TERTIARY EDUCATION NETWORK

Global Research Networking

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Abstract

Several times during the past three years, senior officials of the European Commission invited the then Department of Arts, Culture, Science and Technology to identify a South African "National Research and Education Network" which could connect to the EC's global research network, Géant. This paper gives information about Géant and what such a connection might mean for the local research community, and describes the efforts by the Department of Science and Technology and TENET that are now under way to make the Géant connection happen.

The Global Research Networking Summit – Brussels – May 2002

In May 2002, the European Commission (EC) hosted a conference called the Global Research Networking Summit. Apart from the official launch of the EC's global research network, Géant, the proceedings included technical papers, reports on research networking from many countries, a status report on the Internet2 initiative in the USA, policy papers by EC officials and speeches by politicians.

South Africa's Department of Arts, Culture, Science and Technology (DACST, now DST)[1] was invited by the EC to bring a delegation to the Summit, and to meet with senior EC officials about the possibility of a South African connection to Géant. Having been informed of the existence of TENET by the National Research Foundation (NRF), DACST invited me to join the delegation[2], and since then I have been intensely involved in an initiative, which is coordinated by DST, to determine whether and how the South African research community can act upon an EC invitation to connect to Géant.

The Géant global research network

Over the past three years the European Commission (EC) has built a high capacity network, known as Géant, that inter-connects the national research and education networks (NRENs) of the 15 member countries of the EU and those of a further 16 countries from all over the world – 31 NRENs in all. Over 3 000 institutional networks connect in this way to Géant.

Géant is a "gigabit" network. It inter-connects larger NRENs in Europe at 10 Gbps, while smaller ones connect to Géant at 2.5 Gbps or lower speeds. Two 2.5 Gbps submarine cable circuits inter-connect Géant with Abilene (Internet2, http://www.internet2.edu) in America and thence with Canada's CANARIE (http://www.canet.ca) research network. These two links constitute the beginning of the Global Terabit Research Network (GTRN, http://www.indiana.edu/~gtrn/), a partnership that initially comprises CANARIE, Géant and Internet2.

Administration and operation of Géant is currently contracted out by the EC to a company called Development of Academic Networking Throughout Europe (DANTE, http://www.dante.net), which is based in Cambridge, UK.

Géant was made possible by two main factors. The first is the EC's vision of the importance for Europe of enabling inter-networking between Europe's research institutions and those of all other countries. This vision won strong support in the European Parliament. The second is the over-

[1] In August 2002, following a revamping of portfolios, DACST disappeared into history and its role vis-à-vis Géant was taken over by the new Department of Science and Technology (DST). Dr Neville Arendse, Director of Science and Technology Relations, was and is the officer responsible for science and technology relations with the EC.

[2] The delegation comprised: Dr Neville Arendse (DACST, leader of the delegation), Dr Roy Blatch (CSIR-SAC), Johan Eksteen (CSIR-Icomtek), Mike Lawrie (NRF) and Dr Duncan Martin (TENET).

investment by major carriers in fibre in the ground throughout Western Europe, and the concomitant dramatic fall in the cost of bandwidth.

The EC truly sees Géant as a **global** research network. This can be seen in the name Global Research Networking Summit, and was stressed repeatedly by senior EC officers. The NRENs of many non-European countries are already connected to Géant, including those of Israel, Malaysia, South Korea and Japan. Other NREN connections are in process, including that of a grouping of countries in Mediterranean Africa and the Levant. Several NRENs in Latin and South America have connections to Abilene (Internet2) and hence to Géant, as does Australia's AARNet.

Why have Research and Education Networks evolved?

The growth of the commodity Internet

As everyone knows, the Internet started life as a network that inter-connected computers at various universities and research establishments in the USA. From the mid-1990s however commercial interests and use have dominated Internet service provision and today commercial interests control even the namespace root. In his book [1] "Ruling the root – Internet governance and the taming of cyberspace", Milton L Mueller gives an absolutely fascinating account of the battle for control of the root. Commercialisation has also led to the commoditisation of Internet access in first-world economies, with competitive Internet service provision industries and a high proportion of populations having access from home, from work and from mobile platforms.

The commoditisation of the Internet has dramatically changed the face of academic networking as well. The demand for email and general browsing facilities by large numbers of staff and students diverts networking resources and fills data circuits that, in an earlier era, were used exclusively by a much smaller group of researchers.

