



National Education Network Phase II

Proof of Concept –Final Report

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Audience

The intended audience for this document are:

- REANNZ Management
- Education Sector Officials
- Education sector Ministers

Reference Documents

- National Education Network (NEN) – Network Architecture – A15025 7/4/2008.
- ITPs and Wananga NEN Connection Assessment – A15556 - 14/4/2008
- Libraries Connection Assessment – A15550 – 14/4/2008
- Schools NEN Assessment A15553 – 10/4/2008

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Review and Approval

This document has been approved for release by the following:

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Executive Summary

In Phase I of this programme of work, REANNZ developed planning estimates of the costs to connect all the country's schools, ITPs, Wananga and Libraries to a National Education Network (NEN) backbone run on KAREN. REANNZ also designed the architecture for a NEN and assessed the capability and readiness of the ITP sector to connect.

Phase II was about testing the architecture and getting real life exposure to the hurdles that will have to be addressed in the full national deployment of such an architecture. It was also about testing some specific uses of the NEN by and between schools, ITPs and some trial service partners.

In REANNZ's view, Phase II has been successful;

- The designed NEN architecture has been proven to be appropriate, with some minor elements for improvement identified
- A detailed insight into the nature of supplier and member capabilities has been gained, which will inform some of the design parameters for the scale-up of a full NEN deployment
- The viability of centrally provided and nationally available services over an NEN has been proven
- Participants have been enabled to collaborate, achieve efficiencies and explore new teaching and learning practices that were previously not possible.

Arguably, Phase II has achieved outcomes beyond its original objectives. We have created an embryonic NEN community, overcoming years of little or no on-the-ground delivery of a nationally-driven, open, transparent, high-performance network for the sectors.

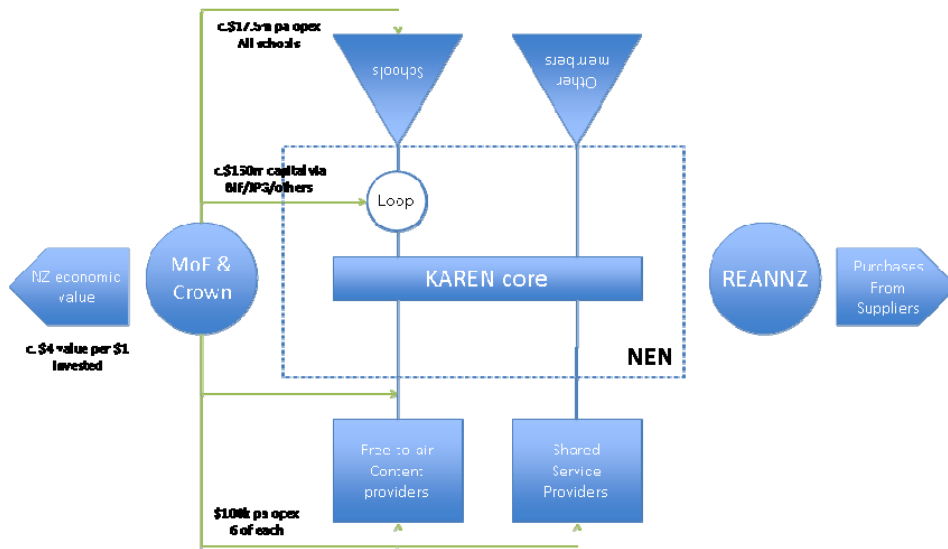
The more detailed knowledge gained from Phase II allows us to estimate the costs of implementing a NEN more accurately. **We estimate this to be \$150 million of capital, including \$50 million for in-school network readiness activities, and c. \$17.5 million pa of increased operating (connectivity) costs. Such an investment would be phased over a period of 3-5 years.**

In REANNZ's view, the Education Sector should explore the following policy options for deployment of a NEN nationally:

- Commit to schools being anchor tenants on any Common Framework compliant services being offered, whether from existing or new providers
<http://www.med.govt.nz/templates/StandardSummary>
- Centrally fund the capital costs of tail connections and offer some transition funding support for any increased operating costs.
- Implement a central mechanism for funding the KAREN membership component of schools NEN costs, via either an optional 'top-slicing' of the per EFTS fee or by negotiating directly with REANNZ.
- Engage REANNZ to develop a scalable product and service suitable to implement in support of a full NEN deployment.
- Provide focused support for the capital costs of high-speed connectivity between ITPs in remote and under served regions and KAREN PoPs
- Invest in a series of exemplar projects (both connection and usage-based) in the tertiary space to further explore the value case for the ITPs / Wananga making a strategic investment in NEN connectivity
- Negotiate with REANNZ to connect a range of key content and service providers to the NEN (for both tertiary and compulsory sectors) to overcome the market failure caused by the connected community being too small in the early stages of NEN deployment.
- Ensure key education sector agencies, i.e. NZQA, Ministry of Education, TEC, are connected to the NEN as Partner members.
- Assess the business models of the Content and service Partners and develop a marketing solution that addresses and then provides a product that is fit for the NEN segment taking into account the embryonic size of the community, its fractured requirements as well as its potential.

The flow of contributions around an NEN can be visualised as shown below.

Phase III/IV National Education Network Visualisation



There is a real sense of momentum developing around the NEN. The community is starting to realise that the availability of such an infrastructure and the efficiency and learning / teaching opportunities it enables are not optional if New Zealand is to continue as a first world economy.

Central leadership and support is needed to ensure a NEN is deployed consistently, openly, and evenly around the country as well as much more quickly than if schools and ITPs/Wananga were left to individually build the business case to connect and participate without such central support.

Phase III of this ongoing programme should address the above commercial, technology and policy factors. At the same time Phase III is being developed current NEN trial participants should have their connection continued Phase IIB.

Introduction

The Ministry of Education (MoE), National Library and the Tertiary Education Commission (TEC) engaged REANNZ to trial a project referred to as the National Education Network (NEN) Proof of Concept (PoC). This project involved implementing the architecture for a National Education Network that had been developed in Phase I of the project and testing a range of services to be delivered over this network.

For this PoC a range of schools and Institutes of Technology and Polytechnics (ITPs) were connected to KAREN either directly or through Network Aggregators. A range of educational services, from defined Service Providers, were also connected to the NEN and their content was made available to the educational entities connected to the NEN.

This PoC allowed REANNZ to test all aspects of the proposed NEN architecture from mid July to mid December 2008.

The objectives of the PoC were:

- Connection of a range of educational entities such as Schools, Institutes of Technology and Polytechnics (ITP), Wananga, through Aggregators to KAREN.
- Connection and trial a range of educational services, from MoE defined Service Providers, to these education entities.
- Demonstration that the proposed NEN architecture could be delivered to schools and the NEN architecture, as proposed during Phase I, functioned as envisaged.

The PoC began mid July and will end mid December 2008. It was designed to test and stress members and partner processes and capabilities. The learnings and outcomes will provide information necessary to develop and define the processes necessary to roll out the NEN on a national basis.

An underpinning assumption of the NEN PoC was that the NEN would be based on KAREN. This was from both a network and service perspective. This PoC was designed to test that assumption.

An additional, informal, goal was to amass sufficient experience and evidence to support any government policy and Budget process development for 2009. There are also a number of existing Ministry schools ICT contracts due to expire December 2009 that this work is informing the future of.

This project includes the wind-up of the PoC in the middle of December 2008 or the extension of it if otherwise agreed. It has now been agreed to continue with Phase IIB until 30 June 2009.

This report documents the outcomes and learnings of the PoC and recommends a path forward.

Desired Outcomes

The desired outcomes of this project are:

- Validate and learn the about the NEN architecture developed in Phase I
- Deliver educational services over KAREN (Connected Education)
- Learn the issues – technical/commercial/ governance/ support arising from the NEN trial that can be applied as future learning points
- Demonstrate and prove the benefits of the National Education Network
- Validate the integrity of the architecture and services through test cases and rigid testing
- Prepare a summary report describing the results of the Phase II Proof of Concept

In addition to achieving the contracted project outcomes, MoE wished to gain information on the following policy issues:

- The costs of School(s) connecting to the NEN. This includes connection costs and any cost implications relating to their IT infrastructure.
- The cost, options and suggestions for connecting the NEN to Schools i.e. “last mile” connection costs.
- A budgetary estimate, based on the results of this NEN PoC, of creating a National Education Network that could be rolled out to all schools.
- Additional focus points from the Tertiary Education Commission (TEC):

In addition to achieving the contracted project outcomes, TEC wished to gain information on the following policy issues:

- How to connect ITPs to KAREN and encourage them to be part of the **wider educational community** by developing relationships with Universities, Schools and other ITPs.
- The understanding of the potential that a high capacity network offers ITPs for the delivery of **educational outcomes**.
- The advantages of sharing **back end administration functions** between ITPs over a high capacity network. Specifically, this would involve connecting WINTEC and Western Institute of Technology Taranaki (WITT) to KAREN so WITT can develop a supportive business relationship with WINTEC.

