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NETWORKING OF INFORMATION SYSTEMS

ON TECHNOLOGY TRANSFER

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INTRODUCTION

In the process of computerization of technology transfer registries in developing countries one shall consider a more complex system of data processing which implies a number of computers interconnected by communication lines. Such configurations are often called computer networks. The reasons for using this option might be two-fold. First, the functional usefulness of CORIS can be significantly expanded by introducing network configuration. Secondly, since early 1984 when the idea of CORIS emerged the prices of basic hardware for PCs decreased dramatically so that under special arrangements it is possible to buy now three pieces of equipment at the price of one at that time.

The need for network configuration has arisen already in the process of CORIS implementation in Nigeria and in other countries may prove useful as well. One can also imagine using network connections for transmission of data between UNIDO headquarters and TIES member. countries. This relates also to the regional co-operative schemes for exchanging information. In view of the above in this preliminary paper an attempt was made to introduce basic concepts relating to computer networking and its application within the framework of information processing in a technology transfer registry and TIES co-operation. Next, the paper identifies typical conditions and alternative technical and organizational arrangements for networking. It ends up with brief conclusions and recommendation as to how this problem might be dealt with in the future development of CORIS.

I. BASIC CONCEPTS RELATING TO NETWORKING[1]

According to the simplest definition the computer network denotes a complex consisting of a number of different computers. interconnected by communication lines. The networks can be basically divided into two categories:

- local-area networks /LANs/;

- wide-area networks /WANs/.

1. Local-area networks /LANs/

A local-area network /LAN/ transmits data over coaxial cable, fiber optics cable, or similar media, and is limited in the distance it can traverse. A network of this type typically does not extend beydond 1.5 kilometers. In practical terms the LAN concept is being used in connection with the installation of computers in the office or organization located in one building or group of buildings.

It is convenient to separate the short-distance, medium-distance and very-high-speed LANs. The first group listed above denotes configuration where the terminals close to an information processor are connected to that system via cable. These connections are often multipoint but can also be point by point. If the distance between a terminal and the processor exceeds about 45 meters, it is usually necessary to install modem bypass devices at each end of the cable. The modem bypasses amplify the data transmitted over the cable, so that longer distances can be handled without an unacceptable diminution of the signals. Connections of these types are very economical and also very simple to install and operate.

1/ The information presented in this section is based on G.M. Booth, "The Design of Complex Information Systems. Common Sense Methods for Success", McGraw-Hill, New York, 1963.

The second category of LAN is the medium-distance cable
or bus connection, usually oriented toward connecting work stations
processors, and possibly other devices in an office or factory envi-
ronment. The medium-speed LAN is typically a coaxial cable with
connectors for each device to be attached to the cable. Transmi-
ssion speed of this type of LAN range from a few thousand to several
hundred thousand bits per second; higher speeds are not usually
required because of the nature of the connected devices and the
types of data which they exchange. A single LAN cable is limited
to about 1.5 kilometers because of signal attenuation if transmis-
sion over greater distances is attempted. This distance is long
enough for many applications in the office and factory, where
devices which need to exchange data are in relative proximity to
one another.

The third type of LAN is very similar to the second but
differs in being oriented mainly to processor-to-processor connec-
tion with very-high volume transmission. As a result, highspeed
LANs may use a bus or computer input/output channel instead of
coaxial cable. Fiber optics can also be used in high-speed LAN.
In a computer installation which includes large mainframes, a high-
speed LAN might allow the computers to exchange jobs and files,
and/or access a set of shared disc devices.

2. Wide-area networks

The principal factor differentiating wide-area networks
/WANs/ fron LANs is the geographic distance between computer faci-
lities linked in a network. This however has a direct impact on
the use of communication lines. At the national level the data
transmission infrastructure is provided by traditional telephone
networks. As a rule, these are common carriers, i.e. authorized
entities /often with a monopoly position/ that provide universal

communication services for a fee. Where countries are contiguous, these common carriers are merely linked up with each other and transborder data transmission can take place. For transoceanic traffic, international record carriers /in most countries the domestic common carriers/ are authorized by bilateral agreements to provide interconnections through submarine cables and, increasingly through satellite links among common carriers. Most of the capacity of these installations is in the northern hemisphere.[2/]

Several categories of WANs might be distinguished. Private links are transmission facilities obtained from postal telephone and telegraph authorities for dedicated use by the leasing organization. The advantage of a private link is that the connection is always available and no time or action is needed to establish it when data are to be transferred. This contrasts with the use of a switched network, in which a connection must be established each time data transfer is required and contention for use of the network facilities may make it impossible to establish a connection when it is needed.

Private links can be configured in two ways: point-to-point and multi-point. A point-to-point link connects two endpoints, usually a computer and a terminal device or terminal controller, but it may also link two computers and two terminals. A multi-point link connects three or more endpoints and may be more economical than a point-to-point connection.

