1976)

	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY 1976	FEBRUARY	MARCH
IIASA	Make proposals for Modems, lines, etc. with options. Define/Select line protocol	Agree choices of interface options with all centres. Define upward interface to line protocol options	Implement Line protocol software and test and loading programs for PDP11 as a host, via UNIX.		Test and debug Line protocol, first locally and later with Budapest.			Make provisional specification of Host-Host protocol. Study questions of common Gateway principles.
IIASA	Make provisional proposals for Packet structures and protocols. Study the special problems of using Dialled Networks and route selection and the implications of this on packet protocol. Distribute reports to all centres for consideration.			Discuss these proposals with all centres & adopt an agreed solution.	Define the upward interface to the packet protocol.	Implement the agreed Packet handling software for Host computer. It is intended that this can then be made available to all other centres with Host computers. To that this shall be possible it will be written in the common language and using the agreed interfaces.		
BUDAPEST	Finalise language & operating system proposals.	Discuss & agree proposals with all centres.	Implement operating system and make arrangements for access to a compiler for the chosen language.	Implement line protocol software and test and loading programs for Node computer. It should be possible to share this software as a pure procedure for all the lines of the network via that Node.		Test and Debug Line protocol with IIASA assistance.	Establish IIASA Host software on a Budapest machine.	
BUDAPEST		Design and construct special purpose hardware for the needs of the Line protocol. In particular the HDLC line protocol would need a black box with V24 interfaces to insert zeroes after every sequence of five ones on transmission and to remove them on reception.					Implement agreed Packet switching software on Node computer. It should be possible to copy this software for other Nodes of the IIASA Network.	
MOSCOW BRATISLAVA VIENNA T.H.	Make a study of Line protocols & operating system / language problems.	Discuss & agree proposals with all centres.	Study packet switching & higher level protocols. Make proposals for IIASANET. Develop test and analysis tools	Order hardware and implement operating system software.			Implement Line protocol & test with IIASA/Budapest.	Establish IIASA Host or Budapest Node software as appropriate.

CONTINUATION OF PROVISIONAL TIMETABLE AND DIVISION OF WORK FOR CONSTRUCTION OF IIASA NETWORK

(period April to August 1976)

	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
IIASA	Implement Host-Host experimental protocol		Test Host-Host protocol at first with processes within the one Host. Later with Budapest and other centres. Start initial exploitation using existing packet transport medium.					
IIASA	Test & Debug basic Packet software with Budapest & any other centres that are ready.							
BUDAPEST	Test & debug Packet software. Provide an ongoing test bed for all centres in this area.			Establish Host-Host protocol on a Budapest machine in cooperation with IIASA & test.				
BUDAPEST	Commence studies & implementation of Gateways to CDC 3300 and R machines		Attempt initial exploitation with IIASA and other interested centres.					
MOSCOW BRATISLAVA VIENNA T.H.	Test & debug Packet software.		Study & implement Host-Host & Gateway software. Start initial exploitation. Devise measuring & accounting techniques.					

Study to Date

Effort at IIASA has been concentrated most recently on the questions of the hardware and "data link control procedure" (also referred to as the "line protocol"), i.e. items 1, 2 and 3 from the program of work. Some results and options are listed below.

1. ## Types of Line Available

    There are basically four categories:

    Dial-up: Opinions vary. According to J. Page former assistant director to ESRO only suitable for speeds up to 300 bits/sec. in Europe. But experiments conducted by P. Darvas and D. Bence of the Computer and Automation Institute of Budapest between IIASA and Budapest earlier this year concluded with the opinion that speeds up to 1200 or even 2400 bits/sec. are possible with acceptable error rates.

    Leased line: Suitable for speeds up to 2400 bits/sec. 4 wire option is available, but costs twice as much.

    Conditioned line: Speeds up to 9.6 Kbits/sec., but modems tend to be expensive for the higher speeds.

    Group band: Speeds up to 48Kbits/sec. are possible. But the line rental is about 8 times that of a normal conditioned line.