In addition to achieving the contracted project outcomes, REANNZ wished to confirm that the proposed architecture and its associated processes, proposed in the NEN PI project, are capable of exploitation to the scale required of a National Education Network.

The Network – Services distinction

Access to the pedagogical benefits of the use of content and services in the teaching and learning arena requires two distinct components:

- The National Education Network – the open, common IP network layer shared by all connecting members
- Connected Education / ITP Shared Services – the services, applications and activities occurring over the NEN that support teaching and learning and sector administration. This also applies within the ITP context where certain organisations have self-organised to explore sharing services.

The ITPs are less affected by the above distinction given their greater ability to self-organise, e.g. TANZ, and their greater ability to develop institution specific value cases for connecting to KAREN / NEN. That said, ITPs have benefited during the trial from the work undertaken to develop the Aggregation community.

The National Education Network

REANNZ involvement, and the scope of this NEN PoC, was focussed around the connectivity provided by the National Education Network, both in support of schools connectivity and ITP connectivity (where an aggregation service was preferred).

In order to ensure maximum participation by potential trial parties, REANNZ adopted a proactive stance to achieving this connectivity. It was obvious that schools have, in general, a much lower level of technical capability and resource availability than current KAREN core members and the existing processes would not work with the NEN. An interventionist strategy was adopted from the outset.

This approach also was used with the Content and Service Partners (CaSPs) selected to be part of the schools element of the PoC. The time and cost of connecting the CaSPs using standard core connection processes was considered unacceptable in terms of the NEN PoC.

This issue was escalated to the REANNZ Board who approved the suggested solution of setting up the MoE as a CaSP Aggregator at the Auckland and Wellington peering exchange locations. This involved REANNZ purchasing two Juniper routers and then leasing them to the MoE for a year. REANNZ is also providing ongoing temporary management of the MoE Aggregation Service.

Connected Education / ITP shared services

In practice the network components of the PoC could not be proven in isolation. The Connected Education component of the PoC was developed to understand the educational perspective of being connected to the NEN.

REANNZ determined that connectivity alone, without access to Connected Education components constituted a project risk. Connectivity has little value if it doesn't have a purpose. Mitigation of this risk was the driver for REANNZ to approach Core–Ed and let a contract for supporting, from an educational perspective, the rollout of the NEN PoC. This work is currently underway and was funded by REANNZ.

Outcomes and learnings - Schools

Summary

For schools, their generally smaller size, large sector size (n=>2,585), very restricted individual financial situation, and limited current collaborative situation presents a wide set of problems. Whilst some of the benefits arising to schools may be directly monetisable (e.g., lower internet costs), most are likely to be non-monetisable (e.g., increased access to specialist teachers, more authentic learning resources, reduced time on administration). This value is only able to be realized by the sector taken over the country at large, and as such implies a much greater role for central policy and implementation support for a full NEN deployment around schools. International exemplars fully support this observation.

The schools (compulsory education) sector requires a coordinated package of network connectivity, education services and funding policy development to achieve the benefits of Connected Education through universal NEN connectivity over a 3-5 year period.

The historically low level of network spend from individual schools is not conducive to network, content and service providers investing much to support this sector. The specific points outlined below illustrate that without a significant inducement to supply, e.g. a centrally driven rollout, many potential suppliers will deliver a less than optimum service to schools.

Our experience throughout this project has highlighted the need for end user support to realise on the benefits of being properly connected to the network.

Supply-side learning points

Connection to NEN Core (KAREN)

- The REANNZ processes to achieve service turn-up are not readily scalable to support a mass rollout of service to 500-700 schools per year
- A number of the aggregators and schools had to get external professional technical expertise to assist with the trial. In order to maximise the use of this expertise many implemented simultaneous changes on their network while connecting onto the NEN. Complex faults occurred because of this lack of change control.

- Two service participants did not understand their own networks! They seemed to be oblivious to the fact that parts of their network were outsourced to a third party and this significantly complicated and delayed their connections.
- The REANNZ service connection process has a 10 working day window, whether changes are physical and/or logical in nature. Customer driven urgency is not a function of this process.
- REANNZ had little visibility of any changes carried out by TelstraClear e.g. REANNZ did not have visibility of the configuration of the KAREN routers.
- REANNZ had designed its network with an “open Point of Presence (PoPs)” policy. Contractors and service providers are supposed to be able to have access to POPs when required. The inability of Vector to get into Kingston St on the 10/10/2008 illustrated the difficulties that can arise when this approach is not followed. A process for easier access into the KAREN POPs by authorised third parties is required.
- REANNZ adopted an interventionist strategy for the NEN in order to drive through connections in a timely manner. This approach accentuated the provisioning process issues. A simple, consistent connection process did not exist for the NEN. The impact of this was that it took up a lot of REANNZ resource that ideally would not be required.

Connection to Schools

- The current contractual processes are slow and paper based requiring conventional mail handoffs
- The schools’ expectations of service support are met when a competent and motivated Aggregator is involved, but a strong commercial incentive for Aggregators to provide that support does not currently exist.
- Aggregators don’t currently have a sound business model for just aggregating NEN Schools. In addition, a disconnect exists between the service required by the schools from the Aggregators and what they received. The lack of a clear business incentive for Aggregators and integration providers to offer the necessary services to schools will require a commitment to large-scale deployment to overcome.
- The Aggregators that participated were either an existing ISP or an entity set up by a cluster of schools. Some Aggregators did not seem to have the technical ability to deliver and meet requirements or provide the required support.

- It was assumed that the Aggregators would also be Service Integrators- this was not always correct. One Aggregator delivered to the traditional telco demarcation boundary and did not attempt to get the School working on the NEN. A connection should only be considered complete when KAREN is the preferred route for the connected Schools traffic i.e. the connection is not only made, but fully integrated with the internal IT infrastructure
- The existing NEN connection process is beyond the ability of most schools - and some Aggregators to execute without the need for any rework.
- Connecting onto the NEN requires changes at the school and by their aggregator. If the aggregator hasn't got the required skills then support has fallen onto REANNZ. If the schools expertise is "borrowed" from teachers or parents, co-ordinating their efforts with those of the aggregator can be challenging.

Demand-side learning points

The Schools identified to participate with the NEN PoC were targeted because they had a reputation as being enthusiastic and catalytic innovators when it comes to using IT. It is believed that this approach maximised the learnings from the project.

Policy Based

- Schools have their own Boards, which limits implementation national approaches
- School money is distributed within the school by its Board according to local priorities. This may not be IT!
- Bulk funding for Content Licences is not available
- Bulk funding for NEN connections is not available
- Bulk screen rights licences is not available
- National agreements for acceptable IT use are not available
- Unexpected costs can cause significant difficulties for a school
- The threshold of this (cost) pain is very low – schools are often not able to directly monetise the benefits when they do arise.

Educational

- The concept of an educational community sharing and maximising resources with a network is still at the early adopter stage in terms of the users thinking. It is driven by individual enthusiastic people.
- Despite years of ICT PD investment, the value of technology (and specifically network) enabled learning and teaching remains unproven to many teachers

Social

- The social implications of high speed network connectivity are beginning to be understood by the early adopters
- A number of schools wanted to extend their school network beyond their campus to the (students) home. SNAP offered free home to school traffic. Point England school wanted to extend their campus to the immediate Tamaki area, Kristin wanted uniform coverage from all NEN connected schools so roving personnel could access their home campus
- The benefits and strengths of video conferencing on a high capacity network are being realised.
- Some reluctance by schools to participate in the NEN was driven by a fear of unquantifiable costs
- Private Schools have generally better resources and, based on a small sample, cope well with networking within the school, and connectivity to KAREN

Technological

- The variable quality of Schools IT infrastructure- it is generally of low quality.
- There is no uniformity regarding the state and condition of existing IT infrastructure in Schools.
- Public Schools generally have little ICT resource, and the resource when available is often variably available and sometimes of a low grade
- Consistent, low cost and available during school hours NEN support is required – automated management desired.

School experiences and value

This initial trial of the NEN concept demonstrated a number of key intra and inter-school benefits to schools of being connected to the advanced network.

While the number of schools participating in this trial was small, the insights provided through their experiences provide some clear directions for the future in terms of practical implementation, and for further research and evaluation.

One issue that became evident as the evaluation team spoke with the various participants was the extent to which those who are currently involved within the school represent the 'early adopters', characterised as those who are willing to 'give things a go' and who are generally optimistic about what can be achieved. These people invariably 'go the extra mile' to make things happen, and are not generally put off by technical or infrastructural difficulties; instead they work to find ways of solving these issues. The benefit of working with an external evaluation team was that it provided an opportunity for these people to reflect on what they'd been doing, and to extract ideas they had about the benefits the connection to the NEN had for their schools and their students. In most cases, the articulation of these ideas and perceived benefits had not been recorded in any formal way before.

Another benefit of working with an external facilitation/evaluation team was in the ability the team had to 'cross-fertilise' ideas, make connections and to co-ordinate some of the activities that occurred. This included in some cases liaising with others to make equipment available or to advise on technical requirements to make what the schools did have work effectively. In the longer term, this level of 'connectedness' may grow within a community of practice as the various individuals and groups become aware of what others are doing and a sense of shared practice emerges. In the short term this will take further facilitation and encouragement.