Private meshed networks are also made up of private, leased links, but the network configuration is far more complex than point-to-point or multi-point. The term "meshed" is descriptive of the typical network configuration which connects a large number of computers and terminals together, and because the require-

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2/ The international use of networks results in the transborder data flows. More on that see "Transnational Corporations and Transborder Data Flows: A Technical Paper", United Nations, New York, 1982.

ments for data exchange between pairs of locations cannot be
accurately predicted, the network connects all endpoints to all
other endpoints.

A distinctive type of networks are public data networks
for which in the United States the term value-added networks is
being used. These are public facilities, shared just as the
voice networks are shared but provided for data transmission
only.

3. Factors affecting the choice of network

The most essential factor affecting the choice of the net-
work type is the distance between the endpoints. Of course, whe-
never the endpoints are geographically located so that connection
using LAN is possible, this ought to be considered before any
other type of network facilities are studied. Even if a LAN can
be used for only part of the total network it may reduce the
costs significantly. Secondly, data exchange pattern shall be
considered. In many systems the requirements for data exchange will
form a star pattern, with local and/or remote terminals or work
stations exchanging data with a central computer location.
In other systems a hierarchical pattern may be formed, with ter-
minals communicating with local information processors, which
in turn communicate with a central installation. Still other
systems have data exchange patterns which form a mesh, because
many endpoints need to exchange data with one another as well
as with one or more information-processing locations. Each of
these three patterns is shown in Figure 1. Other aspects of the
data collection process to be taken into account are the following:
- volume of data exchange;
- periods of time;
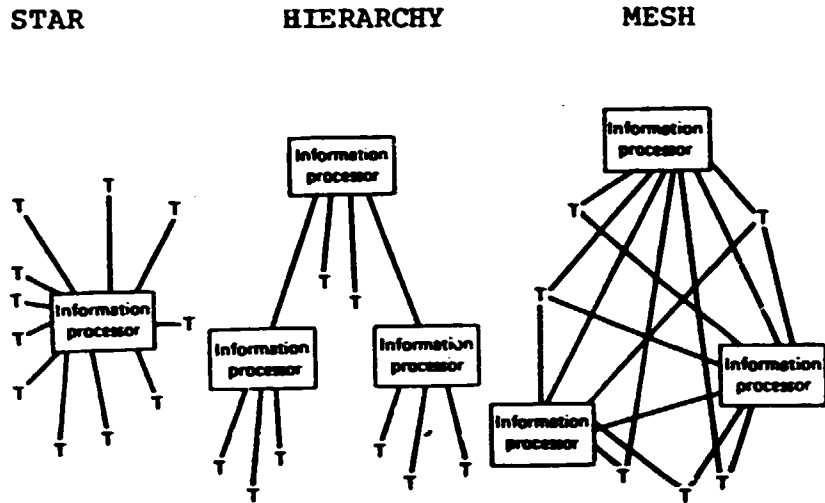- response speed required for each type of traffic.

STAR   HIERARCHY   MESH

Figure 1 \ Interconnection-requirement patterns.

A very important factor in the choice of network facilities
are network protocols. A protocol is a set of rules for exchange
of information and defines both how the information must be forma-
tted for transmission and the series of commands and responses to
be used in the exchange. For many years the protocols were not
standarized, leading to the implementation of networks using many
different protocols - which were often quite inefficient. Some
organizations defined local, specialized protocols which were com-
pletely incompatible with those of any other devices or organiza-
tions. Others modified generally used protocols to meet local
needs. The result was a wide variety of methods for data exchange.

Today thers is a great deal of emphasis on the definition
and support of standard protocols, with more commonality among
different types of computers and terminals than at any time in
the past. The trend is most heavily supported by the work done by
the International Standards Organization /ISO/ in the above men-
tioned area.

II. THE FRAMEWORK FOR NETWORKING IN THE CORIS APPLICATION

In the following analysis typical situations will be out-
lined where the network connections might be used for enhancing
internal and external data transmission relating to the activi-
ties of technology transfer registry.

1. Internal registry local-area networks

The need for establishing internal LAN relates predominantly
to the large technology transfer registries involving substantial
number of agreements being evaluated and complex organizational
set-up. Typically this is being reflected in the functional
and/or branch department organization including the Information
and Documentation Unit. In such case the implementation of CORIS
can be accomplished with a network of 3-5 personal computers:
one with capacity installed in the ID Unit and additional PCs
installed in the evaluating departments and in the office of
registry head. Such network might greatly facilitate the internal
information flows within the registry and control over its opera-
tion. Additional benefits include the possibility of sharing the
peripherial equipment /e.g. printers/ as well as software for
additional functions like word processing, calculations and grap-
hics. The need for network configuration in the CORIS implementa-
tion has been already identified in the case of National Office
of Industrial Property in Nigeria. Consequently a decision has
been made to install a network consisting of one IBM PC/AT and
two PC/XTs.