2. Line Costs

Line charges are roughly proportional to distance up to
about 400 km. If lines are used more than 4 hours/day, then
a leased line is cheaper than dial-up and of course avoids
the sources of noise and difficulty of establishing connection
present with normal dial-up service.

For conditioned lines the charges are about $4 - $10/km
per annum in Europe.

3. Modems

The following features are of special interest:

- Half or full duplex operation;
- Synchronous/Asynchronous;
- Speed and cost;
- Interface;
- Test facilities.

3.1 Half/Full Duplex

Full duplex operation is possible using two pairs of
frequencies over 2-wire dial-up lines and modems are available.
But the speed is restricted to 300 bits/sec. It is felt that
this is just too slow for a computer-computer network, but it
would be possible to conduct some initial tests with such
equipment. However, new modems (and possibly other hardware
and software) would be required when a change to a higher speed
was made.

At higher speeds full duplex operation is only possible
using 4-wire leased lines and appropriate modems.

Advantages

No waiting due to turn-around time of modems. Therefore more efficient utilization of line and greater throughput.

Disadvantages

Reasonable speeds cost twice as much. Change of equipment required for speeds above 300 bits/sec. Software much more complex and difficult to debug.

Half Duplex Operation

Modems available for all speeds. Change of direction requires up to 200 milliseconds depending on modem. This reduces the effective rate depending on the block size e.g. at 2400 bits/sec. transmission of a 1000 bit block takes approximately .4 sec. If the turn-around time is .2 sec., then total time to transmit 1000 bits is .6 sec. This is equivalent to a speed of about 1600 bits/sec. However, this is still much faster than using full duplex operation at 300 bits/sec.

3.2 Synchronous/Asynchronous

Asynchronous operation using start and stop bits with each character is intended primarily for communication with slow simple terminals and is not appropriate to computer-computer communication. If 7 bit characters are transmitted and 1 start bit and 2 stop bits are used the effective use of the line is reduced to 70%.

In any case modems for asynchronous communication are not normally available for speeds above 1200 bits/sec.

Synchronous modems are not normally available for very low

speeds. For the PDP 11 there are two synchronous interfaces

available both intended for operation at 2400 bits/sec. or

higher. The standard version is the DP 11, the other is the

DQS 11 E which is provided specifically for the HDLC line

protocol and does the automatic insertion/removal of zeros,

the inverted checksum (if required) and the construction and

verification of the CCITT Cyclic Redundancy check.

At present at IIASA we have installed two DP 11 - DA's

and also a unit, the KG 11 - A which can be used to perform

the Cyclic Redundancy Check in hardware for any of 5 different

polynomials including CCITT.

3.3 Speed and Cost

A modem for use at 2.4 Kbits/sec. costs upwards of

$1,500. The rental charge for a 9.6 Kbits/sec. modem with

all test features is about $10,000/annum.

3.4 Interface

The CCITT V24 interface is suitable for speeds up to

9.6 Kbits/sec. For higher speeds V35 is recommended. Where

host/node computers have parallel interfaces it will be

necessary to purchase/construct serialisers and avoid spurious

interrupts from Mark or Sync characters transmitted between blocks.

3.5 Test Facilities

Some modems have loop back facilities which permit

local/remote tests without including remote terminal

equipment. The most useful case is where this can be done

on the line side of the modem, but it is often possible to

loop at either side of the modem.

When a synchronous interface is used without a modem it is necessary to have a clock option. This allows tests to be made entirely locally.

4. Error Characteristics

Measures of error rates within Europe over telephone lines show a range of between 1 in 10^3 and 1 in 10^6. Mostly though the errors occur in bursts of which less than 1% are more than 8 bits in length.

For bursty error characteristics it has been found by measurement that the CCITT CRC provides an error rate improvement of about 50,000. So by using this error check and re-transmission it is possible to achieve error rates in the range $\frac{1}{2}$ x 10^8 to $\frac{1}{2}$ x 10^{11}. Taking the pessimistic view, since $\frac{1}{2}$ x 10^8 is about the minimum acceptable quality, it follows that it would be inadvisable to use anything less than CCITT CRC. There are software methods of performing this check using a short algorithm and a table of 256 16 bit entries which are suitable for speeds up to at least 9.6 Kbits/sec.