Pedagogical Benefits

For full details of the realised benefits see the report from Core – ed. This is currently located at <http://www.core-ed.net/karen> It will be transferred onto a REANNZ site at an appropriate time.

- speed/capacity
- national networking
- visualisation
- personalisation

- collaborative activity

System Benefits

- classroom management
- resource sharing
- time management (turnaround of e-asTTle)
- ROI on infrastructure
- Home-school links
- Teacher workload – work from home, sharing planning etc
- Potential in terms of shared services

The detailed report from CORE Education titled 21st Century Learning Challenge will be released into the public domain during February 2009.

Outcomes and learnings – ITPs

Summary

For ITPs / Wananga, the larger size of individual institutions, the smaller number of institutions (n=19) and previous collaborative history (e.g. TANZ) means there is a reasonable chance of ITPs being able to monetise the benefits of NEN connectivity in the medium-term and thus make the value case to join the NEN. However, there are a combination of connectivity challenges (for some), internal technical constraints and operational and teaching benefits (for most) that are barriers.

REANNZ's current feeling is that some catalyzing, pushing and central transition / remote site funding provided is required for this sector to achieve NEN connectivity over a 2-3 year period.

The KAREN Experience Programme (KEP)

The KAREN Experience Programme offered free KAREN membership for 2008 in exchange for an in-kind investment in activities that make use of KAREN's capabilities. This was intended to encourage organisations to think about how to exploit KAREN drive a shift in thinking around the application of KAREN enabled technologies, services and tools.

REANNZ agreed, as part of the NEN PoC, to sign up the NMIT, Wintec, Otago Polytech and CPIT to the KEP programme in order to achieve the outcomes required by the TEC for this Phase.

Supply-side outcomes

- Current connection process are better able to handle the relatively small number of ITPs as opposed to the large number of schools
- ITP IT departments are generally better able to handle connection than many school, although costs are still a challenge in a sector with ongoing financial constraints
- Some remote ITP/Wananga sites may prove difficult to connect as they are some distance from current KAREN PoPs

Demand-side outcomes

Wider education community

- The NEN PoC has seen Wintec, NMIT and Unitec added to the ITP community of Otago Polytechnic and CPIT on KAREN
- Planning is underway to connect Weltec, SIT and Northland Polytech to this increasing ITP community
- Collaboration and access to the wider educational communities, over KAREN, i.e. Universities and Schools is underway through a number of initiatives.
- Venture Southland is planning a community investment in a KAREN PoP in Invercargill which SIT is part-funding. This PoP would also support the connection of Southland schools.

Education outcomes

(Refer Appendix 6 for full details)

- NMIT is trialling video conferencing (VC) over KAREN and its peered research networks to deliver courses in China. [REANNZ KEP initiative.](#)
- NMIT is trialling VC available on KAREN as a means of delivering courses to students in Nelson Marlborough. [REANNZ KEP initiative.](#)
- NMIT is exploring the sharing of services between Otago Polytechnic and the Massey and Canterbury Universities. [REANNZ KEP initiative.](#)
- NMIT is trialling Microsoft "Live Meetings" with Northtec.
- NMIT has reduced its commodity Internet traffic by being connected to KAREN.
- WINTEC is integrating High Definition VC as a means of accessing NZ/US Moodle forums. [REANNZ KEP initiative.](#)
- WINTEC is participating with the Carnegie – Mellon University at Pittsburg on the Socrates Project with the objective to share captured lectures. [REANNZ KEP initiative.](#)
- WINTEC is investigating using KAREN VC to support the joint delivery of courses. Specifically the joint Bachelor of Occupational Therapy course being delivered by Otago tutors. [REANNZ KEP initiative.](#)
- Otago Polytech and CPIT are using KAREN for the delivery of a Midwifery programme. [REANNZ KEP initiative.](#)
- UNITEC are developing and sharing podcast and vodcasts with the University of Otago. [REANNZ KEP initiative.](#)

- UNITEC are using KAREN as a platform to build capability in remote student collaboration. REANNZ KEP initiative.

Back-office

- WITT and Wintec are investigating and working towards the sharing of admin and educational resources. KAREN is considered as the ideal vehicle to achieve this objective.
- REANNZ has engaged local Taranaki Councils, Venture Taranaki and local educational institutes to stimulate a project with the objective of funding and establishing a KAREN breakout in New Plymouth
- The possibility of establishing KAREN Breakouts in Tauranga and Whangarei has emerged. This would significantly lower the last mile costs for those institutions.

Outcomes and Learnings –Network Aggregators and Content & Service Providers

Summary

Whilst the focus of the NEN trial was not on the sorts of content and services that would be desirable to have accessible over such a network, it was the intention to understand in more detail the attractions and challenges to working with such Partners from an NEN perspective (NEN as defined above).

It is absolutely clear that, as the scope of the NEN is delivery of network connectivity to the school gate [or some such termination point inside the school] that establishing ways of working with local or regional network and related-services suppliers is critical to implementation success. In order to minimise costs and implementation time's sufficient demand must be brought to the market through aggregation of contracting to make it attractive for the supply market to engage. In addition, the level of skills and experience we uncovered in the supply market and the schools sector was generally at a level where upskilling by REANNZ (or some other party) was required to ensure a correctly installed and operating NEN service. This is not a "weekend parents" job.

In short, the procurement and project delivery for the NEN must be a centrally driven-locally responsive programme and not a schools-driven one.

Such an approach is also critical to ensure alignment with any associate government (local or central) investment in broadband infrastructure. Such an approach does not negate the requirement for schools involvement - indeed, the more local involvement the greater the probable success.

Observations on Connected Education suppliers (Network Aggregators and Content and Service Partners)

We had several conversations with Connected Education content and service providers during the trial by virtue of us running a pilot connection scheme.

The key barrier that emerged was that the providers were unable to justify the cost of connecting to the NEN. This was for two reasons:

1 - critical mass - REANNZ operates a fixed annual charge for connection, irrespective of the number of customers the provider has signed-up for its services. This creates a risk loop for the provider in that they cannot justify the membership charge without a sufficiently large customer base on the NEN, but cannot build that customer base as they consider it too risky to connect.

2 - absolute network costs - for services relying on very high quality networking, e.g. video downloads, data backups, that the full cost of providing that network has not been factored the current pricing for some provider services, ie even with a very high penetration rate, the service would still not generate sufficient margin to pay for connection to the NEN.

There are several potential ways forward that are not mutually exclusive:

1 - REANNZ develops pricing models that share the risk and reward of supplier uptake. This is something REANNZ will be examining in the first half of 2009.

2 - A central purchase agreement from government / the sector on a per-supplier basis overcomes the business-case risk for particular services

3 - Education sector agencies (or some other sectoral body) relieves the market failure by purchasing a "bundle" of content and service provider memberships that it can distribute to preferred suppliers, e.g. of LMS, commodity internet

4 - Suppliers absorb more of the cost/risk of provision on an NEN and/or increase charges.

In our limited experience, the schools market is so fragmented and the supplier market so strained to make money from it that for continued viability of a Connected Education supplier market some greater level of bulk purchasing over a smaller range of service options is essential.

Architecture and costs

Architecture

The NEN architecture trialled during Phase 2 successfully supported the services required. The challenges referred to elsewhere relate principally to the surrounding operational support processes, including the contractual and service management aspects.

Schools and ITPs connecting do still have some additional work to do before they can fully utilise their new connection. A physical connection to the NEN provides the opportunity to use the services inherent in having that connection, but does not mandate that they will be used.

A good routed network architecture and design is required to ensure that the routing decisions are made at points that are significant in user interactions with lower layer network functions. This may mean, for example, that the http proxy servers need to understand that NEN routes are available, or it may mean that the device that is acting as the default gateway for the Local Area Network (LAN) needs to have the full NEN routing table. In many cases schools and ITPs are moving from having only one routing option i.e. to the Internet, to having the option of sending to NEN or the Internet. The delivery of a single routing option is relatively easy as all decision making points need only understand the answer to the question is this address local?

In addition, before those routing decisions are made, user friendly names need to be translated into numbers that correlate with entries in routing tables. This is achieved via Domain Name Service (DNS) lookups which provide the detail before, and for, the routing decision. In many cases the decision on whether to use the commodity Internet or NEN is made during the DNS lookup. This is particularly true for locations such as www.google.com which is available in both routing domains.

Any changes made to DNS systems or routing behaviour can impact other network based services such as email, local login and other vital local services. It is critical that this environment is well understood before any changes are designed, planned and implemented.

Connecting institutions should also bear in mind that the NEN, like KAREN, is an open access network, meaning any desired security or content filtering needs to be applied at the edge of the network.

Costs¹

REANNZ calculates the cost of deploying a National Education Network to be **\$150 million in capital and c. \$17.5 pa** in operating costs in addition to what the sector currently pays.

This estimate is comprised of the following estimates. For full detail, assumptions and comments on these calculations please see the Appendices of this report.

