UGC-INFONET : A CROSS-SECTIONAL VIEW ON INFRASTRUCTURE

S K Sharma ***Ellora Parida*** ***Manoj Kumar K***

Abstract

Indian education system is one of the largest and oldest education systems in the world. now in the Indian education system, universities form the base for success in higher education. Global competition in education system forced the Indian universities to change their curricula frequently and introduce new subjects, which impose a great demand to have good communication network infrastructure so that researchers, scholars and students can tap the most up-to-date information. To bring quality in higher education, the University Grants Commission (UGC) has taken major initiative to modernise the university campuses with the state-of-the-art campus wide networks and has set up its own nationwide communication network named UGC-Infonet. This paper introduces a cross-sectional view of this initiative.

Keywords: UGC-Infonet, INFLIBNET, ERNET, Universities, e-journals, university-network, Broadband, SATWAN, VSAT, SCPC etc

1. Introduction

India is one of the largest countries in Asia, with a land area of 3,287,590 square kilometres and second largest in terms of population. It has also one of the largest higher education system in the world consisting about 339 universities and about 17,500 colleges affiliated with these universities. Approximately 10.5 million students are studying in these institutions. It is also producing large number of highly skilled manpower.

In Indian higher education system, University Grants Commission (UGC), Professional Councils, Central Government, and State Governments are playing major roles, for inhancing the quality of higher education with the wide coverage. The UGC is responsible for coordination, determination and maintenance of standards and release of the grants to the universities. Professional councils are responsible for recognition of courses, promotion of professional institutions and providing grants to undergraduate programmes and various awards. The major role of the central government is to form major policy relating to higher education in country, providing grants to the UGC and to declare education institute as 'Deemed to be university' on the recommendation of the UGC. State Governments are responsible for establishment of State universities and colleges, and provide plan and non-plan grants for their development and maintenance.

The Indian Universities system forms the base for success in higher education and still using conventional teaching that has emphasised content. Teachers have taught them classes through lectures, presentations interspersed with tutorials, and course was written around textbooks. Learning

activities are designed to consolidate and rehearse the content. Contemporary education system is now favouring curricula that promote competency and performance. Curricula are starting to emphasise capabilities and to be concerned more with how the information will be used than with what the information is. The moves to competency and performance-based curricula needs:

- access to variety of information sources;
- student-centred learning settings based on information access and enquiry;
- learning environments centred on problem-centred and inquiry-based activities;
- teachers as coaches and mentors rather then content experts

Contemporary Information and Communication Technologies are able to provide strong support for all these requirements. The first step in this direction is that to improve the existing education standards and training by integrating Information and Communication Technology (ICT) in the process of learning and education management. Instrumental in implementing the ICT in Indian universities requires its own high speed and scalable nationwide communication network infrastructure. The UGC-Infonet is a step in this direction.

1. What is UGC-Infonet?

The University Grants Commission (UGC)9 is the apex organization and was established an under an Act of Parliament in 28th December,1953. It has launched an ambitious programme to bring about a qualitative change in the academic infrastructure, especially for higher education and to make use of the benefits of Information and Communication Technology to all the universities and colleges across the country. Under this initiative, UGC is modernising the university campuses with the state-of-the-art Campus Wide Networks and has set up its own nationwide communication network named UGC-Infonet7. The UGC-Infonet is supporting the higher education in several ways:

- It has full capability to support distance learning.
- It constitutes mixed heterogeneous network environment to distribute the educational material and e-journals to the remotest place.
- Researchers and scholars can use this network to search and retrieve the up-to-date information from the Internet.
- It can be used as medium for collaboration among teachers and students, not only within the country but also all over the world.
- It forms as an Intranet for Indian universities; therefore, the accessing cost of e-resources hosted within the network is very low.
- The universities can also use this network to establish a channel for globalization of education and marketing their services and developments.

2. Network architecture and topologies

UGC-Infonet is based on open IP platform, employing state-or-the-art technologies like IP multicast, TCP spoofing and other Internet tools that provide interactive education on PC or TV, enabling on-line response to queries. Open system architecture will ensure support for current and future applications. Users from participating universities would enjoy high data rates while accessing Intranet and Internet resources. The main features of UGC-Infonet are:

- Nationwide Terrestrial backbone using Fiber optic links;
- Integrated Satellite WAN supporting Broadband and SCPC VSAT technology;
- linkage with other academic networks and research networks all over the world;
- comprehensive Network Management Systems for overall monitoring of the network, down to each device;
- data security and virus protection using firewalls and Intrusion detection systems;
- dedicated data centre for web hosting and mailboxes;
- Broadband multimedia and video channels for distance learning.