A second source of trouble are circuit interruptions. These of course are more prone to happen on dial-up lines. An indication of their nuisance value is given by the following figures:

50% are longer than 100 m$^{sec.}$

20% are longer than   1 sec.

10% are longer than 10 sec.

The latter group include of course interruptions of several hours. It is clear that the system needs to be capable of automatically recovering (re-routing or re-starting) from well over 90% of such interruptions and difficulties could arise if time-outs are set too short. Wherever possible at least two routes should exist between any two nodes of the network. Most of the above figures have been derived from papers widely available in the literature, but as a convenient source two books can be consulted. One is D.W. Davies and D.L.A. Barber's book on Data Communications, the other "Computer-Communication Networks" edited by Abramson Kuo.

Data Link Control Procedures

There are two serious contenders for our network. They are HDLC (High level Data Link Control procedure) an ISO standard, and IBM BSC (Binary Synchronous Control). Procedures such as the CDC UT 200 are unsuitable for computer-computer communication. They are intended for terminal control, and difficulties arise due to their demands on processor time. In a terminal they are implemented by hardware which is capable of real-time parallel processing.

HDLC is a relatively new and as yet not fully defined ISO standard. But it has been adapted for use within the European Informatics Network and the Canadian DATAPAC network. In France too a change is proposed to HDLC on the Cyclades network, where TMM-UC and IBM-BSC have been in use to date.

This change is partly for uniformity, but also because of dissatisfaction within the present procedures.

The principal difficulty with HDLC is that a special interface is required to insert a zero after each chain of five ones and to remove these zeros on reception. This is done to prevent the flag character 01111110 from occuring by chance in the body of the message. If we are to use HDLC we must either purchase ready made equipment such as the DQS 11-E (available for the PDP 11) or make our own hardware to do this interpolation. The latter is not too difficult since integrated circuits are available for the HDLC protocol and it is only necessary to provide them with the appropriate environment all of which can be done on one small board, although power supply and connectors would also have to be provided.

If it is felt that the expense or effort required is too great then it would be necessary to fall back on a procedure such as IBM BSC. In any event it will be necessary to add commands to enable automatic dialing/answering and to cope with line break down.

Options

The most fundamental choice is between half and full duplex working. These are as follows:

Either 1) Start with full-duplex asynchronous 300 bits/sec. dial-up lines. Later change to full-duplex, synchronous operation at 2400 bits/sec. leased 4-wire lines.

Or   2)   Use half-duplex synchronous operation at

2400 bits/sec., initially with dial-up lines

and later with leased lines.

The writer would prefer the second option since it is much cheaper, requiring no change of modem and only 2-wire lines. Also the change from asynchronous to synchronous operation would involve extensive re-programming. The experiments with Budapest showed that a speed of 2400 bits/sec. is workable.

Other choices include whether to use existing modems, loop back and other options.

The Data Link Control Procedure Options

Bascially the options are:

1)   Use HDLC and buy/make zero-interpolation;

2)   Use IBM-BSC.

In case 1) it is further necessary to decide what form of HDLC. Here the options are:

A)   Use the EIN format which does not use the address
     and control fields.