NEN Capital Cost
\$78m – High Speed Network Extensions
\$50m – Internal schools network readiness
\$8m – NEN interface connections
\$6m – IT provisioning services
\$8m – Core Network / Backhaul additions
\$150m TOTAL

NEN Operating Cost
\$15m pa – Increased regional connectivity costs
\$2.5m pa – Core network connectivity costs
\$17.5m pa TOTAL

The above estimates are only valid when an NEN deployment will be:

- Centrally funded and managed (implemented)

¹ The costs here do not include the costs of 10 -12 additional KAREN PoPs and inter-PoP connectivity necessary to support the required reach of a NEN, and to keep the last mile costs realistic. Many PoP costs could be minimised if the NEN rollout were undertaken in conjunction with Whole of Government network initiatives, or Broadband Investment Fund initiatives. It may be possible to offset some of the required additional PoPs and core connectivity from better last-mile costs due to bulk procurement.

- Non-discretionary
- Provided as an extension to KAREN

Dispersment of funds to individual schools will not create the commercial scale required to achieve supplier commitment of roll-out efficiencies.

Conclusions and recommendations

Conclusions

We are well through Phase II of the NEN trial. This Phase has been successful and has achieved its objectives, in that we have uncovered in some detail, backed by real experience, the technical and commercial challenges of connecting schools and service providers to the NEN.

We currently have 5 ITPs and 22 Schools connected, representing 26 % and 1% of the sector potential respectively. Another 2 ITPs are expected to connect before the end of 2008 bringing ITP participation to 37% of the potential Institutes.

Phase II is currently due to be wound-up on 15 December, after which point connected ITPs, schools and NEN Content and Service Partners would be able to stay connected only upon payment of standard REANNZ dues, i.e. the current arrangements of heavily discounted tariffs implemented as part of the NEN trial would end.

Whilst most ITPs are expected to continue with membership, the continuation of many schools membership (and certainly the development of significantly increased school EFTS coverage) is less likely given the longer time and wider reach needed to deliver value.

The NEN work over its first two phases has generated solid momentum in an area that has traditionally large inertia. The level of expectations and hopes amongst the community to a commitment to a centrally-driven full NEN deployment are growing.

REANNZ will shortly begin planning the architecture and procurement options around its network refresh. It requires a high level of certainty over the extent to which a refreshed architecture should account for NEN. REANNZ also has other strategic opportunities and needs to understand how to allocate its resources most effectively.

Problem

It is clear that to successfully implement a full NEN rollout across all schools and ITP/Wananga sectors a number of commercial, operational and policy challenges (as identified in Phase I and Phase II) need to be solved.

These problems are different for the each sector.

For ITPs / Wananga, the larger size of individual institutions, the smaller number of institutions (n=19) and previous collaborative history (eg TANZ) means there is a reasonable chance of ITPs being able to monetise the benefits of NEN connectivity in the medium-term and thus make the value case to join the NEN. However, there are a combination of connectivity challenges (for some), internal technical constraints and operational and teaching benefits (for most) that are barriers. Our current feeling is that some catalyzing, pushing and transition funding centrally provided is required for this sector to achieve NEN connectivity over a 2-3 year period.

For schools, their smaller size, large sector size (n=>2,585), very restricted individual financial situation, and limited current collaborative situation presents a wider set of problems. Whilst some of the benefits arising to schools may be directly monetisable (e.g., lower internet costs), most are likely to be non-monetisable (e.g., increased access to specialist teachers, more authentic learning resources, reduced time on administration). This value is only able to be realized by the sector taken over the country at large, and as such implies a much greater role for central policy and implementation support for a full NEN deployment around schools. International exemplars fully support this observation. The schools (compulsory education) sector requires a coordinated package of network connectivity, education services and funding policy development to achieve the benefits of Connected Education through universal NEN connectivity over a 3-5 year period.

Recommendations

In REANNZ's view, the Education Sector should explore the following policy options for deployment of a NEN nationally:

- Commit to schools being anchor tenants on any Common Framework compliant services being offered, whether from existing or new providers

- Pay for the capital costs of tail connections and offer some transition funding support for any increased operating costs.
- Implement a central mechanism for funding the KAREN membership component of schools NEN costs, via either an optional 'top-slicing' of the per EFTS fee or by negotiating directly with REANNZ.
- Engage REANNZ to develop a scalable product and service suitable to implement in support of a full NEN deployment over say 3 years
- Provide focused support for the capital costs of high-speed connectivity between ITPs in remote and underserved regions and KAREN PoPs
- Invest in a series of exemplar projects (both connection and usage-based) in the tertiary space to further explore the value case for the ITPs / Wananga making a strategic investment in NEN connectivity
- Negotiate with REANNZ to connect a range of key content and service providers to the NEN (for both tertiary and compulsory sectors) to overcome the market failure caused by the connected community being too small in the early stages of NEN deployment.
- Ensure key education sector agencies, ie NZQA, Ministry of Education, TEC, are connected to the NEN as Partner members.

There is a real sense of momentum developing around the NEN. The community is starting to realise that the availability of such an infrastructure and the efficiency and learning / teaching opportunities it enables are not optional if New Zealand is to continue as a first world economy.

Central leadership and support is needed to ensure a NEN is deployed consistently, openly, and evenly around the country as well as much more quickly than if schools and ITPs/Wananga were left to individually build the business case to connect and participate without such central support.

Phase III of this ongoing programme should address the above commercial, technology and policy factors. Specific actions and deliverables for each are outlined below:

Moving forward

There are two over-arching questions to be answered:

- What will be New Zealand's approach to a NEN for schools?
- How do we better support the value case for ITPs joining the NEN?

The answers to these questions will impact the rate of connectivity to and use of an NEN and hence to REANNZ's development of this aspect of KAREN.

Approach

It seems that a three stream approach is the best way to address these questions:

1 - Preparation of a paper that outlines the National Education Network vision and proposes a national implementation solution within the existing funding envelope. This paper should be presented, initially, to the MoE ICT Standing Committee and then to the appropriate Ministers and decision makers.

Acceptance of this project and the subsequent rollout of a scaleable product to all schools is considered as the National Education Network Phase III project.

2 - All participating organisations build on the existing NEN PII Proof of Concept momentum, maintaining the present trial funding arrangements for schools that are already connected to the NEN trial, connecting any additional schools that either pay their own KAREN member fees, or who have these fees paid for by the MoE, connect up to 4 new Content and Service partners for a 6 month period with their Member fees also paid by the MoE. This is referred to as the National Education Network Phase IIB project.

It is planned to work with a combined ITP/Schools cluster, in parallel with the NEN PIIB project, in order to understand the service dynamics and associated issues that will occur when these clusters work together for a collaborative outcome.

3.- TEC develop an explicit programme of connectivity assistance to the ITP's and Wananga campuses that have the optimal balance of institution and community benefits.

The deliverables for part 2 of the recommended approach (in effect a Phase IIB – extension of the current trial), including lead delivery responsibility and funding responsibility are drafted below.

These efforts need to be developed and agreed on a coordinated basis to have maximum value and effectiveness. Some progression of individual components will remain possible however.

Deliverable	Lead Responsibility	Funding source
Continue connection of self funding Schools to the NEN	REANNZ	BAU
Maintain current NEN PoC connections for 6 months post 15 December 2008. (14k FTEs at \$2.65 per FTE per annum pro rated)	MoE	MoE
Add additional schools as required (\$2.65 / per FTE per annum pro rated)	MoE	Schools
Connect up to 4 Content and Service providers for a 6 month period	REANNZ	MoE

Appendix 1: Participants

The Content and Service Providers (CASPS)

The Content and Service Providers involved with the NEN PoC were:

- e-Cast
- Ministry of Education
- Christs College
- TelstraClear (TCL)
- LERN – KnowledgeNet
- Ed Tech – UltraNet
- KVCS (KAREN Video Conferencing Service)

The URL pointing to a specification of the requirements of a CASP is:

<http://www.karen.net.nz/assets/Uploads/Documents/REANNZ-Content-Services-Policy-FINAL.pdf>

Network (Connectivity) Aggregators

The Network Aggregators involved with the NEN PoC were:

- DTS
- TCL
- Inspire Net
- Nelson Loop (Nayland College)
- Wellington Loop (Wellington Trust)
- SNAP
- Ministry of Education

The URL pointing to a specification of the requirements of a Network Aggregators is:

<http://www.karen.net.nz/assets/Uploads/Documents/REANNZ-Aggregation-Service-Policy-FINAL.pdf>

Institutes of Technology and Polytechnics (ITP)

The ITPs targeted to provide the TEC outcomes for the Proof of Concept were:

- Otago (Otago Polytechnic)
- CPIT (Christchurch Polytechnic Institute of Technology)
- NMIT (Nelson Marlborough Institute of Technology)
- Wintec (Waikato Institute of Technology)
- Unitec

Schools

The Schools targeted for the Proof of Concept were:

- Christ's College (Christchurch)
- Kristin School (Auckland)
- Hunterville Consolidated School
- Palmerston North Boys High
- Pt. England School
- Mangamaire School
- College St Palmerston North
- Rangiruru Girls
- Wellington East Girls College
- Wellington College
- Wellington High School
- Wellington Girls College
- St Mary's College Wellington
- The Correspondence School
- Westlake Boys High School (Not connected)
- Westlake Girls High School (Not connected)
- Takapuna Normal Intermediate (Not connected)
- Takapuna Grammar School (Not connected)
- Nayland College
- Nelson College for Girls
- Collingwood Area School
- Appleby School

Appendix 2: Observations and assessment of PoC participants

The following summaries outline REANNZ's experiences with each class of participant in the Proof of Concept. We have attempted to be factual wherever possible in our observations and comments, but, naturally, there is an element of subjectivity in our assessment, REANNZ has striven to be fair and accurate in its approach and in recording its observations and comments. Any comments or concerns should be raised with REANNZ directly.