Primary versus secondary research

In parallel with this, information technology has radically impacted the methods and tools of research. In many areas, including particle physics, remote sensing of earth resources, oceanography and astronomy, expensive measuring tools routinely produce massive amounts of digital data, within which scientific illumination hopefully awaits the analyst. This has led to a dichotomy between "primary" and "secondary" research. In primary research, well-funded teams build great instruments, perform experiments and capture oceans of data. Secondary research is the extraction of patterns, insights, lessons, conjectures and other intellectual harvests from the data ocean. Any researcher anywhere can do this, provided that he or she has adequate access to the data ocean and to adequate computing resources.

Grid computing

Grid computing is the ultimate evolutionary target of distributed computing, in which the speed with which data flows between computers on the network compares with the bus speeds of the individual computers themselves. Several grid projects were described at the global summit, most of which make use of a grid operating system called Globus. Development and use of grid services is a major driver of Australia's Grangenet (Grid and Next Generation Network, http://www.grangenet.net) that will have points of presence in Brisbane, Canberra, Melbourne and Sydney.

So, what is a research and education network (REN)?

Taken together, the factors discussed in previous section mean that commodity Internet services, while providing email and browsing services to campus communities generally, do not satisfy researchers who need very high bandwidths between specific sites. The response in many countries has been the creation of national research and education networks (NRENS). And international research networks such as Internet2 (Abilene) and Géant inter-connect multiple NRENs.

A research and education network (REN) may be thought of as an organisation and an Internet that:

- are managed on behalf of specific member institutions, which are mainly higher education and research sites,
- Inter-connects campus networks of its member institutions;
- Binds the member institutions to using the REN to carry only traffic that complies with the REN's **Acceptable Use Policy, which excludes commodity traffic** but may include some pre-commercial, nonprofit research traffic;

- May have gateways to other RENs and/or to international networks such as Géant that inter-connect NRENS;
- Supports research and experimentation on networking itself, such as distributed computing, special protocols, IPv6, quality of service management;
- Has plenty of bandwidth waiting for a user to give it a go!

The third bullet point is the one that protects the researcher's special needs from being swamped by the cumulative demands of "commodity" users, *provided that the sites to which he wants to connect are accessible via the REN.* Therein lies the incentive for inter-connecting RENS on a global basis.

Bandwidth ready and waiting

The last bullet point was beautifully illustrated during a Q&A session at the Global Summit:

Question directed to a representative of Internet2: "I have seen that the Internet2 circuits carry very little traffic. What's wrong? Is Internet2 a failure?"

Answer: "Great balls of fire! No way! An absolute success criterion for research networking is the availability of sufficient bandwidth on demand. That bandwidth has to be there, ready and waiting, in case a researcher needs it."

The "bandwidth ready and waiting" philosophy was also amply evident during the successful "world record speed attempt" that took place on the final day of Brussels Summit. The objective had been set in advance: to find out how much data could be transferred from Seattle, Washington to Brussels, over the Internet 2 / Géant connection, during a period of 17 hours and 40 minutes[3], using commonly available, off-the-shelf computers (Dell PCs with Intel Gigabit Ethernet cards) at either end, and conveying a comprehensible description of the data transferred. There was essentially no competing traffic.

Earlier experiments had shown that using standard ftp, the maximum transfer rate that could be achieved was of the order of 50 Mbps. Now standard ftp is designed to cope with congestion – each packet sent is acknowledged and the sender adjusts its sending rate so as not to send too many packets ahead of the last acknowledgement received. In research networking, because of the presumption that the bandwidth is available, this is overly cautious, and several modified file transfer protocols have been designed, in which the transport is by UDP rather than TCP and it is left to the receiver to request resends. One such protocol - the Tsunami protocol - was developed at the University of Indiana, and was used in the "speed record attempt".

An average transfer rate, over 17 hours and 40 minutes, in excess of 850 Mbps was achieved. In total, 6.5 terrabytes of data were transferred – about twice the text content of the entire United States Library of Congress.

More information about this demonstration can be found in the presentation overheads of Berkhout and Wallace, 2002.

Research and education networking in Southern Africa

Is the HEIST network a REN?

The HEIST network links most, but not all, of South African higher education and research institutions and has gateways to the general Internet. But is it a REN? Since more than 80% of the traffic carried on the HEIST is to or from the general Internet, both nationally and internationally, the simple answer has to be negative. Only the HE-Internetworking "core" network, through which TENET sites exchange traffic between themselves, potentially constitutes a national REN, albeit one that hardly sports plenty of bandwidth! In addition, the HEIST Agreement between TENET and Telkom currently excludes some major players such as CSIR, Mintek, the Agricultural Research Council, the research units of the National Parks Board and several government research laboratories. Private higher education institutions are also excluded.

The only other RENs in South Africa of which I am aware are those provided by Telkom and used for specific research projects in terms of Telkom's Centres of Excellence program.

