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Biodiversity Conservation Information Network: A Concept Plan

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Abstract

A network that ensures the availability of reliable, up-to-date environmental information is necessary to realise the objectives set out in Convention on Biodiversity (now a treaty) that followed from the Earth Summit at Rio, June 1992. The task of building a nature conservation information network should, therefore, be considered an important part of the biodiversity conservation agenda. This paper presents an outline of a hypothetical information network, designated as Conservation Information Network (***CiNet***), to meet requirements of bio-resources conservation, mapping, inventorying and monitoring on a large scale. The dataflow framework presented takes into account the existing data networks in India.

Keywords: Biodiversity, Conservation, Databases, Information, Network

Background

The Convention on Biological Diversity (**CBD**) that emerged from the United Nations Conference on Environment and Development (**UNCED**) or the Earth Summit at Rio de Janeiro, in June 1992 is now a treaty. The CBD covers almost every aspect of biodiversity conservation. Article 17 of CBD concerns exchange of information. However, it does not lay down any operational framework for achieving information exchange. Nevertheless, an information network that ensures the availability of reliable, up-to-date environmental information is necessary to realise the objectives set out in CBD. The existing information systems are considered to be inadequate to meet these challenges[1].

The task of building a nature conservation information network should, therefore, be considered an important part of the conservation agenda. This paper presents an outline of an information network to meet requirements of bio-resources mapping, inventorying and monitoring programme. The hypothetical network is designated as Conservation Information Network (***CiNet***). The dataflow framework is presented taking into account the ready availability of well-developed data networks in India and the CiNet is conceptualised as an overlay network riding over the existing networks.

Special Interest Groups on Global Networks

Computer networking has gone beyond setting up data links to creating information highways over which organisations and individuals are connected across the globe. The nature conservation efforts need to take advantage of these developments in information technology and create a niche for itself in the cyberspace. There are several important initiatives in this direction such as the INFOTERRA of the United Nations Environment Programme (**UNEP**) consisting of 170 national nodal points coordinated from the UNEP headquarters at Nairobi, the Environmental Resources Information Network (**ERIN**) in Australia with a biodiversity information system designed to meet the changing user needs, the Bio-diversity Information Network (**BIN21**) dedicated to the CBD with its secretariat at the Tropical Database in Brazil, the Long-term Ecological Research Network (**LTER**) based in the University of Washington and the projects in Capacity Building for Biodiversity Information Management begun by World Conservation Monitoring Centre (**WCMC**) based in United Kingdom and the BioNET-International proposed by CAB International to pool the global resources in biosystematics. With the assistance from the United Nations Development Programme (**UNDP**) under CAPACITY 21, a large number of Sustainable Development Networks are also

expected to be set up.

The capacity building project of WCMC is supported by the European Union and allows it to carry out the strategic development work as well as testing of networking and other cooperative approaches for biodiversity information management. BioNET – International is a Global Technical Cooperation Network of institutions and people concerned with biosystematics of Invertebrates and Micro-organisms. The goal of this network, as stated, is the mobilisation and enhancement of the world's bio-systematic resources for the benefit of developing countries. BioNET will build and sustain bio-systematic self-reliance in developing sub-regions and provide the bio-systematic backup to biodiversity.

Several special interest groups and networks (**SIGN**) dedicated to biodiversity conservation have sprouted up all over the global computer network. These SIGNs provide various facilities to users. Some of these are available to the email subscribers to the list. Subscribers usually join a list by sending an email with requisite information to the listserver or the master of the list. The user's name, email address and other information are then added to the email database maintained by the SIGN.

Biodiversity Information Networks in India: current status

There are a large number of Non-Government Organisations (**NGO**) and research organisations involved in conservation related activities and research. India is not only rich in biodiversity, but can also boast of large baseline information on this wealth. The repositories of this information are numerous and diverse, with some of the agencies being more than a century old. Invaluable information exists in a variety of forms: as specimens, field notes, reports as well as various kinds of computerised data.