Network Aggregators

Aggregators	Comment
SNAP	<p>SNAP are the aggregator and ISP for Christ's College. They offer innovative services to the College, one example being that they do not charge for home to school broadband traffic. SNAP assisted the College with their plans to offer multicast TV over the NEN. After some investigation it was decided to upgrade the SNAP Cisco routers' operating systems. Although this is yet to happen [October 2008] it illustrates the point that SNAP are interested and involved with the Schools and do not always demand commercial drivers.</p>
DTS	<p>DTS is the incumbent ISP for a number of Schools on the Auckland North Shore (NEAL). They agreed to become an aggregator for the NEN PoC by extending the Vector VLAN from the Skytower to the KAREN Point of Presence at Mt Albert by an Areneo radio link. The initial connection was non-compliant with REANNZ standards and disconnected because of the spanning tree errors introduced onto KAREN.</p> <p>A number of concessions were made to DTS such as their ability to have a copper interface and the sharing of the radio link, albeit with another KAREN member.</p> <p>This connection has still not been completed although DTS remain keen to be involved in the NEN.</p>
Nelson Loop (Nayland)	<p>Nayland agreed to become an aggregator in early 2008. They were granted an exemption because they were using a non-</p>

Aggregators	Comment
	compliant router that couldn't provide multi-cast peering. Their aggregator connection to the NEN went to plan. Bringing on Schools behind the aggregator was difficult as the Nelson Loop has its own filtering and virus protection which complicated the connection. The cost of bringing on 4 Schools was in the vicinity of \$6k. The Nelson Loop has recently indicated a desire to join the NEN en masse.
Wellington Loop Trust	The Wellington Loop Trust was set up to provide aggregation and ISP services for the Schools on the Wellington Loop. In order to meet the timings of the NEN the Trust installed an interim Allied Telesyn router: this step took some time. The cutover process onto the NEN was cautious and always reversible, but took some time to achieve. The cutover of the aggregation service was achieved with School IT staff borrowed from their usual day job. Planning and timeliness is not always possible in this environment.
Inspire Net	Inspire Net is an innovative ISP. They have built up a business by seizing trench open opportunities to extend a fibre optic network around Palmerston North which they extend with point to point radio. Inspire Net lent Hunterville school a PC for the trial. They appear to be a strongly community minded Supplier.
TCL	TCL had agreed to become an Aggregator approximately a year ago. They agreed to be part of the NEN and aggregate PT England, Te Papa, Rangiruru and deliver standard definition Freeview TV as part of the trial.

Content and Service Partners (CaSPs)

CASP	Comment
Christ's College	Christ's College is connected to KAREN through SNAP as the Aggregator. Christ's College offered to deliver streaming TV containing German and French content as part of NEN PoC.

CASP	Comment
	<p>This proved not to be as straightforward as first considered. Their edge router is suitable for an aggregated School but not as a CASP. No Multicast functionality available on their Allied Telesyn edge router. SNAP agreed to do a unicast/multicast conversion for the College. Not yet implemented (29/10) although the unicast German IP TV channel Deutsche Welle is now available. Christ's have expressed a desire to expand their streaming media delivery.</p>
e-Cast	<p>E-Cast is delivering their educational content onto the NEN through the Ministry's aggregation router. This was a requirement of the Ministry of Education from the trial outset. They struggled with Ministry's aggregation concept initially but quickly saw the potential and then pushed aggressively to be connected.</p>
Ministry of Education	<p>The Ministry of Education quickly saw the advantage of setting up as an Aggregator for the NEN PoC. REANNZ leased, installed this equipment, and then operated it, for the Ministry for the PoC period. The primary objective was to allow schools to use the Ministry's student assessment application (e-AsTTle) at Schools. Currently this application is out of favour with schools as the internet delivery version is considered too slow. Getting this configuration available on the NEN proved difficult and more complicated than it should have been.</p>
LERN / Edtech	<p>LERN / Edtech (two separate companies) stated they wanted to supply content to the NEN PoC. They are to be connected to the Ministry's aggregation router. The connection will be straight forward but as of the 12/02 this has still not happened.</p>

Loop Schools

LOOP Schools	Comment
Appleby Collingwood Nayland Nelson College for Girls	<ul style="list-style-type: none"> • Connected after many attempts over weeks • Connection cost \$x • Volunteer support • Slower that it should have been
Wellington (Wn) East Girls Wellington College Wellington High School Wn Girls College St Mary's College Correspondence School	<ul style="list-style-type: none"> • Aggregated by Wellington Loop Trust • Coming across onto NEN as a complete Loop • Motivated to connect • Took a long time to get moving and then to connect
Westlake BHS Westlake GHS Takapuna Normal Takapuna Grammar	<ul style="list-style-type: none"> • Require DTS to be working as an Aggregator • Under Action – Investigating connecting “Vector Net” to the Auckland Aggregation device

Individual Schools

Schools	Comment
Hunternville	<ul style="list-style-type: none"> • Connected 5/9/2008 • Radio-Fibre connection • 10Mb/s radio measured throughput of 8Mb/s • IT infrastructure in School dated and not maintained – IT ranking 1.6/5 compared with national average of 1.46 /5 (DH-MoE 15/9) • IT distribution switches 10 years old and changed out by Inspire Net • IT infrastructure works at 2Mb/s but not 10Mb/s • Faults in structured cabling-lack of maintenance • Keen to be involved- see the potential • Got up and running only through the involvement of Inspire Net

Schools	Comment
Palmerston North (PN) BHS	<ul style="list-style-type: none"> • Connected 22/9 – No problems but installation done when resources available at InspireNet and relied on InspireNet goodwill and skills
Mangamairie	<ul style="list-style-type: none"> • Connected with fibre connection from Inspire Net
PT England	<ul style="list-style-type: none"> • Low decile primary school that wants to bring in the world of music • Has Tandberg VC equipment locked onto School Zone • Radio/fibre connectivity to TCL aggregator. Operating at 12Mb/s symmetrical and up to 28Mb/s asymmetric
Rangi Ruru	<ul style="list-style-type: none"> • Awaiting TCL to complete aggregation connection
College St (PN)	<ul style="list-style-type: none"> • Awaiting fibre connection from InspireNet
Burnside	<ul style="list-style-type: none"> • Not committed • Questioned requirements of Schools Contract
Kristin	<ul style="list-style-type: none"> • Previously connected to KAREN • Impressive competence , resources and commitment
Christ's College	<ul style="list-style-type: none"> • Previously connected to KAREN • Impressive competence , resources and commitment

Core Network Providers

TCL General	Comments
	<p>TelstraClear supply the connectivity between the KAREN Points of Presence and operate this network for KAREN. At various times through out the establishment of the NEN architecture, TCL failed to meet the target network response times of 10 days for physical changes and 3 days for logical changes. All changes have to be carried out by TCL as NEN is a subset of KAREN. This arrangement does not reflect customer or user requirements.</p>

REANNZ	Comments
Network Support	<ul style="list-style-type: none"> • In critical path of all connections • Require contractual commitment before proceeding • Involvement in connection processes is at the personal level – If named person away or working on BAU process stops • Requests Connection information that seems to beyond the technical ability of some Aggregators and possibly most schools • Require network measurements , fibre characteristics etc before connecting • Compensate for the lack of security inherent within the network by policing the edge • Try to handhold connections based on lack of information and sometimes commitment often compounding the problems of the user • REANNZ is not resourced to handhold a large number end user connections. This keeps costs down and is adequate for competent core members – not schools
Technical	<ul style="list-style-type: none"> • The network architecture (technically) functions as designed i.e. provides the expected connectivity • Good NEN core performance • The network architecture proposed for the PoC does not separate the KAREN and NEN communities. As implemented only one community exists. This situation need to be resolved before perpetuating the architecture • The MoE CASP aggregation service has problems as to the preferred routing. The lack of visibility of outsourced router configs compounds this issue. Emphasis was placed on getting it working without resolving underlying issues. • REANNZ has no knowledge or visibility of Schools connecting behind Aggregators
Commercial	<ul style="list-style-type: none"> • Obtaining contractual commitment from all participants by

