Advanced Network Backgrounder

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Introduction

The New Zealand government has committed to the development and construction of an Advanced Network (AN) for New Zealand. This document has been created to provide some background information on the network and some straight forward answers to common questions about the network from a non-technical perspective. In addition, some resource references on networks, projects and applications are included.

What is an advanced network and why do we need one?

Information technology has changed the face of modern science and research. The experimental and experiential nature of many sciences requires researchers to capture huge volume of data produced by activities such as astronomical observations, seismic monitoring and archaeological field work. Scientific disciplines such as bio-computing, medical computing, environmental sciences, physics and astronomy increasingly rely on the ability to distribute and share these data repositories. Theories are tested by the development of computational models, and comparison of the models' outputs with collected data.

To participate in this modern world of science, New Zealand scientists require access to the tools that will allow them to participate in the sharing of large data sets and the development of large computational models. These tools include a network capable of moving terabytes of data in a reasonable amount of time and providing access to computational and data resources throughout the world. Supporting software tools, often called "middleware" are also required to manage the complex use of this network. Such a network is called an advanced research and education network.

Forty other countries currently have one or more advanced networks, all of which are reachable from each other. The development of an Advanced Network for New Zealand will ensure that our scientists are able to catch up with their partners and participate in this exciting world of modern science. Without an Advanced Network, New Zealand science will fall further and further behind in conducting scientific research essential to our future. (Already New Zealand researchers in bioinformatics, bioengineering and biotechnology lack adequate access to global databases of genomic and proteomic data.)

This is why the government has committed to the AN project– not to build a network but rather to develop a catalyst for capability building in new approaches to research and education.

The AN is designed to provide extremely high speed connectivity between research and education (R&E) users. AN users will benefit from being able to share resources and exchange data with national and international research colleagues on a par with researchers in the rest of the world. By creating a network that is optimised for some of the specialised needs of the academic and research communities access to computationally intensive modelling, large data sets and analytical tools will be greatly improved.

Commercial network providers prefer to configure their networks and assign network resources (e.g. bandwidth) for individual users in a way that is application dependent and, where necessary, conservatively designed specifically for the mission-critical needs of their customers. Their charging schemes reflect their focus on "critical needs" for individual institutions and a pricing premium on bandwidth. The collective AN approach means that the users have access to common tools in an environment which generally does not have to be application aware. Although the network is not inherently designed for the mission-critical applications, the majority of users will enjoy a very high level of network availability performance.

The AN is focused on the specific needs of the research, education and innovation communities. Currently 40 countries have one or more advanced networks or national research and education networks (NRENs) which are reachable from each other; the AN will ensure that New Zealand, while well behind other developed nations in this area, will be able to catch up with its partners in developing this type of infrastructure. A key objective of the project and its funding policy and processes will be to ensure that New Zealand is able to maintain and grow it's AN capability and not allow itself to slip behind so far again.

What are the objectives of the Advanced Network Project?

The New Zealand government's objectives for the AN are to:

1. • Enable leading edge e-research. The rate of progress of many areas of research is being determined in part by the availability of high capacity communications infrastructure - as technology evolves, research potential increases.
2. • Facilitate universal connectivity throughout the New Zealand and international research and education community. This will enable users to participate in global research and education community and to access international resources that are, at present, unable to be utilised.
3. • Encourage broad participation in e-research by the research and education sector in New Zealand, through accessible technology and reasonable pricing.
4. • Connect the research and education sector to the broader innovation community for pre-commercial, R&D based collaboration.
5. • Facilitate participation by multiple telecommunications sector partners so as to ensure the greatest possible flexibility for on-going evolution.

How fast will the Advanced Network be and why does speed matter so much?

Today a typical research institution, such as a University, will have a 100Mbit/sec connection to the commodity internet. This connection will be shared by many hundreds of users. An individual researcher would be very lucky to maintain a data flow to the desktop of 1Mbit/sec for the 22 hours it would take to transfer 10Gbytes of data.