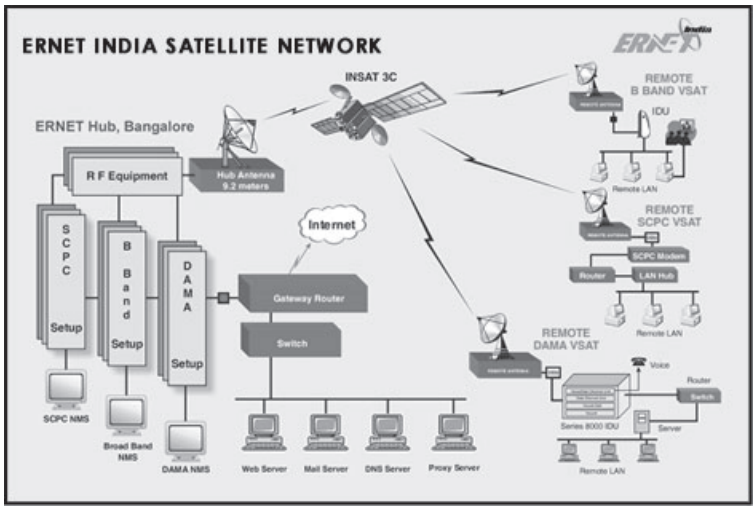
The UGC-Infonet is using the backbone of ERNET2 network, which is a judicious mix of terrestrial and satellite-based wide area network. The Satellite Wide Area Network (SATWAN), using C-Band transponder on INSAT-3C and VSAT technology has facilitated reliable and quick access from remote areas. The SATWAN hub, located at STPI Bangalore, supports broadband VSATs with up to 52.5 Mbps shared bandwidth and Single Carrier Per Channel (SCPC) VSATs capable of providing up to 2 Mbps dedicated bandwidth.

2.1 SATWAN hub architecture

The hub architecture is based on industry standard TCP/IP protocol ensuring connectivity of heterogeneous computer systems and Local Area Networks at user sites. At the application level, all applications conform to International standard such as HTTP, SMTP, FTP, RTP, TELNET and NNTP2.

The hub consists of RF and IF equipments. The RF equipments consists of C-band 9.2m antenna, Low Noise Amplifier, Up-converter, Down-converter, High Power Amplifier-700W and Antenna tracking unit. Broadband IF equipments are modular in design and consist of: Hub Satellite Process (HSPs) to control the transmission through the satellite, Hub Protocol Processors (HPPs) to interface with the user's host and an advanced object-oriented Network Management System (NMS). It is illustrated in the figure-1.

Figure -1



2.2 SCPC VSAT Network

Single Channel Per Carrier (SCPC) network is based on TRES(Trunking Earth Station)2 satellite modem from Hughes Network Systems (HNS). SCPC network is a two-way, star topology using C-Band transponder on INSAT-3C. The network is based on industry standard TCP/IP protocol. It provides data rate from 32 kbps to 2.048 Mbps in 32 Kbps increments and excellent performance. Remote SCPC VSATs will consist of a TRES modem, Power Distribution System (PDS), outdoor unit (ODU) and 3.8m antenna. The indoor unit consists of a modem and PDS. The modem provides the function associated with modulation forward error correction and demodulation. The PDS provides DC power, a high stability frequency reference and HF/LF outdoor equipment and multiplexing over a single cable to the ODU. The outdoor equipment consists of RF equipment and a 3.8m antenna. The RF equipment provides frequency conversion and amplification functions.

2.3 Broadband TDM/FTDMA VSAT Network

The Broadband TDM/FTDM2 (Time Division Multiplexing/Frequency and Time Division Multiple Access) VSAT network is based on an industry leading product the SkyBlaster 360E from Gilat Satellite Networks.

The SkyBlaster 360E, Broadband VSAT network is with high speed quality and reliability, which leads to increased operational efficiency and provides a competitive advantage. The architecture of the network is a two-way, star topology using C-band transponder on INSAT-3C. The two-way functionality allows for high levels of interaction, feedback and access to resources.