REANNZ	Comments
	<p>requiring authorisation of physical documents is slow and cumbersome especially when this process is always in the critical path of being connected</p> <ul style="list-style-type: none"> • Current non-provision of Commodity Internet over KAREN / NEN limits value case for schools. REANNZ has several options to address this in the short- and medium-term

ITPs

ITP	Comments
Otago	<ul style="list-style-type: none"> • Connected to KAREN during 2007 as a Direct Connection to KAREN
CPIT	<ul style="list-style-type: none"> • Connected to KAREN in 2007 as an aggregated connection behind SNAP
NMIT	<ul style="list-style-type: none"> • Connected to KAREN in 2008, for the NEN PoC, as an aggregated connection behind Nayland College
Wintec	<ul style="list-style-type: none"> • Connected to KAREN during 2008, for the NEN PoC, as a Direct Connection
Unitec	<ul style="list-style-type: none"> • Connected during 2008, for the NEN PoC, as an aggregated connection of TelstraClear

Appendix 3: ITP outcomes in detail

Wider Educational Community

Nelson Marlborough Institute of Technology

NMIT will trial a number of video conferencing tools for roll-out in 2009 to support the shared delivery of new Diplomas to partner institutes in China. KAREN facilitated links and multi-party bridging capability will greatly reduce the capital and operational expenses. It will also greatly enhance the quality and timeliness of the relationships between institutes, and reduce travel costs.

Video conferencing and other real time virtual classroom tools also will be used for distance education to students across the Nelson Marlborough region. A core part of NMIT's selection criteria for tools will be their operability on and off net – they are seeking a one-size fits all to reduce training and other operational costs. Such tools will enhance NMIT's ability to provide teaching expertise based in Nelson to remote locations across the region and to bring external expertise into NMIT classes.

Update 20 October 2008

- Currently exploring shared service options for video/web conferencing over KAREN, including Elluminate (server at Otago Polytechnic), Adobe Connect Pro (Massey and Canterbury servers), Microsoft Live Meeting (NorthTec server)
- Establishing a discussion forum for educators with interest in shared services for supporting teaching and learning
- IT has noticed a large reduction in network load/traffic - as R&E traffic now goes over KAREN

Waikato Institute of Technology

Project 1: Moodle across the Pacific

Wintec is integrating high definition video conferencing over KAREN into their participation in monthly NZ/US Moodle forums. The focus of these international collaborative forums is to improve teaching and learning using the learning management system Moodle. Wintec's participation in monthly best practice meetings will be enriched through utilising video conferencing in combination with other tools such as presentations, multi media and virtual

whiteboards. For Wintec this activity is the beginning of a drive to build ongoing capability for international video conferencing over the KAREN.

Project 2: Panopto CourseCast

Wintec is a member of the Socrates project, a collaborative programme in testing lecture capture technology developed at Carnegie-Mellon University at Pittsburg. Because of KAREN, Wintec will be able to participate as an equal partner in this project, sharing high quality best-practice presentations over advanced video conferencing. They will also be able to retrieve and share captured lectures and other learning resources from other Socrates members, enriching the pool of learning resources available to New Zealand students and taking our country's content to the world.

Update 20 October 2008

- Wintec are currently exploring options for tools and services to run over KAREN
- They are also focusing on raising awareness among staff and particularly among Executive Management about the potential of KAREN
- Investigating the VC capabilities and the potential to support co-joint delivery of courses, e.g. Wintec and Otago Polytechnic have just launched a joint Bachelor of Occupational Therapy degree, delivered by Otago tutors

Educational Outcomes.

CPIT and Otago Polytechnic (joint plan)

Christchurch Polytechnic Institute of Technology and Otago Polytechnic are collaborating on a project which will use KAREN to support the delivery of a jointly owned midwifery programme offered to students throughout the South Island. They will use video conferencing over KAREN to hold regular, informal, low-cost meetings between tutors and midwives for course development. Video conferencing is also being employed to deliver the course, enabling students from remote sites to participate.

Collaborative research is another feature of this project which will see CPIT and Otago participating in international research via online collaboration tools.

Update 20 October 2008

- ITPQ approval gained for Midwifery programme on 13 Oct

- Now waiting for TEC funding to progress developments
- VC kit undergoing final testing. Ready for deployment in mid November
- CPIT midwifery group has a VC with colleagues in the UK in November.
This is only possible because of KAREN

Unitec

Unitec is collaborating with the University of Otago in developing and sharing podcasts (audio) and vodcasts (video) as part of a contemporary music programme. Students will record, share and critique each other's weekly original podcast or vodcast reflecting on music and interviews with local musicians. This content will be shared on multiple platforms available over KAREN (including iTunes U hosted at Otago University).

Students will learn production techniques and build capability in remote collaboration. KAREN will enable the sharing of rich media at a speed and on-demand approach previously impossible without the bandwidth that KAREN provides.

Update 20 October 2008

- Unitec connected only very recently
- Currently investigating service options to trial over KAREN, including Moodle, and VC
- Looking at establishing a iTunesU hosted site (on KAREN)

Back End Administration Functions

WITT

An outcome the TEC wanted to achieve through this project is to have the Western Institute of Technology at Taranaki (WITT) connected to KAREN. WITT is an Institution that would benefit from an educational and administrative perspective with a relationship with a larger institute. WITT has a relationship with Wintec (Hamilton).

Wintec was connected to KAREN on the 24/9/2008.

A number of alternatives to connect WITT to KAREN at an existing KAREN Aggregation Point (AAP) were priced and presented to WITT. This required WITT to purchase backhaul to Palmerston North and access KAREN through InspireNet aggregation service. WITT indicated they needed at least 100Mb/s to achieve their strategic outcomes. The cost of 100Mb/s backhaul was in the

vicinity of \$30k/month and was considered to be too expensive. The most cost effective long term solution for WITT, and other educational entities in New Plymouth, is to establish a KAREN AAP in New Plymouth.

Interest in developing a New Plymouth AAP and funding a KAREN breakout has been registered with Venture Taranaki at a meeting in New Plymouth on the 21st October 2008. A final action point to appoint a Project Manager was accepted by Venture Taranaki. REANNZ will continue to push and encourage this initiative.

There are a number of advantages in pursuing this strategy. Some of the initiatives being investigated or trialled by existing members are:

- The ability to rationalise data storage and backups. This service is currently being trialled between the Victoria and Auckland Universities.
- The ability to rationalise software versions and backups over a larger platform can deliver operational benefits and impact users less.
- Information systems and Admin support applications can be rationalised and specialist support consolidated. This can be more cost effective than managing multiple disparate sites with different systems.
- It is possible to achieve more with the scarce IT resource available through the standardisation of infrastructure and the downstream impact on training, spares and support.
- The rationalisation of IT infrastructure can save power and by reducing infrastructure and supporting services such as air – conditioning etc.
- Storage for applications and hosting can be rationalised and appropriate savings made.
- Admin support services such as voice, video conferencing, and data communication can be made across KAREN, at a flat rate charge.
- Educational services can be shared.

It will take some time to achieve these objectives and this initiative must be considered a long term project. It was suggested to Venture Taranaki that they should have a plan within 6 months and a solution within 12 months. It was also suggested, based on the Hamilton experience, that they consider involving a private partner to take on the immediate project risk of driving this initiative on the understanding they will get a later return from the resultant infrastructure.

This work is ongoing and REANNZ will support Venture Taranaki through this project.

Details of the options considered for WITT are contained in Appendix 7.

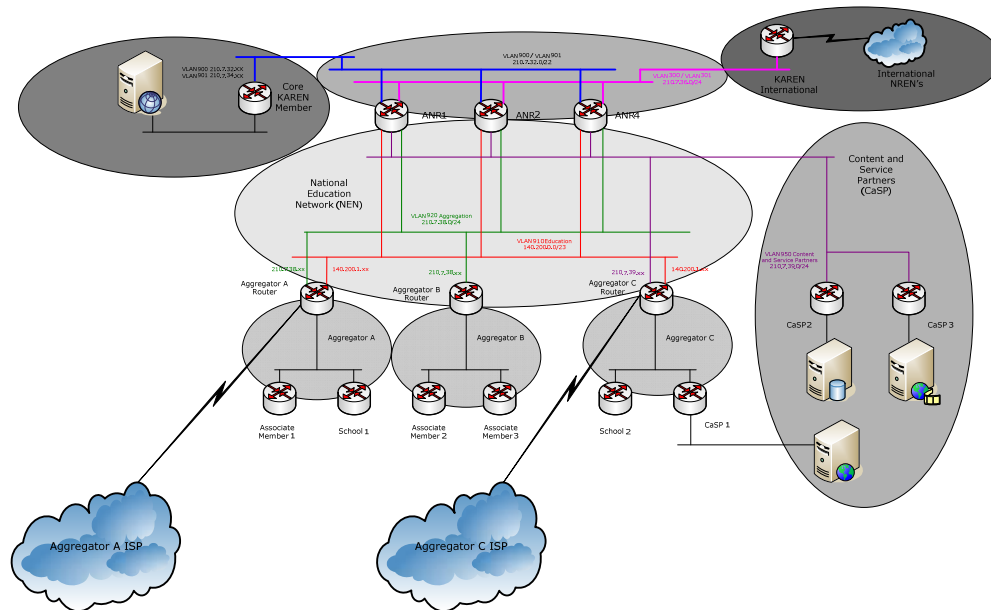
Further Initiatives

REANNZ is currently working with Northland (Whangarei) Polytechnic, Southland Institute of Technology (SIT) and Weltec (Wellington Institute of Technology) with an objective of adding them to the educational community.