2. Registry connection within the ministry local-area networks

Typically administrative units performing the registration
functions are placed within larger government bodies such as
ministries, investment boards, etc. In view of the recent inte-
rest in the computerization by government institutions in deve-

loping countries this may favour a network configuration where the personal computer in the registry is being linked to the mainframe, i.e. central processing unit located in the ministry computer department. Such connection facilitates operational integration of technology transfer unit within a given ministry or parastatal and the government administration as a whole.

As to the possible approaches towards ministry LAN connections by the registry two situations shall be distinguished. The first one relates to the case where a given ministry has a well defined computerization programme including detailed specifications for network configuration, hardware and software. Under such circumstances the main problems encountered by the registry may eventually result from different requirements for ministry and TIES/CORIS network connections. A more typical case involves the situation where the ministry has already acquired central processing unit while formulating only general computerization programme with the future plans for networking. Obviously, this provides a more flexible framework for the registry as to the choice of hardware and sotfware. However the overall computerization programme has to be consulted first in order to make sure that when the ministry network becomes operational the equipment installed in the registry fits well into its configuration.

3. Registry wide-area networks

The registry WANs might be used when the registrating functions are spread over a number of government institutions, i.e. various ministeries or regional offices. Under such circumstances it is necessary to establish an operational network facilitating direct exchange of data among respective agencies.

The need for registry WAN may eventually arise in the course of CORIS implementation in the Peoples Republic of China.

4. Regional and interregional wide-area networks for exchanging data on technology transfer

The CORIS system has been developed for facilitating information flows on technology transfer not only within a given country but also internationally, i.e. between UNIDO headquarters and participating countries as well as within regional co-operative schemes. Principally, the network connections have been foreseen in the overall concept of CORIS including some basic requirements on software and hardware as well as data inputs and outputs to be used each registry. Obviously, the international transmission of data requires the use of wide-area networking. As to the communication lines the implementation of CORIS will drastically diminish the flow of hardcopy documentation towards the increased use of mag..etic discs and tapes as well as the transborder data flows through telephone connections.

III. BASIC TECHNICAL AND ORGANIZATIONAL ASPECTS OF NETWORKING WITHIN CORIS/TIES FRAMEWORK

1. Designing network configuration

The comments presented below relate primarily to the local-area networks. Before installing a LAN one has to resolve basic organizational and technical issues. First, the needs and requirements of all network users shall be carefully examined leading to the preliminary decision on the location of each workstation. The design of the configuration shall be further adjusted while taking into account technical parameters of a given network such as the distance between the computer and the tap-box, maximum length of cables connecting computers, maximum number of computers in the

networking environment, requirements for installing signal repea-
ters, etc.

It shall be emphasized again that the networking environment
makes possible to share network rsources like mass storage devices,
printers, etc. In the extreme case a workstation can be operated
only with keybord and terminal while using peripheral equipment
installed in other segments of the network.

2. Software for network operation

Basically there is no need for the customer to write its own
software as the major suppliers offer ready-made network configura-
tions including relevant software enabling network operation.

The principle elements of software adjustment for networking
are the procedures enabling control of access to the network reso-
urces. This is being done most often through password establis-
hing user's privilege at a "server"/whether user can log in, from
what station, and which files he may or may not access/. A more
sophisticated method is based on differentiated security levels
for each category of users. Users may access files only when they
have a security number greater than or equal to that of the file
they are trying to access. The most comprehensive access control
programmes introduce different types of file attributes, e.g.:
- private file-once the file is open, no other user can open
  the same file;
- permissive file - many users may open and read the file, but as
  soon as one user writes onto the file, only he can update it
  and he has exclusive rights until the file is closed;
- implied record locking - many users are allowed to open and
  update the file. When a record is read, a lock is placed on
  that record. If another record is read by the same user, the
  first record is released and the new record is locked. Other

users have access to the record only when it is released;

- explicit record locking - many users are allowed to open and update the file. As many records as necessary can be locked concurrently;

- exclusive update - this mechanism is used in order to assure that only one person can update at a time. Updating a file allowed only once all other users have closed the file. This is useful for files where the update may affect large portions of a file.

CONCLUDING REMARKS

The analysis conducted so far has made clear that networking might add additional advantages to the computerization programme of technology transfer registries. Therefore such option shall be carefully examined while implementing CORIS in various countries.

At the same time it became obvious that networking shall not be merely seen as the acquisition of additional equipment.
It creates specific technical and organizational problems which shall be resolved already at the planning stage. More important however are implications of networking for the registry activities and operations. New opportunities and capabilities in the prospective network arrangements in international TIES exchange have been already incorporated in the overall design of the CORIS system. Definitely greater attention shall be paid to the intra-registry networking and establishing direct computer linkages between technology transfer registries and other government bodies and institutions within each country.