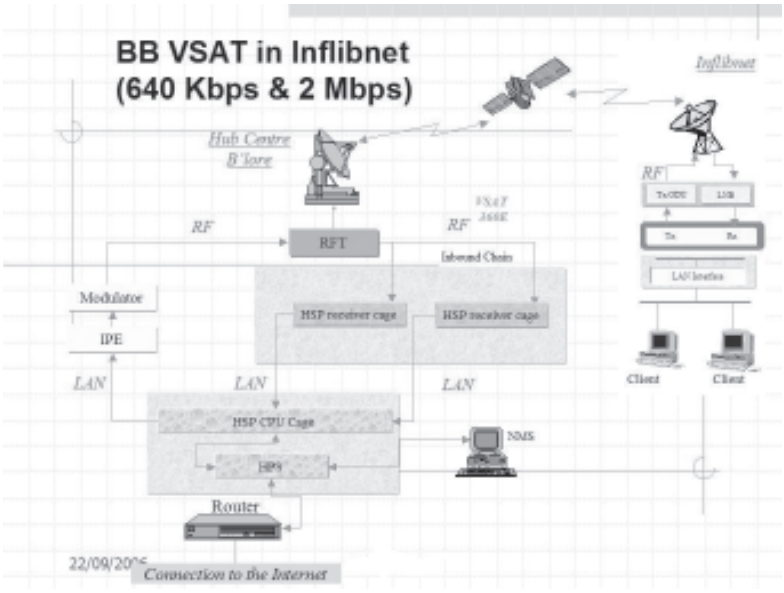


Figure. -2

Main applications supported on the Broadband Network are:

- Voice over IP
- Two way interactive IP communications
- IP Multicast
- Reliable software distribution
- Internet/Intranet access
- FTP access
- E-mail

The VSAT network acts as an overlay for the terrestrial WAN by providing backup links between the backbone sites. It is illustrated in figure-3. International connectivity is achieved through gateways at New Delhi, Bombay, Bangalore and Calcutta, with a total capacity of 6.64 Mb. Daily traffic over ERNET exceeds 20 GB.

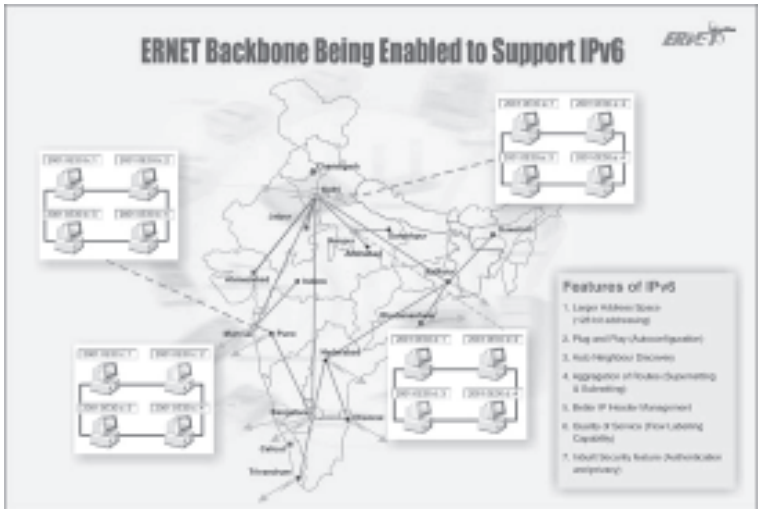


Figure -3

3. Role of NIXI

The National Internet eXchange of India (NIXI)5 is the meeting point of the ISPs in India. Its main purpose is to facilitate handing over of domestic Internet traffic between the peering ISP members. This will enable more efficient use of international bandwidth, save foreign exchange. It will further improve the Quality of Services for the customers of member ISPs, by being able to avoid multiple international hops and thus lowering delays. It is illustrated in the figure -4.