3 This time interval was chosen because the first trans-Atlantic telegraph that was successfully transmitted over a submarine cable was a short message from Queen Victoria to President James Buchanan, and it took 17 hours and 40 minutes before both sides were satisfied that the message has been correctly transmitted and received.

Why connect to Géant?

However, and this is the crucial question: if this core HEIST network had a gateway to Géant that carried all traffic between TENET sites and the over 3 000 research and education sites that connect across the entire World to Géant, and if bandwidth on the core and the connection to Géant was sufficient, would the traffic carried on the core HEIST network become a sizable proportion of the total HEIST traffic?

For each TENET institution, the answer to this question determines the importance of a national or regional connection to Géant. Potentially, Géant is a means of enormously expanding our research and education networking, *as opposed to* simply increasing (or reducing the unit costs of) our access to the commodity Internet. I believe that the existence of high bandwidth connectivity to and from Géant sites would stimulate and enable new kinds of research and attract new kinds of researchers to our higher educational institutions.

The opportunity

Right now the concurrence of three factors creates a unique, historical opportunity for getting South Africa's research community re-connected. These factors are:

- The EC has invited South Africa to connect to Géant, and is truly keen to see this happen. There is a possibility of limited financial support through EC development programs.
- The (South African) Government is aware of the EC's invitation, and is actively and constructively investigating the requirements. The DST Task Team, which includes TENET has reported on the opportunity and potential benefits to Minister Ben Ngubane, who instructed DST to prepare a memorandum for him to take to the Cabinet.
- The SAT-3 undersea cable has been commissioned and certainly has the capacity to support a high performance connection to Géant, probably in London.

The hurdles

Several major issues have to be resolved before a connection to Géant will be possible.

Who is the SA NREN?

The first hurdle is to create the National Research and Education Network, as an organisation, that the Government would be prepared to support and identify to the EC. The NREN should include, or should not exclude, any higher education or research institution that is not profit seeking. For this reason, it would be a mistake to identify the HEIST network with the NREN. The NREN should be a "network of networks", inter-connecting the core HEIST network with other institutional and/or collaborative networks in a flexible model that would allow government laboratories, the CSIR, Mintek and other research institutions to connect to it and thence to Géant.

Who should manage the NREN?

I believe that the NREN should be owned and funded by the South Africa Government, with the funding coming as part of the Science vote and administered by DST. The NREN should have a Board appointed by the DST that determines its strategies and policies, and which would contract a suitable party to manage the NREN.

TENET is in an excellent position and is keen to manage the NREN, possibly in terms of a contract from the DST. I am actively promoting this model.

Drafting and agreeing an Acceptable Use Policy (AUP)

Géant requires every NREN to have an AUP that binds its member networks and institutions and that encapsulates the NREN's nature as a research and education network. We need to agree a suitable AUP for the SA NREN.

Seeking Government support

The DST team is briefing other Departments, including Communications, Education and Foreign Affairs, as part of the preparation for putting a proposal to the Cabinet. The proposal will require budget indications as to the costs of establishing the NREN and the recurring annual costs of operating it.

DST is convinced that the Cabinet will want to take a SADC-wide perspective of research networking, and the team has already conducted a survey of research networking in other SADC countries. The

survey was carried out by Henry Watermeyer, who found that while campus networks at most universities are well developed, Internet access is limited and costly.

Getting SAT-3 on board

SAT-3 comprises two cables - the South Africa West Coast (SAWC) cable, and the South Africa Far East (SAFE) cable. Both of potential value to the South African research community. The SAWC cable runs around the bulge of Africa between Lisbon and Cape Town, with landing points at several West African countries. It has a design capacity of 20 Gbps, although this will not all be available from the beginning. I'm assured that there is an abundance of cheap bandwidth between Lisbon and London.

An international consortium owns SAT-3. There are some 30 members, most of whom are the national telcos of African countries, partner telcos such as BT, France Telecom, Sprint (and many others). Telkom SA has the largest single share – some 30%. Telkom managed the deployment of the cables and will manage sales and operations. Telkom is, as before, the vital player with whom we need to work. In this regard, I believe that throughout our HEIST experience, Telkom has recognised the special needs of the higher education community and has sustained its commitment to provide customer-specific solutions that meet our needs far better than off-the-shelf ones could.

Conclusion

NRENs have emerged in many countries as a means, in the face of the tyranny of demand for the commodity Internet, to meet the needs of researchers and scholars for extraordinary bandwidths and extraordinary networking services within and between the nation's research institutions. Géant and other international efforts are shifting the paradigm from national to global. The EC's invitation to connect a South African NREN to Géant is surely a wake-up call to the South African research community and its networking professionals – let's do it – let's get connected!

References

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