The goal of the AN is to be able to deliver 100Mbit/sec or more to the desktop of an individual researcher. This would allow the 10Gbytes of data to be delivered in 13 minutes. To achieve this the AN will deliver at least 1Gbit/sec to larger research institutions, in most cases using optical fibre. Backbone speeds are expected to exceed 40 Gigabit/sec on the network within a few years. At these speeds it is essential that the optical transmission technology economics that underlie such a network are accessible to the AN - not distorted by commercial business retail models which price bandwidth on a different basis.

Speed and low latency (delay) are crucial because these both have a direct bearing on the most efficient movement of massive data sets, or how well complex, multi-site, interactive applications will run. This is particularly important for international collaboration where additional latency caused by non-optimum network arrangements could hamper network performance.

What will Advanced Network users do with all that computing power and speed?

Users will participate in a range of global, collaborative research and education programmes using the tools provided by the AN and its user communities.

Existing tools like email, telephone and basic videoconferencing are now seen as insufficient to achieve effective collaboration within geographically scattered teams. The AN makes possible a virtual multimedia interactive environment linking many different locations together, in real time. Using a capability called access grids they create true online collaboration by enabling the simultaneous sharing and interaction of data, voice, high quality video, and other media across multiple locations. For example, New Zealand geologists and geophysicist will be able to use NEESgrid (Network for Earthquake Engineering Simulation) to directly access sensor data from fault lines off the Californian coast.

The revolution in technology has also fostered the growth of e-research. This term refers to large scale research that is carried out through, local, national and international collaboration, enabled by NRENs.

Much work is now underway overseas on tools for manipulating large heterogeneous research datasets (spatial, temporal, image, video, audio, 3D, spectral, graphical, and multimedia). This will allow the datasets within domain-specific scientific databases to be accessed, shared and integrated with other information resources from other domains, digital libraries (e.g. publications, journals, and digital theses) and the Internet (web sites). The AN is a new tool for the sciences and the humanities.

Scientific modelling and data sharing focuses more and more on the growth of complex computer modelling. Collection of data from sensor networks can be facilitated by the AN where high speed and/or internationally distributed connectivity is required. Only by improving the existing infrastructure, through the creation of the AN will New Zealand be able to contribute to and learn from these models and systems. The AN becomes the focus of multi-institute activity to develop skills and capability that otherwise would not develop as quickly or at all.

What are people doing internationally on Advanced Networks now?

Right now science and research work is being undertaken internationally that is dependent on cyber-infrastructure. Collaborative efforts that were not possible before the advent of NRENs are now common in many countries. The Distributed Systems Laboratory (led by NZ'er Dr. Ian Foster), Argonne National Laboratory, University of Chicago, defines an infrastructure concept called a "Grid" which is the catalyst for collaboration –

"A Grid is a persistent infrastructure that supports computation-intensive and data-intensive collaborative activities, especially when these activities span organizations. Grid computing facilitates the formation of "Virtual Organizations" for shared use of distributed computational resources."

NRENs incorporate or support key Grid functions to allow the underlying high performance networks to be accessible to collaborative end user applications. Examples of existing collaborations include NEESgrid for earthquake engineering (http://www.nees.org) and the Australian Virtual Observatory (http://www.aus-vo.org) which will become part of the global virtual observatory (http://www.ivoa.net).

End user applications of the AN in New Zealand will be as varied as the research undertaken by the user. We can gain some insight into the sort of tools being developed overseas that the AN, with its user organisations, will provide or support in New Zealand to facilitate e-research and education.

These tools are generally called "middleware", which tend to be grouped into the following three broad categories:

1. Grid Services/Resource Management
2. Open Grid Services Infrastructure (OGSI) - access, communication, accounting, security, trust and coordination between (computational and data) resources of the grid and the higher level resources that use them (Resource Management Middleware)
3. Knowledge Management
4. Tools and services that enable indexing, archiving, discovery, analysis, integration, management and preservation of large heterogeneous distributed data repositories and digital archives.
5. Collaboration
6. Tools and services to support formal and informal, real time and offline collaborative activities between remotely located researchers, research and education communities, and resources.