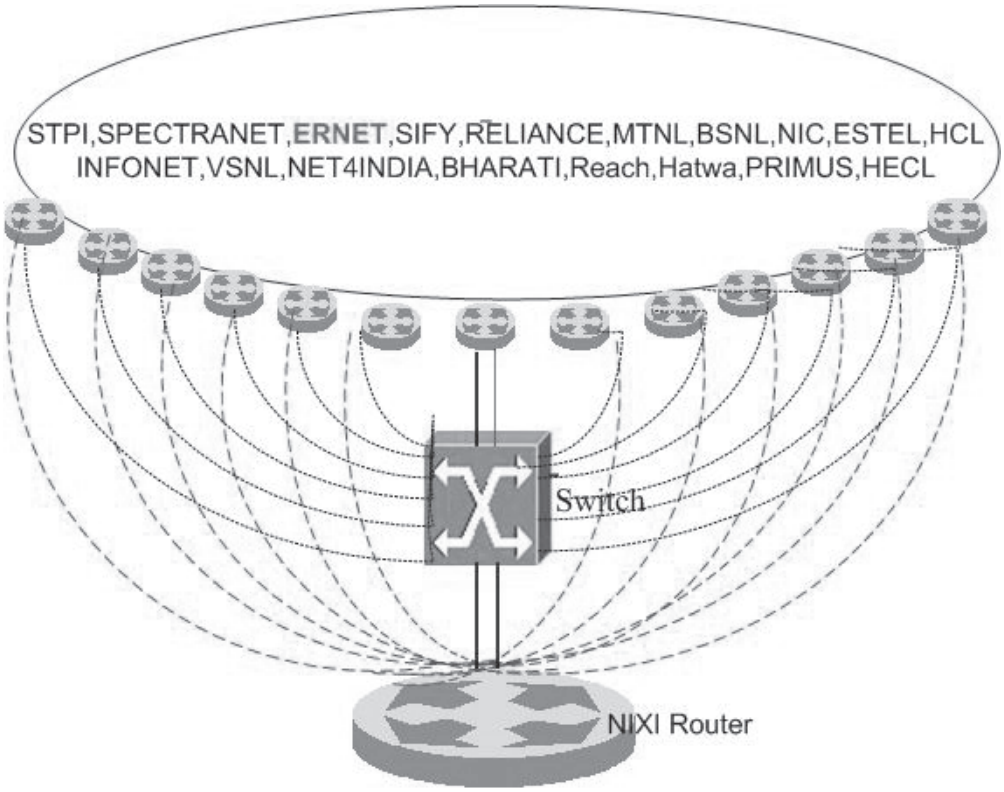


Figure-4

Since the ERNET India is the one of the member of NIXI therefore the domestic traffic generated from the UGC-Infonet can be managed within the country and avoid the international hops and thus allowing faster access to e-resources available within the country.

4. Available connectivity options

The complete range of connectivity options are available to universities depending upon their location and bandwidth requirements. Since the terrestrial media offers greater scalability and performance, effort are made to connect the universities on terrestrial media. Alternatively, satellite connections are provided through VSAT.

4.1 Digital Leased Lines

In the localities where telecom network is, well developed, dedicated leased lines are hired from basic telecom service providers. Such links are primarily for 256 Kbps to 2 Mbps speeds. Since fiber optic connections facilitate better connectivity, efforts are made to bring fiber links as near to the university as possible. Most of the universities have potential to become hub of communication for the affiliated colleges. Therefore, basic service providers are locating their terminal essentially at the university premises.

4.2 Radio Frequency (RF) link

The universities located within 30 kms of the ERNET PoPs are provided with dedicated radio links operating from 256 Kbps to 2 Mbps speeds.

4.3 Satellite based Wide Area Network

VSAT technology represents a cost effective solution for users seeking an independent communication network connecting a large number of geographically dispersed sites. The potential advantages of VSAT are wide area coverage across borders, rapid deployment of new sites, independent of terrestrial infrastructure, no local loop problems, distance independent costs and flexibility.

4.3.1 Single Channel Per Carrier (SCPC)

it is a point-to-point network technology with equivalent conventional leased lines. With SCPC, sites with VSAT dishes communicate directly with each other using dedicated satellite bandwidth. SCPC VSATs are used for establishing dedicated two-way channels of 256 Kbps to 2 Mbps raw from Hub. SCPC VSATs are ideal for those universities, which are located in remote areas but wish to host their own Internet server for providing access to their information through Internet from all over the world.

4.3.2 FTDMA or Broadband VSAT

Broadband VSAT operate in a shared bandwidth mode for optimal utilization of the precious satellite resources. Since the Internet traffic is asymmetric in nature, Broadband VSATs are optimized to receive high bandwidth (shared beam of up to 45 Mbps) and relatively smaller capacity for outgoing traffic (shared channel of up to 307 kbps) from the university.

