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Optimising Internet Bandwidth in Developing Country Higher Education

Higher education institutions in developing countries have to deal with growing demands on their Internet infrastructures. Managing this demand usually requires that infrastructure – telecommunications, computers, etc. – is upgraded and extended. However, since this can be costly, other approaches need to be pursued. This *infobrief* argues that, through better understanding of actual Internet usage, improved management of Internet applications, enhanced training and awareness-raising for users, and the introduction of measures to control undesirable uses and behaviours, existing bandwidth can be made to go much further.

Pressures on performance

With wider Internet connectivity, educational institutions in developing countries are beginning to tap the many opportunities offered by today's information societies. These digital connections act as gateways where researchers and librarians can find, download and share world knowledge and learning materials; they can be platforms where local research is published, disseminated and uploaded; and they can facilitate links and collaboration among scientists, promoting discourse and dialogue on shared issues and problems.

However, the same connectivity also supports all sorts of applications and behaviours that consume bandwidth. For example, it helps to distribute email spam and viruses, it allows music lovers and sports fans to keep up with their hobbies and favourite artistes from around the world, it can be used to view pornography, it can provide opportunities for computer hackers to practice their skills, and it facilitates cross-border movement by all kinds of 'intelligent' software, agents, worms and spiders harvesting and indexing content or simply tracking usage and offering upgrades. Where these applications hamper the intended uses of the Internet connection, it can be termed abuse.

These, and many other applications, all consume the limited bandwidth of higher education institutions in developing countries. As a result, response times slow down and performance drops, leading to frustrated users and ICT managers. Most

researchers, information providers and institutions remain unable to access the high speed, broadband connectivity that is more and more necessary for research, teaching, and learning.

Typical solutions are to upgrade infrastructure, to install faster, larger, and higher performing systems, lines and facilities. However these are costly solutions, and may only solve short-term needs. As demand continues to grow, and as overall available bandwidth shrinks, performance will again decline, necessitating further upgrades.

Bandwidth in developing countries is expensive. In a report for the Partnership for Higher Education in Africa, Mike Jensen calculates that Makerere University pays about \$22,000/month for 1.5Mbps/768Kbps (in/out), Eduardo Mondlane pays \$10,000/month for 1Mbps/384Kbps, while the University of Ghana pays \$10,000/month for 1Mbps/512Kbps. These figures indicate that African universities, outside of South Africa, are paying over \$55,000/month for 4Mbps inbound and 2Mbps outbound. These figures are about 100 times more expensive than equivalent prices in North America or Europe.

Clearly, one solution to controlling costs and improving access is to press for more affordable access by, for instance: suggesting that governments open up their telecommunications markets; by joining forces with other academic institutions to negotiate better connectivity deals; by encouraging local Internet service providers to set up country Internet exchange points – that route traffic within the country

instead of via Europe and North America; and by making use of open source systems and software.

A different approach?

An alternative response is to recognise that 'bandwidth' is a valuable institutional resource or asset that needs to be managed, conserved, and shared as effectively as possible. Instead of simply extending computer and network infrastructure, or finding cheaper providers, this approach puts emphasis on ways to control and manage the many hungry Internet applications, uses, and practices that consume bandwidth.

Such an approach has technical implications regarding network configuration and management. Suitable policies and guidelines are also needed to encourage proper bandwidth saving behaviour. Most critical, it requires that people with the necessary technical expertise and understanding of users' needs are available to the organisation.

Making better use of bandwidth helps to ensure that high priority applications get the access and the performance that they need – when it is needed.

A cross-country study

This *infobrief* draws on a report commissioned by INASP in response to the concerns of partner organisations in Africa, Asia and Latin America.

The report was prepared with input from eight countries (from Africa, Asia and Europe), and has been written for three main audiences – senior management, librarians, and IT managers. It first identifies access problems in university environments, and then explains why access is frequently slow and costly, and how it can be affected by government policies as well as by other regulatory and economic restrictions. Finally, the report identifies how each stakeholder group can influence and improve online access within their institution.