Despite dramatic developments in information technology and quantum leaps in telecom facilities, the conservation efforts in India are yet to make the best use of the options available for information exchange, barring a few exceptions. The recent discussions on the mechanisms and scope of the information base for biodiversity conservation in India[2], is an indication of this realisation. The information networks for biological conservation are at a formative stage, the front-runner being the network initiative of the Foundation for Revitalization of Local Health Traditions (**FRLHT**).

The well-established and nationwide biological information network is the Bio-Technology Information System (**BTIS**) consisting of the Distributed Information Centres of the Department of Biotechnology supported by **NICNET** - the computer network of the National Informatics Centre (**NIC**). Another biological information service available is the access to the Medical Literature Analysis and Retrieval System (**MEDLARS**) over NICNET, provided to select institutions by NIC. The different institutions with access to MEDLARS do not, however, exist as inter-connected nodes.

Although FRLHT has taken an initiative in creating the Indian Medicinal Plants National Network of Distributed Databases (**INMEDPLAN**), it falls short of the larger needs of networking the conservation activity and bio-resources mapping. This can only be met by the 'inter-networking' of several networks such as INMEDPLAN, BTIS and those in the offing like the Biodiversity Information System (**BIS**) of the Indira Gandhi Conservation Monitoring Centre (**IGCMC**) established by the World Wide Fund for Nature (**WWF**) and the Environmental Resources Information System (**ERIS**) being devised at Wildlife Institute of India (**WII**). The IGCMC proposals, unlike that of FRLHT, appear to favour an over centralised system, rather than a true network of several fully autonomous, distributed information systems.

The INMEDPLAN is a network of organisations involved in identifying, documenting and reviving folk and traditional health systems and in the inventorying of medicinal plants. FRLHT has also attempted to bring about some sort of standardisation in data compilation formats. A large number of organisations are also involved in the consultative process of standardisation.

Although, the BTIS does not have conservation priorities, it provides rapid access to a wide variety of biological databases, besides those

related to biotechnology. Moreover, considering the role that molecular biology and DNA fingerprinting are destined to play in biodiversity inventorying and monitoring, it is important to bring BTIS within the ambit of conservation network.

A recent study of biological databases available in India indicates that the majority of these are developed under BTIS[3]. Although the study does not appear to have examined the information resources available at reputed ecological research institutions, its overall conclusion that the contribution from sources other than BTIS is marginal, may have some validity. The same study also notes that the use of the available databases is restricted due to lack of electronic data transfer facility and networking. The BTIS users make use of NIC's satellite based network for data communication. However, BTIS does not function as a true on-line computer network due to certain limitations imposed by NICNET.

Both ERIS/WII and BIS/IGCMC/WWF are at an early developmental stage. It is important that the originators of these information systems lay down some long-term networking and standardisation goals as part of the design and development activity. What needs to be clearly recognised is that the highly centralised information systems relying on high performance computers are a thing of the past and the future belongs to inter-networking of special interest groups. With a highly decentralised and participatory approach to conservation, it becomes all the more important to anticipate the need for an truly extensive data network and take into account the multiplicity of end-user needs.

As important as access to information or even more, is the access to people and person to person communication on the network. It is such communication which makes the network come alive. The conservation effort in India, has an overwhelming need to create such a 'live' network, particularly because, informal networks of people and organisations exist and have been able to open up large areas of co-operative endeavour.

Information Sharing: some contentious issues

The CBD introduces new elements into the ticklish question of information sharing across political boundaries. Even, where national boundaries are not involved, there are many important matters of protocol and copyrights as well as the rights of local communities that need to be addressed for the network to be operational. However, it is better to take on the bull by its horns.

It has been argued, albeit with good intentions, that electronic exchange of biodiversity information will open a Pandora's box of possible infringements of national rights over genetic resources caused by information flow over global networks. Other contentious issues relates to Intellectual Property Rights (**IPR**) and cultural heritage rights in the context of CBD.