5. Implementation methodology

The UGC-Infonet is overlaid on ERNET infrastructure in a manner to provide assured quality of service and optimal utilization of bandwidth resources. The ERNET India is responsible for installing and managing the entire network on turnkey basis. The Information and Library Network Centre (INFLIBNET) is nodal agency for monitoring and coordination of the project. UGC-Infonet is funded by the UGC with 90% infrastructure and 100% of recurring costs. The selected universities can join this project after signing of agreement with INFLIBNET, ERNET and UGC. This agreement consist responsibilities of ERNET, INFLIBNET, UGC and the University.

Type of Connectivity	
FTDMA(BBVSAT)	50
SCPC	45
LL	54
Bandwidth wise Status	
SCPC 256Kbps	6
SCPC 512Kbps	33
SCPC 1 Mbps	6
BBVSAT 1Mbps	1
BBVSAT 512Kbps	3
BB VSAT 256 Kbps	46
LL 256 Kbps	12
LL 512 Kbps	15
LL 1Mbps	4
LL 2 Mbps	23

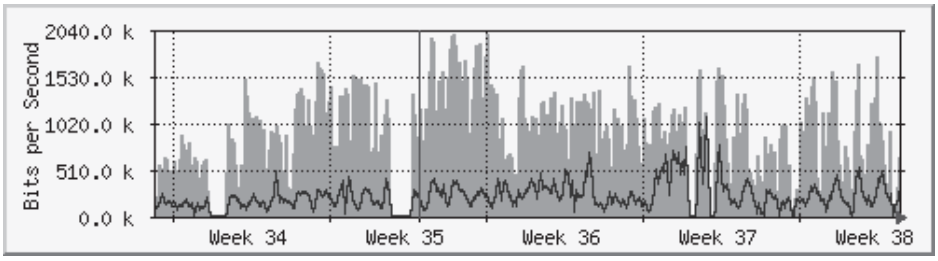
5.1 Monitoring Committee

A Joint Technical and Tariff committee (JTTC) 7, consisting of leading experts in the country has also been setup to guide and monitor the design, implementation and operations of the UGC-Infonet. The JTTC has now been renamed as Central Connectivity Monitoring Committee (CCMC). INFLIBNET Centre and ERNET India are making efforts for providing supporting documents like UGC-Infonet guidelines, web-hosting guidelines, brochures etc to participating universities for creating awareness about the technology and project execution. These documents are available online at http:// www.ugcinfonet.ernet.in/ .

5.2 Monitoring Bandwidth

The UGC–Infonet Connectivities given to the Universities are regular monitoring in 5minutes average and the Bandwidth Utilization graph is displayed by MRTG on hourly, weekly, monthly and yearly basis depending upon the usage of respective Universities. Bandwidth is increased by CCMC, by taking the parameters such as no. of users, no. of articles downloaded, Percentage of Utilization, etc.. A graph for monthly average is given below as an example.

Monthly'Graph of Banaras Hindu University(BHU) (2HourAverage)



Max In:	2005.2 kb/s (97.9%)	Average In:	896.5 kb/s (43.8%)	Current In:	673.1 kb/s (32.9%)
Max Out:	1082.0 kb/s (52.8%)	Average Out:	241.3 kb/s (11.8%)	Current Out:	366.9 kb/s (17.9%)

5.3 Network-Trained Manpower

Trained manpower is one of the most critical resources for successful implementation of high-tech programmes like UGC-Infonet. ERNET India has setup a modern training laboratory to train network systems managers and users of UGC-Infonet. The basic level course on networking and UGC-Infonet management was organized by INFLIBNET with ERNET India for operational/technical staff from each of the participating universities. Future programs are planned to provide advance level training on networking and its security for operational staff of participating universities, who handled the network in universities.

6. Present status

The whole program is being implemented in phased manner. In-first phase, 150 universities from 171 universities coming under purview of the UGC are selected for connectivity, 149 Universities are connected till date. The figure -5 is shows the distribution of type of connectivity's provided to 150 universities.