B)   Use something along the lines of DATAPAC formats
     which makes good use of the control fields. The
     existing procedures for managing dialled-up lines is
     however inadequate and the writer is currently
     developing an improved procedure. A paper on which
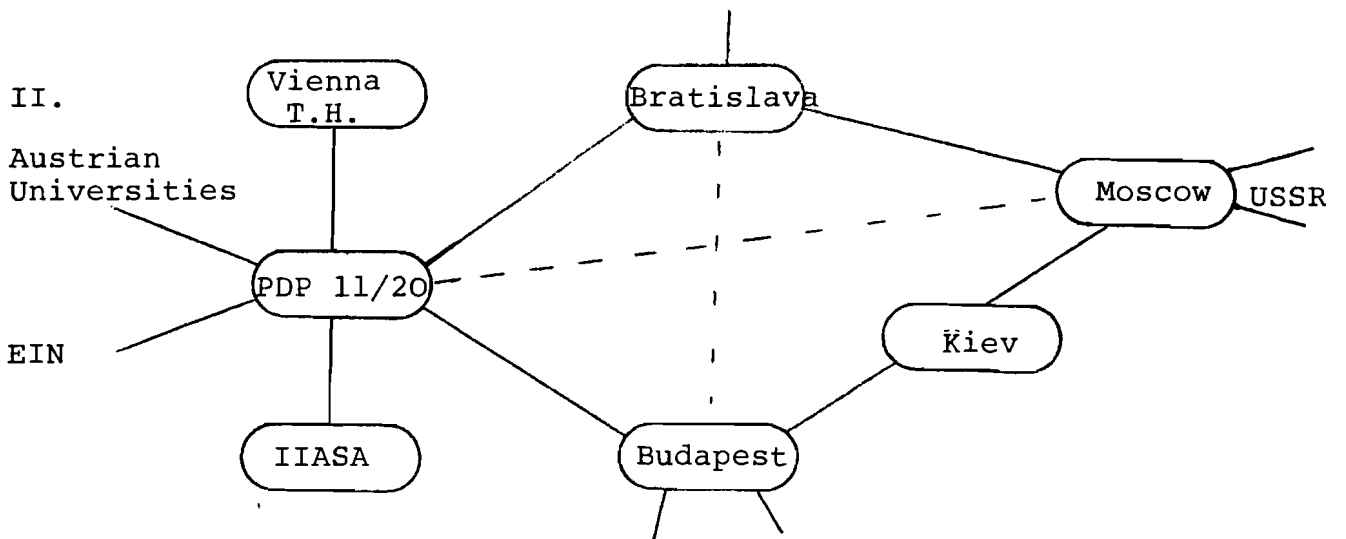   will be circulated to all centres.

The writer's preference is the second case, since it is
much closer to the ISO proposal and there have been some
useful developments in HDLC since its adoption by EIN.