Appendix 4: Architecture & Network Service Concepts

Architecture

The following diagram shows the architecture used during the Proof of Concept.



Network Service Concepts

FCAPS is the [ISO Telecommunications Management Network](#) model for [network management](#). FCAPS is an acronym for Fault, Configuration, Accounting, Performance, and Security which are the management categories into which the ISO model defines network management tasks. In non-billing organizations Accounting is sometimes replaced with Administration.

The FCAPS processes of KAREN will need to be modified to be allow the NEN to be suitable for the wider educational community – specifically schools. It is suggested that the NEN be engineered to achieve the following FCAPS outcomes.

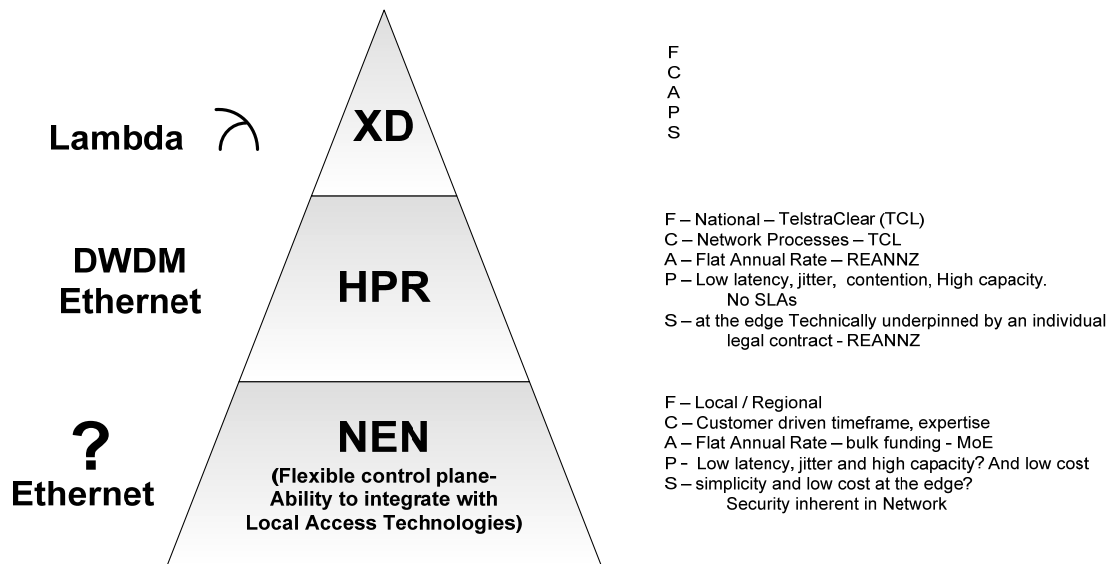
User Analysis **FCAPS: NEN ideal (proposed)**

Faults	Local Support (T1) with Area Support (T2) and National Support (T3) http://en.wikipedia.org/wiki/IT_support
Configuration	Must be simple recognising little expertise at school.

User Analysis	FCAPS: NEN ideal (proposed)
	Must be low cost. Must minimise School disruption.
	Connection timing must meet Schools expectations
	Must integrate into School internal network
Accounting / Administration	Flat rate, no volume or distance charges, one invoice to minimise school processing costs – bulk funding?
Performance	Low latency, jitter achieved by ample capacity
	The ability to integrate local access/area technologies i.e. local vicinity radio coverage may be required
Security	KAREN has no internal network security but access to KAREN is closely managed by REANNZ through contractual and the implementation of technical configurations. The result is that the connection process is slow and cumbersome. Schools may require NEN internal network security?

This is shown diagrammatically below as a hierarchy of educational and research networks.

KAREN - The Vision



Appendix 5: Cost Analysis for creating a NEN

Overview of Cost Relationships

The NEN PoC identified a hierarchy of costs as it relates to a National Education Network. This report addresses the elements of this hierarchy beginning with the Network layer and working up to the Connected Education component.

Component	Costing covered in this report
Connected Education (including services, content and applications)	NO
REANNZ costs	YES
Operational network costs (members)	YES
IT provisioning services	YES
NEN interface	YES
Schools internal network	YES
Network physical layer	YES
Core Network / Network Backhaul	YES

Network Physical Layer

Cost estimate local access

The following assessment is predicated on the assessment carried out for Phase I of the NEN project. (Refer REANNZ NEN PI Report Objective A15553)

	T1 Fibre Optic	T2 Fibre Optic	T3 DSL- Radio- other	TOTAL
High Estimate Total	\$5,388,560	\$64,848,000	\$6,936,000	\$77,172,560
Applicable sites	349	420	1,738	2,584

The high estimate has been used as the basis to this report. In summary it was estimated **\$78m capital** is required to connect all schools (T1 and T2) by fibre, T3 by DSL²

-
- ²Tier 1 sites require minimal investment to connect to existing fibre loops (within 100m).

Cost estimate core network / backhaul

It is estimated that REANNZ would install an additional 12 KAREN breakout points, nationally, to interface the local access fibre connection to Schools with the KAREN core. Based on current experience, and costs, a figure of \$500k each is allocated for this aspect of the network.

An additional \$2m would be required for backhaul transport from these KAREN breakouts.

\$8m of Capex for core / backhaul

Comments

The magnitude of monies required to connect all schools to a National Education Network is \$78m. In order to get commitment from Schools it will be necessary to take into account the political, economic, social and technological (PEST) environment that exists for Schools and which was verified by the NEN PoC.

It is suggested that a staged approach be offered by the Ministry of Education (MoE) for Schools to connect to the NEN. Schools could be offered as an Anchor Tennant (AT) to the Broadband Investment Fund (BIF) applicants of Urban Fibre Networks, by the MoE, for a guaranteed period of three years. Schools can then decide to participate or not. If they do participate, their high speed connection costs are paid for three years, if not they have the choice to go their own way or maintain their existing connection.

The choice resides with the School. The MoE would pay BIF Urban Fibre Networks (UFN) developers a sum of money to connect and operate schools for a three year period. This would underpin the BIF (UFN) developer's business case and be beneficial to all parties as well as offering choice.

-
- Tier 2 sites require moderate investment to connect to existing fibre loops (within 1 km). This also includes sites which form natural loops within 1 km of each other, where 1 site is within 1 km of existing fibre distribution networks.
 - Tier 3 category consists of sites that do not meet the criteria of the above categories. Connectivity to these sites will be dependant on the development of regional fibre network infrastructure.
 - Alternatively, connectivity at sub-optimal speeds could be provided by non-fibre aggregation methods, such as copper (ADSL) or wireless.

This approach is seen as the most cost effective and significantly less cost than a greenfields re build.

Schools internal networks

Cost estimate

A total of **\$50m capital** is required to ensure that Schools connected to the NEN can utilise the speed and bandwidth offered by being connected to a national network.

The average grade of the IT infrastructure of schools in New Zealand is 1.46/5. This is based on a MoE survey of all schools. The MoE believe that this liability will take a total of \$150m - \$200M to completely refurbish the School IT infrastructure and bring 70% of all New Zealand Schools up to the MoE published IT standards.

The state of the School's IT network has a direct impact on the NEN, as the benefits of high speed connectivity (>10Mb/s) cannot be realised if the internal school network is not able to support that same speed of operation.