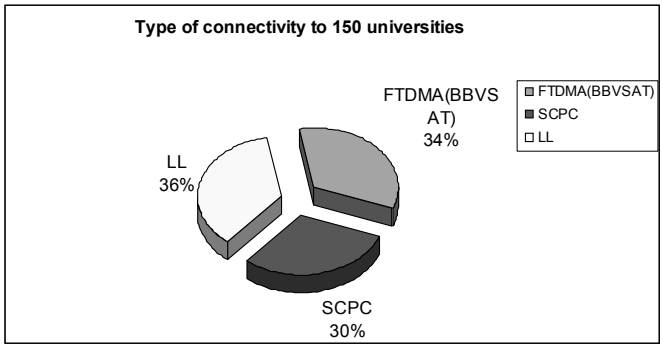
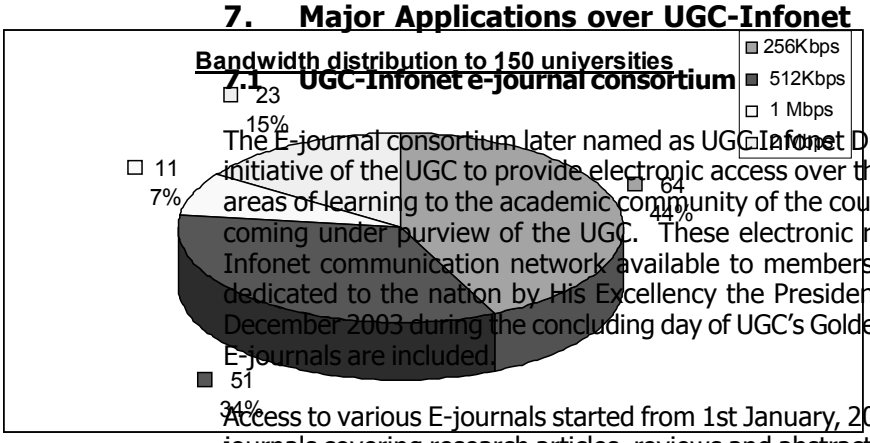


Figure -5

The minimum data rate provided to universities was initially 64 kbps, which has now been increased to 256 kbps. The maximum data rate is 2 Mbps raw (1:1). The allocation of bandwidth to universities is illustrated in Fig.6.

Figure -6



7. Major Applications over UGC-Infonet

7.1 UGC-Infonet e-journal consortium

The E-journal consortium later named as UGC-Infonet Digital Library Consortium; is another major initiative of the UGC to provide electronic access over the Internet to top scholarly literature in all areas of learning to the academic community of the country. This program covered all universities coming under purview of the UGC. These electronic resources are provided through the UGC-Infonet communication network available to members of this network. E-journal program was dedicated to the nation by His Excellency the President of India Dr. A P J Abdul Kalam on 28th December 2003 during the concluding day of UGC's Golden Jubilee celebrations and now about 4500 E-journals are included.

Access to various E-journals started from 1st January, 2004. The literature made available includes journals covering research articles, reviews and abstracting databases. Various disciplines covered under the programme are given blow in the tables and graphs in fig7.

Subject coverage Science Journals

Sl. No.	Science Subjects	No. of Journals
1	Agricultural Science	45
2	Anthropology	26
3	Astronomy and Astrophysics	17
4	Biological Sciences	460

Sl. No.	Science Subjects	No. of Journals
5	Chemistry	227
6	Computer Science	161
7	Engineering & Technology	192
8	Fish & Fisheries	07
9	Food & Industries	10
10	Forest & Forestry	01
11	Information Science	06
12	Mathematics	288
13	Medical Science	579
14	Physics	203
15	Science General	19
16	Veterinary Science	13
	Total	2254

Subject coverage Social Science Journals

Sl. No.	Social Science Subjects	No. of Journals
1	Agricultural Science	45
1	Area Studies	136
2	Art	03
3	Business & Management Studies	181
4	Communication	19
5	Consumer and Education	03
6	Demography and Population Studies	09
7	Economics	178
8	Education	192
9	Environmental Sciences	84
10	General Studies	07
11	Geography	66
12	Geology	116
13	Insurance	02
14	Journalism	01
15	Library and Information Science	31
16	Meteorology	48
17	Music	07
18	Operations Research Management	31

Sl. No.	Social Science Subjects	No. of Journals
19	Public Administration	03
20	Social Science	56
21	Sports & Games	03
22	Theatre and Fine Arts	11
23	Tourism	01
24	Visual and Performing Arts	05
	Total	1193

Subject coverage Humanities Journals

Sl. No.	Humanities Subjects	No. of Journals
1	Crime and War	38
2	Cultural Studies	42
3	Humanities	81
4	History and Archaeology	86
5	Law	58
6	Language & Linguistics	144
7	Museum	01
		124
		291
		78
		23
		40
		1006