Some Possible Alternative Configurations
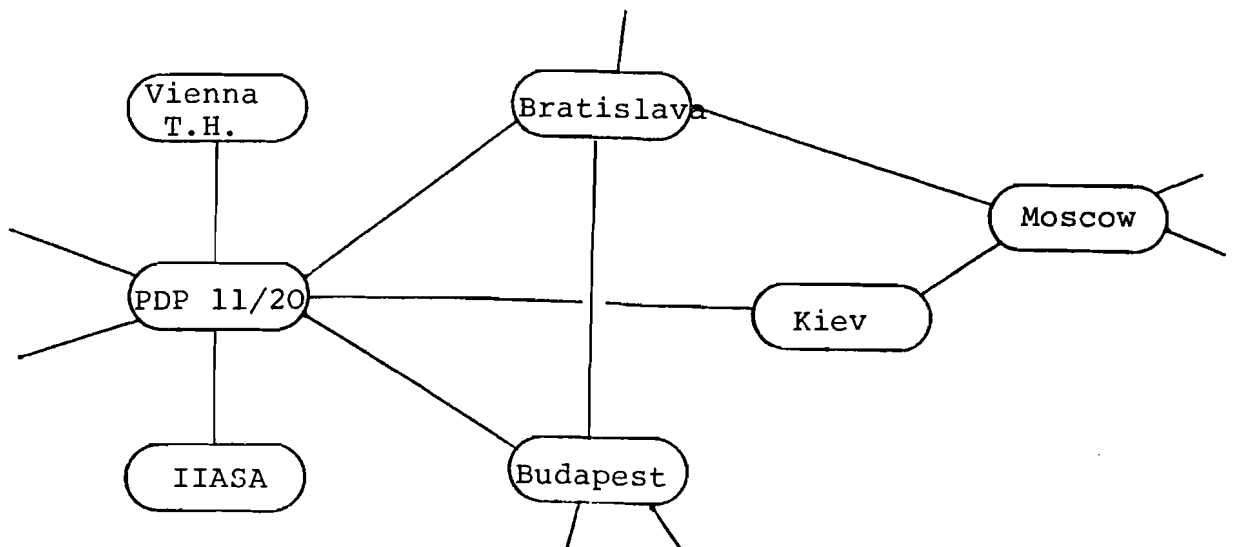for the IIASA Network
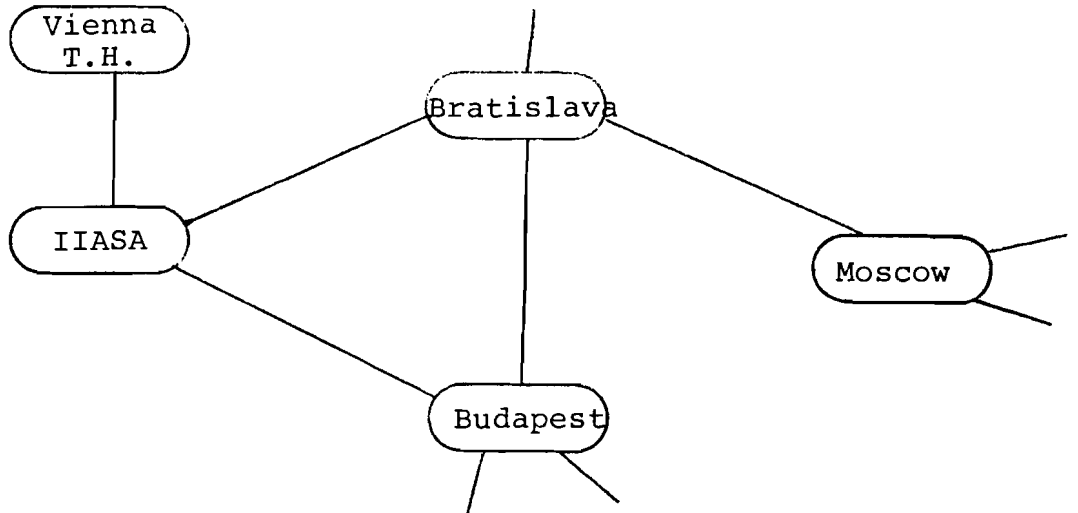
The introduction of a new node between IIASA and Vienna Technical University as shown in II. would have many advantages. Firstly it is not really practicable to use the IIASA PDP 11 as a switching node so that in case I. there would be severe difficulties in routing traffic through the PDP 11/45 to the Cyber or into EIN. It also reduces the load on the IIASA machine to a single channel which could be used both for the network and also in the provision of CDC and IBM service emulators which could reside in the new machine. The IIASA link to the new node would then be operated exclusively with the IIASA net protocols. It would also allow the connection of other Austrian centres and facilitate the proposed EIN connection. Whether such a new node should be purchased and managed by IIASA or whether Vienna Technical University might wish to purchase and manage it is a question which would have to be resolved and comments from interested parties are welcome. The re-arrangement of the links in II. and III. would satisfy the requirement to have at least two connections at each node.

Conclusion

This paper is an attempt to put on paper a lot of the ideas that are now being discussed and it is expected that there may have to be several more iterations before final decisions and programs of work are agreed. All comments should be addressed to IIASA which will function as a clearing house for these decisions. Further papers will follow shortly on the details of the line and packet protocols.

Appendices

The following papers are attached for information:

1. Computer Science Networking document CSNOO1;

2. Extract from DEC PDP 11 manual describing the
    DP 11 interface;

3. Description of the DQS 11E interface;

4. The ISO document ISO/TC97/SC6-1005;

5. A paper by L. Pouzin on "A Symmetrical Point-to-Point
    Procedure with HDLC."