There is a view that until and unless these issues are fully resolved it would be rather premature to think of electronic networks. However, what needs to be taken note of is that most of the information that may be available on these networks will in case be published sooner or later in journals. Publication of findings *per se* cannot be and should not be stopped, irrespective of the media used. Once published in journals, anyone around the globe can put that information out on a network. Thus, any blanket ban on information transfers on network cannot make sense today, when scientific journals are being available on CD-ROMs and almost every important journal is providing back issues as CD-ROM volumes.

It needs to be noted that in countries where the IPRs are enforced, rather stridently, that has not become a damper to information flow on networks. These services are being made use of in India, too, by scientists at research institutes in physical sciences and molecular biology as well as by the software developers. The IPR issues need not be a detriment to the emergence of CiNet. Besides, the network will only allow access to information that is open to public. It does not permit anyone to access any kind of information; all access being subject to the restrictions imposed by the network administrators.

The CiNet

The goal of CiNet is to create a voluntary, on-line 'live wire' network of researchers, government

officials, ecosystem managers, executive decision makers, NGOs and local communities for biological conservation and sustainable development in India. It must be based on best available, cost effective technologies and workable administrative arrangements. Instead of setting out to make large investments in infrastructure building, the network must make the best use of available facilities and function on a cost sharing, no-profit-no-loss basis. To cut costs, the existing networks and access providers can be made active participants in this process.

The CiNet must play the following two roles: a) organise a loose network of organisations interested in conservation and b) establish a well coordinated data network with features and functions similar to the special interest computer networks that exist elsewhere in the world.

The CiNet can succeed only by cooperating with other initiatives and by assuming an inter-networking role. The necessary administrative and technical protocols can be worked out to ensure meaningful cooperation and active collaboration among such organisations. The network must provide mechanisms at different levels for free information flow between these numerous organisations and between networks. The conceptual framework articulated here attempts to address the data flow challenges of the 'massive, decentralised' bio-resources mapping exercise with the active participation of people, suggested by Madhav Gadgil[4]. He contemplates a 'nationwide village level programme of mapping of natural and man-made habitats on the scale of a hectare or so'. The Panchayat Level Bio-Resources Mapping Programme, that he advances, involves teams of 'bare foot ecologists' under the guidance of taxonomic experts and are referred here as Bio-Resources Mapping Teams (**BMT**).

The proposed CiNet consists of a network of Distributed Biodiversity Information Centres (**DBIC**) for data compilation, information processing and dissemination services assisted by several Field Studies Units (**FSU**) and BMTs. Selected institutions active in ecological research and willing to assist the CiNet activities could act as Associate Resource Centre (**ARC**) for the DBIC. These ARCs will also function as value adding nodes on the CiNet. The ARCs are expected to 'add value' by way of analysis and critical evaluation of the data as well as assist the BMTs. The data flow framework of the network is given in Fig. 1 and 2.

The distributed information systems can be networked *via* land and satellite links making use of the telecommunication facilities and datalinks already available in India. The CiNet National Centre (**CNC**) can also provide decision support services to the Ministry of Environment & Forests, Government of India (**MoEF**) and other governmental agencies. The CNC will also be responsible for the overall co-ordination and technical support for the CiNet. In addition, the CNC will also carry out appropriate clearinghouse functions as the information travels across the network. The clearinghouse mechanisms will ensure reliability of the network and enforce quality control and validation checks on the data that is added to the central databases. The CNC must, therefore, have a technical secretariat for its clearinghouse functions. Ideally, the CNC could be located at a site where the best facilities and expertise in information technology as well as bio-resources mapping, inventorying and monitoring are available.

The User Community

The end users of the network are envisaged at different levels of decision-making and management:

a. Macro level executive decision makers, national policy makers, planners, national institutions, national level NGOs such as WWF (India), inter-governmental organisations under United Nations, international development agencies and international institutions for the implementation of the CBD.

b. Decision makers, policy makers, managers, scientists, NGOs and individuals at the state, district and community level.

c. Microlevel planners, community organisations and grass root level NGOs.