A key area of work for the AN project is "capability building" in the above middleware tools and services so that New Zealand researchers and educationalists can quickly be effective users and develop collaborative relationships. Significant dedicated funding will be available to ensure the desired outcomes in capability building.

International and local examples of NRENs, research institutes, communities and application work are included in the following table. Of the overseas NRENs, the most interesting to visit have their own home pages and reference sites containing details of their user policies, funding and operating models and users projects. Browsing these sites, it is worth remembering that each of the NRENs have their own distinct operating and funding models and it should not be assumed that New Zealand's AN governance and funding policy will be exactly the same as any of them.

Research and Education Networks	1. • AARNET– Australia http://www.aarnet.edu.au/ 2. • GrangeNet – Australia http://www.grangenet.net 3. • Abilene / Internet2 – USA http://www.internet2.edu/ 4. • CANARIE – Canada http://www.canarie.ca 5. • JANET – UK http://www.ukerna.ac.uk/ 6. • DANTE, GEANT – Europe http://www.dante.net/ 7. • CERNET – China http://www.edu.cn/HomePage/english/cernet/index.shtml 8. • TWAREN – Taiwan http://www.twaren.net/english/ 9. • SINET – Japan http://www.sinet.ad.jp/english/
Advanced Computing Facilities	1. • Australian Partnership for Advanced Computing http://nf.apac.edu.au/ , http://www.ac3.edu.au/ 2. • European Large Scale Facilities http://www.epcc.ed.ac.uk/tracs/ 3. • Laboratory for Advanced Computing University of Illinois http://www.lac.uic.edu/
Advanced Network Instrumentation	1. • Synchrotron http://www.synchrotron.vic.gov.au 2. • CERN http://public.web.cern.ch
People Networks/ Research Communities	1. • Next Generation Internet -NZ http://www.ngi-nz.co.nz/ 2. • Third Frontier Network http://www.osc.edu/oarnet/tfn/
Grid Computing/Grid Services	1. • Argonne National Lab http://www-fp.mcs.anl.gov/dsl/ 2. • NSF Middleware Initiative (NMI) www.nmi-middleware.org 3. • DOE Science Grid http://doesciencegrid.org 4. • Enabling Grids for E-science in Europe (EGEE) http://egee-intranet.web.cern.ch
Digital Libraries/Research Repositories	1. • Digital Libraries Initiative 2 http://www.dli2.nsf.gov/ 2. • Perseus Digital library http://www.perseus.tufts.edu/ 3. • Orphan Film Symposium http://www.sc.edu/filmsymposium/
Data Mining	1. • University of Illinois http://www.ncdm.uic.edu/ 2. • University of Alabama

	http://www.itsc.uah.edu/labs/
Knowledge Management/ Semantic Grid	1. • Semantic Grid Community Portal http://www.semanticgrid.org/
Visualisation, Simulation, Interactive Virtual Environments	1. • HIT Lab University of Washington http://www.hitl.washington.edu/ 2. • HIT Lab Canterbury http://www.hitlabnz.org/
Applications	1. • Computational Chemistry 2. • Bioinformatics 3. • Nano-materials and Meso-scale physics 4. • Environmental Modelling / Climate Prediction 5. • Earth Sciences / Solid Earth and Environment Grid 6. • Marine and Oceanographic Modelling 7. • Computational Engineering 8. • Astronomy and Computational Astrophysics 9. • Particle physics 10. • Mesh-based computation 11. • Financial modelling 12. • E-learning 13. • E-health 14. • Computational Linguistics 15. • Social Sciences – data analysis

So what about opportunities for New Zealand?

The greatest benefits for New Zealand researchers will be through the collaborative access that the AN will give to colleagues and peers internationally involved in similar work to their own.

Who will own and operate the Advanced Network and who will be able to use it?

The AN will be owned and operated by an independent structure with a Board and advisory panel representing New Zealand research and education agencies and institutes. Funding will come jointly from Government and user institutions. The AN will be implemented in stages across New Zealand starting with a main centre backbone network and international connectivity.

More Information?

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