For management, the report explains the institutional decisions that need to be made, including the purchase of bandwidth and delivery of Internet services (cable, satellite or wireless).

The question of usage policies is discussed, including enforcement measures and incentives that help to ensure that all users are aware of their responsibilities and how their actions impinge on others. The various possibilities related to charging users for Internet access are also discussed, along with possible revenue generating options to subsidise such services.

The report also looks at the roles that librarians need to play in the provision of Internet access as part of their information services, and what questions they need to ask of ICT and management in order to ensure that their goals are met.

Ways in which ICT staff can improve how they configure, manage, monitor and control their networks are also presented.

The full report contains eight case studies of Internet optimisation. Each gives first-hand experience of bandwidth problems and solutions from various situations (Addis Ababa University, Ethiopia; Malawi College of Medicine; the Multilateral Initiative on Malaria network (MIMCOM); University of Zululand, South Africa; University of Moratuwa, Sri Lanka, University of Dar es Salaam, Tanzania; Makerere University, Uganda; and the University of Bristol, UK).

Recommendations

The findings of the report are summarised below, presented as recommendations for each of the stakeholder groups: management, information service providers, and IT staff.

Recommendations for senior management

- Make bandwidth management a priority. Ask questions concerning Internet and network usage, security, and user behaviour. Reward staff that install the often unglamorous applications that help to conserve and share this scarce resource.
- Be safe. Insist on strong network and server security, firewalls, and virus protection. Once an undesirable has access to the system, any nightmare is possible.
- Respond to demands. Understand why and how different users make use of the Internet, prioritise among user categories and among applications, and help users to be more effective by providing appropriate training. Expect regular usage reports so that everyone knows what the Internet connection is being used for, and so the right decisions can be made when deciding how much bandwidth to get.
- Encourage positive behaviour. Devise a usage policy to be signed by all users before they use the Internet. This identifies good practices and appropriate 'netiquette' and it sets out procedures to be followed. It should be relevant to the average user and it should be enforced. The existence of such a policy (which explains that browsing and other Internet uses can be monitored), can often be a sufficient 'scare factor' to quell selfish or illegal behaviour.
- Monitor the IT team. Sometimes the IT experts are themselves the biggest abusers of bandwidth. Competent and dedicated IT personnel are essential, not only for normal ICT functions, but also to keep bandwidth use under control. More broadly, a representative high level governance mechanism or committee can be used to set overall ICT policy goals, directions, and priorities.
- Give everyone an identity. Tracking usage requires that each user of the network have an individual identity or logon that confers rights and responsibilities. It is a relatively small step to also provide each with a unique local email address as well as efficient ways to access it from remote locations. Providing such a facility will help to

reduce the use of large bandwidth consumers like hotmail and yahoo.

- Evaluate connection options regularly. Bandwidth becomes cheaper every year. As prices go down, upgrades may enable a university to provide a better Internet service (and to make it available to more users). Moving to another provider or re-negotiating contracts may provide more bandwidth at lower cost. However, the benefits may not outweigh the cost of changing. It is also important to ensure that the contracted and paid for bandwidth is actually being provided.
- Join forces. Explore network integration – create networks between academic institutions within the country that allow for joint bandwidth purchasing, help to keep local traffic local, and lobby for regulatory or other political changes.

Recommendations for librarians

- Obtain an understanding of the technical issues, in order to ask the right questions and to demand an appropriate service from the IT team.
- Expect usage reports and statistics, and encourage appropriate use through training.
- Understand what library users are using the Internet for.
- Get PDF and PostScript reader software installed on library computers, so students can read online journals and other publications.
- Train library users in proper use of the Internet, especially in search techniques. This saves bandwidth by enabling users to find resources more easily. It also enables them to use the Internet productively, and to avoid random browsing.
- Consider setting up library 'portals' or gateway websites where users are quickly directed to relevant and annotated Internet resources. This reduces random searching and, if local caching is used, saves frequently used resources to the local network.
- Where feasible, obtain large electronic resources, full text journals databases, or images for example, on CD-ROM or DVD formats, making them available on the local network. This avoids online downloads that consume bandwidth.
- When downloading is the only option, do it during quiet times (at night for example). Saved files can then be made available locally (where copyright allows).