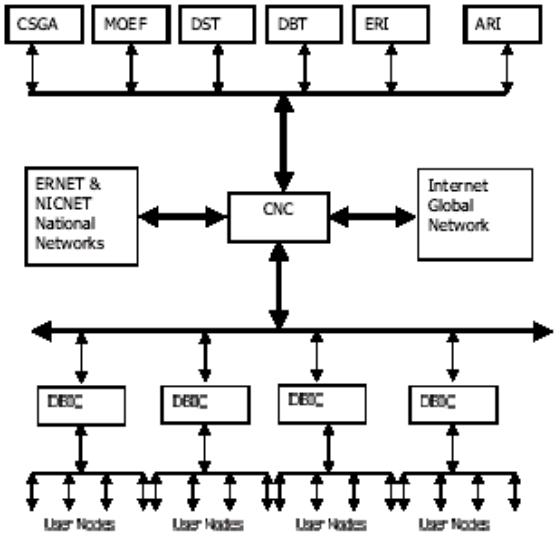
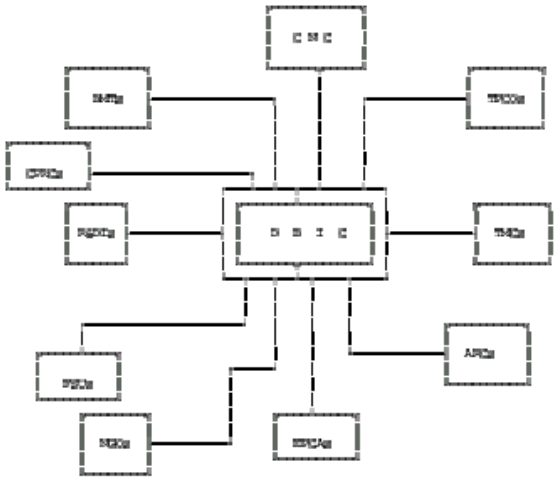


Figure 1: The logical CiNet with links to existing networks

ARI: Agricultural Research Institutions; CNC: CiNet National Centre; CSGA: Central and State Government Agencies; DBIC: Distributed Bioresources Information Centre of CiNet; DBT: Department of Biotechnology, Government of India; DST: Department of Science and Technology, Government of India; ERI: Educational and Research Institutions; MOEF: Ministry of Environment and Forests, Government of India; User Nodes: See fig. 2



Legend

ARC Associated Resource Centre
BMT Bioresources Mapping Team
CNC CiNet National Centre
CPRC Common Property Resource Centre
DBIC Distributed Information Centres of CiNet.
EPCA Environmental Protection/Conservation Authorities
PSU Field Studies Unit
NGO Non-Governmental (non-profit) Organisations
R&DI R&D Institution
TPCO Traditional People's Community Organisation
TMC Traditional Medicine Centre

Figure 2

The logical network at a Distributed Bioresources Information Centre (DBIC)

The CiNet can help the larger goals of biodiversity conservation by addressing the information needs of:

- Protected area management
- Short and long term ecological studies
- Socio-economic studies and development programmes
- Community based development programmes
- Adapting and improving the traditional methods of resource use
- Local communities and bio-resources mapping programmes

The CiNet Databases

Some of the major databases that must be organised under the CiNet are:

- Data on the flora and fauna of India with taxonomic details and information relevant for conservation of bio-diversity.
- Environmental Impact and Status Data
- Sustainable resource use potential and practices; sustainable technological options; socio-economic profiles of sustainable resource use
- Hydrologic and agro-climatic and metrological data
- Institutions, Experts, Resource Persons and NGOs with information on area of specialisation, infrastructure facilities, experience and catalogue information on educational software (printed materials and audio-visuals).
- Bibliographic data extracted from on-line databases and those compiled from Indian publications not covered by international bibliographic services
- Metadatabases on information sources, specimen and herbarium collections, map archives and photo/audio-visual libraries
- Socio-economic and demographic data relevant to Ecosystem Management & Conservation

Standards

The most important question that the network builders need to recognise and deal with is that of data standards. Certain standardisation process is already on. However lot more remains to be done. Considering the large amount of information available in different forms, drawing up standards is an urgent need.