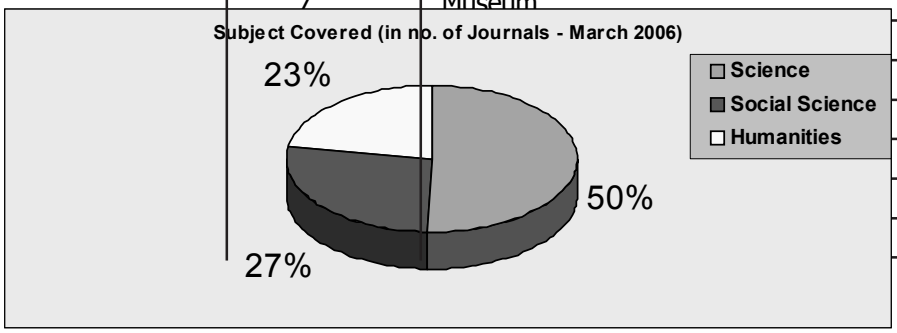


Fig.7 Major Subjects covered in e-Journal Project

The IP based authentication mechanism is used to provide access to these resources under the consortium, i.e., the users can access E-journals from within the premises of participating universities.

The E-Journals programme is a cornerstone of the UGC-INFONET effort, which aims at addressing the teaching, learning, research, connectivity and governance requirements of the Universities. This programme demonstrates how communication networks and computers can be used to stretch and leverage available funds in furthering these aims.

7.2 Access to Bibliographic information

INFLIBNET has been developing and providing online services through following databases over Internet:

- **Books database:** It is a collection of bibliographic information of the books residing in libraries of the Indian universities. Around 80 lakh records from 115 universities have been processed and merged into the database.
- **Theses database:** It has more than 1.75 lakh records of doctoral theses submitted to various Indian universities.
- **Serial holdings:** It has more than 58208 unique serial titles having over 66021 holdings of various universities in the country.
- **Experts Database:** Provides useful data relating to the name(s) and details of the experts in different disciplines. It has more than 15000 records, and is growing continuously.
- **Experts database (Science & Technology):** It has more than 20000 expert's profiles in the area of Science and Technology.

All these databases can be accessed though Internet and UGC-Infonet at http:/www.inflibnet.ac.in.

7.3 24 Hour Higher Education Channel

UGC through its IUC - Consortium for Educational Communication (CEC)8 and in association with IGNOU has launched 24 hours Higher Educational Channel, VYAS, targeted at providing learning opportunities to masses across the length and breadth of the country. The channel telecasts 8 hours of educational program daily, which are repeated twice during the course of the day so as to ensure convenient and suitable access to a wide variety of learners across the country.

This channel is available to VSAT and Leased line users of UGC-Infonet. The multicasting IT technique is being used to provide VYAS channel over Internet and users of UGC-Infonet can watch programmes on their desktops using Microsoft Media player 7.1 or higher. Links are available at site http:// 202.41.99.76/ or http://202.41.97.63/VOD

7.4 Free web hosting & Domain name registration

The architecture of UGC-Infonet is designed such a way that each participating university can host its static web site at ERNET2 data centre, free of cost. Each registered university will have login and password to manage its web site through Internet. The ernet India is one of the Internet Domain registrars therefore; each university can register their unique Internet domain name under ac.in, edu.in, res.in, or ernet.in. The domain under ernet.in is free for all participating universities of UGC Infonet.

8. Conclusion

The initiative has been taken by the University Grants Commission, with INFLIBNET to provide high-speed Internet connectivity and E-journals through this network. This has started making good impact on researchers and academic community. The universities are showing high utilization of provided bandwidth, that is the result of good Local Area Network (LAN) infrastructure development within the university. As a result, universities are also demanding more bandwidth. Number of universities under UGC-Infonet are using satellite based communication network which usually expensive and include more delay than terrestrial network. Therefore, efforts may be made to increase leased line connections in the UGC-Infonet, which will minimize the propagation delay and improve accessibility.

Network security is one of the major problems for UGC-Infonet. However, to secure Internet connection from virus and spam at university end, is the responsibility of respective universities. Inadequate security infrastructure, security policy and lack of trained manpower may reduce the bandwidth utilization.

The UGC-Infonet network has vast capacity of carrying digital contents, is still not utilized till its maximum extended because of few applications are available over this network. However, the Govt. may take initiatives to encourage universities to host various applications like online full text thesis, course materials, online professional courses etc. within this network. This will encourage domestic network traffic, accessibility to e-contents that will in-turn reduce the bandwidth cost.

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