Recommendations for IT staff

- Install good security and adopt anti-virus practices that prevent situations where malicious actions cause bandwidth to be used up.
- Track all relevant aspects of the network, bandwidth and Internet usage. Regular reports help all concerned to understand usage patterns

and trends, to pinpoint problems, and to signal potential bottlenecks.

- Implement content filtering to block undesirable web content such as gaming, pornography and commercial streaming media. Email can also be restricted, to some extent, to exclude certain types of files or files that are very large.
- Use proxy servers and local caching DNS servers to keep local copies of previously retrieved web pages and Internet addresses. This prevents a situation where the same page (or address) is retrieved from the Internet several times per day.
- Use the network to locally manage upgrades and updates. Updates, fixes, and patches for software and systems (as well as commonly used software readers etc.) can be downloaded once to the network and then made available to individual workstations. This avoids situations where users are using international bandwidth to update their computers. Such downloading can be done at night when demand is low; updates to individual workstations can be automated.
- Make sure all user activities can, if necessary, be traced. This is only possible where the network has an authentication system (users must log in before they can do anything). A usage policy should spell out which data on users is collected and how it can be used.
- Consider implementing a bandwidth manager product that allows you to give bandwidth priority to certain protocols (such as web), and to throttle others (such as Kazaa – an application used to share music files).
- Discourage and control certain types of 'peer to peer' networking. Hungry applications like Kazaa need to be 'rate limited,' using a bandwidth manager, or prevented via network layout changes.
- Offer email addresses and web based email facilities to users, allowing them to access their emails from anywhere if necessary. This reduces the need for staff and students to set up hungry web accounts like hotmail and yahoo.
- Configure the network to avoid open relay hosts (mail servers that will accept connections from anywhere) and open proxies (proxy servers that will accept connections from anywhere). These can easily be abused by outside interests and can lead to the 'blacklisting' of your network. Ensure that these servers only relay mail or accept connections from the University network.
- Train all users to use the Internet safely and efficiently. They should especially not reply to spam, and not launch unknown programs they receive via email. Encourage bandwidth-conserving behaviour. All users should be aware of the impact they can have when competing aggressively for bandwidth, for example by downloading music. They should realise the potential consequences of their actions to the whole network community.

- Consider outsourcing and mirroring options. Depending on which audiences the institution wants to reach, separate strategies for internal and external (international) users can be followed. For example, consider directing international users to an international site or server, guarding local bandwidth for local users and applications.
- Charging for bandwidth may help encourage users to use bandwidth sparingly. Charging should be based on the amount of traffic a user generates on the international link (and not per hour of use, for example).

More information

This report has been commissioned by INASP in response to concerns over bandwidth management expressed by Country Coordinators of the Programme for the Enhancement of Research Information (PERI) - concerns which were echoed at the 2002 Partnership for Higher Education conference held in Addis Ababa, and expressed in their workshop report "Securing the Linchpin". (see www.foundation-partnership.org).

Copies of the printed report (without case studies) can be obtained from INASP. The full report is available online:

<http://www.inasp.info/pubs/bandwidth/>

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About INASP

Enabling worldwide access to information and knowledge

The International Network for the Availability of Scientific Publications (INASP) aims to enhance the flow of information within and between countries, especially those with less developed systems of publication and dissemination. The International Council for Science (ICSU) established INASP in 1992.

The objectives of INASP are: to map, support and strengthen existing activities promoting access to and dissemination of information and knowledge; to identify, encourage and support new initiatives that will increase local publication and general access to scientific and scholarly literature, and; to promote in-country capacity building in information production, organisation, access and dissemination.

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