Some of the entities that must be accorded high priority for standardisation (in alphabetical order) are:

- Abundance Codes for Trends and Status
- Bibliographic Formats
- Biodiversity Mapping Grid Identification Codes relating it to Survey of India Toposheets.
- Biogeographic Site Descriptors
- Biosystematics
- Conservation Status Descriptors for different levels of taxa
- Degradation/Disturbed Area Classification
- Descriptors of Anthropogenic Pressures on Ecosystems
- Directory of Castes and Tribes based on the data from Anthropological Survey of India's Peoples of India Project
- Distribution classes associated with different taxonomic levels
- Ecological Classification/Habitat Types and Classes
- Faunal and Floral Attributes or a Simplified Taxa Identification Key System
- Landuse Related Descriptors
- Location Identity/Site Codes
- Macro and Micro-Climate Types
- Resource Use Related Descriptors
- Soil Related Descriptors
- Species - Species Relationships/Associations
- Water: Nutrient and Water Quality Related Indices

Geographical Information System (GIS) and Biodiversity Maps

The CNC must be equipped with state of the art workstation based GIS facilities while at each DBIC, either a middle or entry level based GIS facility that can be run on a personal computer must be established or arrangements must be made for sharing GIS resources with a well equipped ARC. The GIS makes it possible to make use of computers for the analysis of spatial data. The spatial data such as maps are first converted into computer readable form. This is achieved using hardware such as scanner or digitizer. GIS can also make use of satellite

imageries and compare such images taken at different times. It is also possible to overlay these computerised maps with information collected from ecological surveys by the FSUs. The data residing on well-structured databases can also be incorporated into the GIS to produce spatial representation and visualisation of such data. It is also possible to undertake substantive statistical analysis of the spatially aggregated data.

The GIS facilities at the DBIC must provide facilities for updates and retrievals of spatial data for use by the FSUs. Therefore, besides computer systems, requisite input/output and display devices like large high resolution colour video display units, digitizers, scanners and colour printers needs to be installed at the DBICs. These facilities only need to be added to the DBICs in a phased manner keeping in step with the growth of the bioresources mapping programme.

CiNet needs to work towards developing a comprehensive GIS based bio-resources map library and make it available on-line to the CiNet users. Since the spatial scales envisaged for the Biodiversity Map Grids under the bio-resources mapping programme is of the order of 1 to 10 hectare grids, the map libraries must organise spatial data on maps of very large scale. In practice, it will be difficult to organise map libraries for 1-hectare grids and it may be necessary to opt for larger biodiversity mapping grids of nearly 1000 hectares.

Information Sharing Mechanisms

The major databases of CiNet must be organised using database management system technologies that conform to industry standards. It is desirable that the large central databases of CiNet are well structured based on relational database management concepts. Such well-structured databases can be used to hold the authenticated baseline data, with a bare minimum of essential details. It is also necessary to develop multimedia databases that can include text, pictures and sound. These databases will reside on servers providing access to data in several ways. However, as pointed out earlier, information on computers are not organised merely as well structured databases; there is certainly a lot more to information sharing *via* networks, than databases. Besides, well-structured databases, information needs of the network users have to be met in several other ways as well. A recent workshop that examined the linking mechanisms for BIN21 concluded that the best approach was for it to function as a SIGN having several participating nodes with web servers[5].

Typically, the information on a network will consist of non-database entities such as documents, graphic objects, messages, news bulletins, reports on new findings, electronic journals, file archives, and large amounts of information organised in a hypertext format. The network has to provide nodes with servers that can provide a host of services available on the **Internet**, which is a 'network of networks' linking computers all over the globe. The CiNet can be built by creating an exclusive network of members or by becoming a part of the global internet community. The later option is cost effective and it is possible to make use of the Internet connectivity in collaboration with the Education and Research Network (**ERNET**) project. The ERNET infrastructure can be augmented to meet the needs of CiNet. It must be noted that the users will have varying degrees of difficulty in network access. Therefore, a host of linking mechanisms, that allow connectivity by means of low speed dialup telephone lines as well as high speed links over leased telephone lines, satellite links and public data networks, must be made available to the CiNet users.

The networks on Internet maintain mail lists, news bulletins boards, special interest groups, file archives and help individuals find the right information or the right contact. The main Internet tools are **Gopher**, **World Wide Web (WWW)** and the **Wide Area Information Server (WAIS)**. The information available on Gopher servers are limited to text. Gopher organises information in a hierarchical menu based system analogous to the table of contents of a book. The WWW uses hypertext links to connect together pieces of information contained in documents located at different nodes. The information in the documents is organised using the **HyperText Markup Language (html)**. Files are transferred using the **HyperText Transfer Protocol (http)** and the **File Transfer Protocol (ftp)**. The WAIS is a

client-server tool that can be used to search and retrieve files, based on full test indexing of the contents or titles.

These internet services can be organised on a cost sharing basis with the major initiative coming from a large organisation or university. The network must provide all or some of these facilities, besides off-line email. The CNC and each DBIC must set up a WWW or Gopher. The CNC need to operate a listservers and bulletin boards. The CNC also need to provide access to major databases. The DBIC must provide user access to on-line searches on the databases located at any of the DBIC or CNC.

It is important that besides email, CiNet users have access to internet services such as ftpmail and mailgopher. The DOS or Windows based PCs connected to the DBICs using modems can be provided shell accounts on the servers at the DBIC. Those nodes which can be connected to the DBIC servers using high speed links or leased telephone lines can make use of the services such as Gopher, WWW or WAIS. Each of the BMT, FSU or ARC must have *at least* email access, and if possible other facilities based on **TCP/IP**. The TCP/IP (**Transmission Control Protocol/ Internet Protocol**) is a way of packaging data for easy movement between many different computer systems. It consists of a collection of search, retrieval and communications utilities. Personal computers (PCs) running DOS/Windows can make use of the network services by means of either the **Serial Line Internet Protocol (SLIP)** or the **Point-to-Point Protocol (PPP)** with the TCP/IP stack up and running on the PC, provided the DBICs offer SLIP or PPP accounts on the servers.

To facilitate network connectivity there are certain software and hardware needs. To enable simple email facility for a CiNet user equipped with a PC, all that is needed is a mail service account on the DBIC server, a telephone, a modem and communication software loaded on the PC to enable terminal emulation after getting connected to the DBIC server. The DBICs, also need to have facilities for remote users to login *via* telephone lines and must therefore have the DBIC server also connected to the telephone lines through modem. The modem speeds in this can be even as low as 300 bits per second (bps) and faster modems can be used where higher speeds can be attained. The computer at the user end can also be a multi-user system running UNIX. If only a dialup link with the DBIC is possible, then an UUCP (Unix-to-Unix Copy) account can be created on the DBIC server to transfer email as a fully automated service.

If the user has access to better communication facilities such as the X.25 based connection or a leased high speed telephone line to a DBIC server, and the computer system at the user end is multi-user running any port of System V Release 4 UNIX complete with X/Windows Graphical User Interface and TCP/IP, then all the network services can be made use of. Email can be transferred using the Simple Mail Transfer Protocol (SMTP) rather than UUCP. Several other facilities such as FTP and TELNET for remote login to the CiNet servers will also become possible. A high-speed modem is needed because if the user is to make the best use of network services, connectivity must be achieved at speeds of 14.4 Kilo bps or above. Otherwise the network access can become very tiresome. High-speed modems and interface cards are required at both ends.

Software support is needed by way of the communication protocols (TCP/IP and SLIP or PPP). Both the PC at the user's end of the CiNet and the DBIC server of the CiNet must be running either SLIP or PPP as well as the versatile TCP/IP. With the software and hardware (interface cards on the computers and the modems) in place, the user will have full access to all the public information resources on the CiNet as well as Internet, assuming that CiNet has full internet connectivity.

The field units, which are the key to the biodiversity mapping programmes, also need to remain 'online' with the DBICs. Very often the FSUs may be conducting surveys in remote locations with no possibility of access to telephone links. It is, indeed, possible to resort to wireless data transmission to access the nearest DBIC when such a need arise. There are, of course, certain legalities to be sorted out in order to realise this technical possibility because of the restrictions imposed by the laws governing

wireless communication. Sometime in the near future, mobile telephones that can be used from any geographical location will be available. The costs of such systems may, indeed, be rather high at the introductory stage. When the use of such devices becomes more widespread and cheap, the FSUs can use it for establishing dialup links with the DBICs.

Communication Options

The CiNet is conceived as a loose network of organisations that can share information on a cost sharing basis. It can make use of the different computer networks available such as the satellite based NICNET services using **Very Small Aperture Terminals (VSAT)** and the ERNET services based primarily on terrestrial dial up links. ERNET, too, is expected to provide access *via* VSAT soon.

There is no need to go through the whole cycle of developing networks and physical links, since the network can be developed using the data communication facilities available in the public and private sector. In a national context where many data networks already exist, the feasible low investment proposition is to make the best use of existing network infrastructures on a cost sharing basis and let the CiNet 'evolve' on its own as the activity increase. ERNET with its vast experience in networking can possibly play a pivotal role in establishing the required network facilities and CiNet can ride over the ERNET.

There are, indeed, several communication options available. Depending on what is appropriate at each level of the data flow, the best option has to be exercised. The national network of DBICs and the CNC that make up the CiNet need to be linked by high-speed links. The VSAT based links is a reliable option. Another possible option is to go in for the INET facilities offered by the Department of Telecommunications (DOT), which allows X.25, based communications. The X.25 is the name for a widely used network layer protocol described by the International Standards Organisation (ISO) and the International Telegraph and Telephone Consultative Committee (CCITT).

The wide area network (WAN) services can be implemented by establishing permanent physical connections using dedicated lines or private lines, by **circuit-switched** physical connections based on dialup links and by demand digital service based on **packet switching**. A network of networks, typically, uses packet-switching methods. Rather than trying to establish a dedicated communication line between two computers located in the same or different network, which is rather clumsy when several computers are competing for connections, the inter-networking typically uses packet switching techniques. This is because packet switching allows several computers to share communication links, by transmitting packets of information with an addressing system through the packet switching circuit.

Packet switching has in-built error detection and correction mechanisms and provides dynamic re-routing of calls as well as interconnection of computers/terminals at different speeds. It will be far too expensive to build a private data network dedicated only to CiNet activity. The facilities provided by DOT on INET - a X.25 based Packet Switched Public Data Network - include permanent point-to-point connection between two end users of the circuit or multipoint connections between more than two end users.

Given the communication options available, the pros and cons need to be weighed carefully. While making the choice the following aspects are to be considered

(a) The communication option must ensure high-speed connectivity to major national and international networks, particularly the *NICNET*, *ERNET* and *INTERNET*
(b) The communication link should not be prone to frequent breakdowns
(c) The recurring costs must be kept low and
(d) The communication facility must support multiple protocols.

Some of the constituent units of a DBIC may be linked together using modem based dialup or leased telephone lines. The X.25 based links could also be used when higher levels of connectivity are needed. As network service providers, particularly in the private sector, make their bid for a slice of the Indian cyberspace more options will be available for networking and CiNet itself can possibly become a value adding, financially self-sustaining service provider with its

specialised information resources.

Conclusion

The conservation of biodiversity is an enormously complicated and difficult task requiring information flow on an unprecedented scale. The conservation efforts need networking of individuals, organisations and information systems. Co-operation and collaboration on such a wide scale will be possible only with the support of an appropriate information network, such as the one presented here.

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