Comments

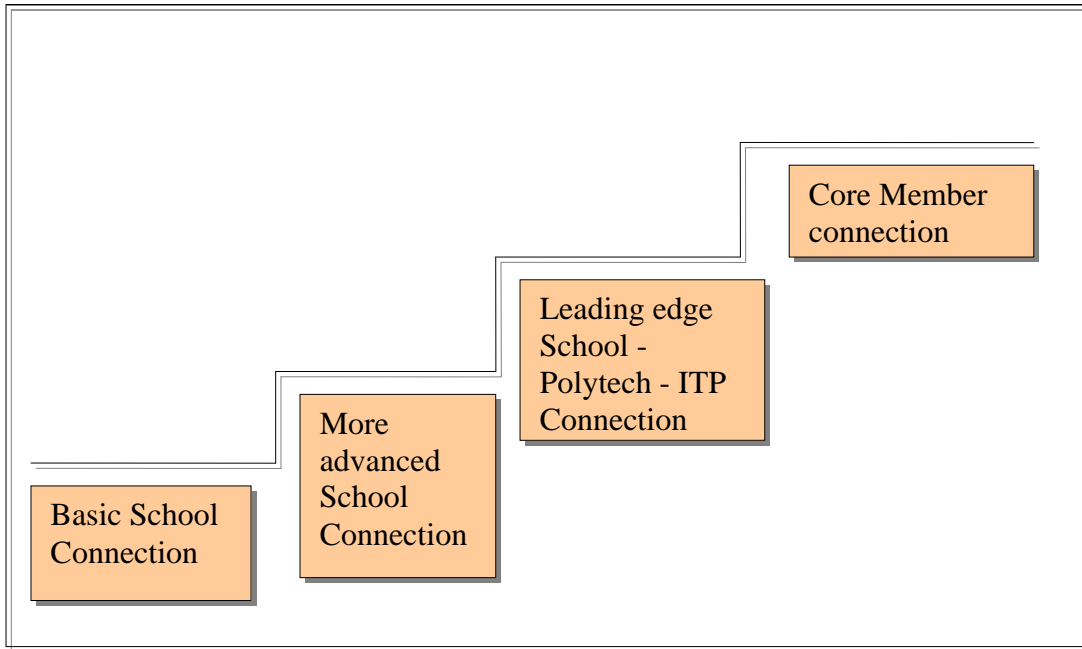
The NEN PoC experience of connecting schools to a high speed network verifies that the School IT infrastructure must be of a standard that is compatible with a high speed backbone network such as the NEN.

It is suggested that Schools IT infrastructure is made ready as Schools connect to the NEN. A complete IT refurbish should not be in the critical path of the rollout of the NEN. Our observations are that the \$50m estimated for this work is reasonable however in order to maintain current IT infrastructure labour cost dynamics this work must be staged to the connecting of Schools to the NEN

NEN interface

Cost estimate

A number of interface options exist for connecting to the NEN. Each option has its own price points and features. It is expected and recommended that Schools begin at the "simple" end of the continuum and evolve as their requirements and expertise grows. This is shown diagrammatically below.



Capital Cost estimates for each tier of connection are shown in the table below

Tier	Cost	Features	Support
Basic School	\$2,000	<ul style="list-style-type: none"> • Out of box Switch/Router • WAN Ethernet • 6 LAN ports • Unicast • 10-100Mb/s • Aggregated Connection • Includes single mode media converter 	<ul style="list-style-type: none"> • 20 hour set up • Remote Management
More advanced School	\$3,500	<ul style="list-style-type: none"> • Out of box Switch/Router • Multicast • WAN Ethernet • Advanced School features • 100Mb/s • Aggregated Connection • Includes single mode 	<ul style="list-style-type: none"> • 20 hour set up • Remote management

Tier	Cost	Features	Support
		media converter	
Leading edge School and Polytech (ITP)	\$5,000	<ul style="list-style-type: none"> • Bespoke • Multicast • Advanced features • 6 x 1Gb/s SFD interface 	<ul style="list-style-type: none"> • Competent IT resource available on call
Core Member	\$15,000	<ul style="list-style-type: none"> • Bespoke • Multicast • Advanced features • 1Gb/s SFD interfaces 	<ul style="list-style-type: none"> • Own competent IT resource

It should be noted that the cost estimates above relate to the capital purchase price of the relevant edge device, and do not include labour or other operational costs. IT Provisioning costs and Operational costs are summarised separately below

Each school will require a compliant NEN interface. It is recommended that for budgetary purposes the T1 and T2 Schools be considered as a more advanced School. This will cost \$2.7m. The T3 interface is estimated at the basic level of \$2000. The T3 interface cost will be \$3.4m.

It is also recommended that a remote management and diagnostic service be offered for these interface devices. At 20% of the interface capital cost per year this will cost \$1.2m.

Total number of Schools 2,584. Total monies required for the device plus support to connect is c. **\$8m capital**

IT provisioning services

Cost estimate

It is estimated that **\$6m one-off** will be required for the IT labour support to connect schools to the NEN.

This is based upon the estimated 20 hrs at \$100/hour (\$2,000) and the \$6,000 it cost to transition 4 schools on the Nelson Loop onto KAREN. This is proportioned at \$1,500 each. An estimated \$500 per school added to cover the volunteer labour provided on site during the NEN PoC connections.

Over a total of 2,584 Schools this equates to \$5,172,000 which has been rounded up slightly.

Operational network costs (members)

Cost estimate

This work is culled from Phase 1 work (Refer REANNZ NEN PI Report Objective A15553).

There are 2,584 sites that are either currently connected or categorized as Tier 1-3. Based on the analysis documented in A15553, the local access service costs are estimated to be:

Calculations	Totals
Low Estimate Total	\$9,785,790
Medium Estimate Total	\$11,004,030
High Estimate Total	\$12,211,695

\$12m pa opex will be required to operate the local access component of this network.

In addition a budgetary estimate of \$3m will be required to operate the core network / backhaul aspect of this network.

\$3m pa opex operate the backhaul component of this network.

Total network operating opex - \$15m

REANNZ Costs

The standard REANNZ charge for Student Full Time Units (SFTU) is \$2.65 per SFTU per year. Currently there are 759,663 students in New Zealand.

Total yearly cost is therefore \$2,013,107 or, rounded, **\$2m pa opex**

REANNZ would also require \$4,200 for each one off direct connection assuming 50 schools per Aggregator \$217,056 or **\$200,000 capital**. This component is not included in the core network estimate.

Connected Education

The Connected Education aspects of the NEN PoC are not addressed in this report. However as part of managing the NEN project rollout some observations have been made albeit on a limited sample.

- Schools do not seem to have the resources to explore educational opportunities
- Schools expect immediate training
- They think that a high speed network will automatically make a difference

The costs of connecting CaSPs to the NEN have not been included in the above cost estimates.

A planning estimate of **\$500,000 pa opex** should be used to cover REANNZ / NEN usage and connectivity. This has been included in the planning cost estimates. This is in addition to any money the education sector wishes to invest in shared services development.

Appendix 6: Connected Education – Core-Ed contract

Scope

Core ed were engaged by REANNZ to actively help the NEN schools realise value from their NEN membership once they were connected as part of the NEN proof of concept, in accordance with the Service provider’s proposal entitled “21st Century Learning Challenge. This is a collaborative project across four regions to demonstrate the pedagogical benefits of being linked to the advanced network (KAREN), delivering the National Educational Network”.

Deliverables

The following high level deliverables, to be provided to a good professional level, were identified for the proposed programme were agreed to by Core ed.:

- A new PoC school, after being connected, was able to articulate the benefits of being connected.
- A new PoC school could point to one or more specific activities that have been made possible by being connected.
- Each of these aims was broken down into a number of specific questions and observational foci which were to be included in the evaluation rubric used by participating teachers, and by the project coordinators in their role as external observers.

Throughout the project evidence of activity and benefits was accumulated within the various online environments etc. including:

- Feedback with artefacts from individual teachers (student work, teacher reflections, blogs etc.)
- Collaboration record (e.g. on wikis, forums, video conferencing etc)
- Project celebration artefacts (video clips, slide shows, web sites, etc.)
- Participant reflective comments/reports (blogs, wikis etc.)
- Record of formal feedback.

The accumulation of evidence will be collated and made available to other educators to reference in future initiatives.

Detailed findings

Reflection & Evaluation

A critical component of the project is the ability to report on and transfer the considerable qualitative findings that have emerged from this project. The project team, via contributors input, will act as the primary knowledge transfer agents.

Reflections were collated and are presented in two ways:

A website containing case studies, including video interviews of each participating school and their activity(ies)

<http://www.core-ed.net/karen/>

A final summary report that will address the two key goals of the project and provide recommendations about how this activity may be sustained will be available late December 2008.

Activities and benefits

The following table illustrates some of the specific activities made possible by being connected to the KAREN, and the benefits realised.

Activities	KAREN Contribution	Benefits
<p>Use of Google docs for word processing, presentations and spreadsheets etc. and for e-portfolio development.</p>	<p>The KAREN network provided the capacity for whole classes of students to work on their Google Documents simultaneously</p> <p>Access to “virtualised/cloud-based” services (in this case, Google docs) as part of the REANNZ on-net partnership with Google.</p> <p>Capacity of KAREN to cope with large amounts of data for personal e-portfolios, including swimming assessment videos, school reports, summary sheets from school management systems, e-asTTle pdf result forms plus other learning artefacts.</p>	<p>Student access to their documents and portfolios from anywhere and at any time, using browser access and not dependent on installed software.</p> <p>Enabling come-school communications between/among learners, parents and school staff.</p> <p>Long term access to personal documents – no longer dependent on school-based storage, archiving and document portability.</p>
<p>Use of e-asTTle as an assessment tool to establish learning outcomes and set future goals for individual students.</p>	<p>Increased number of concurrent users can have access to e-asTTle.</p> <p>Access to a high-speed network made accessing and piloting the web-based version, e-asTTle, feasible.</p> <p>e-asTTle tests were quick to load for both teachers and students on the network.</p> <p>Schools were unlikely to have</p>	<p>Reduction in time spent setting up, marking and reporting on learning assessments. Consequence is a more rapid impact on teaching and learning programmes.</p> <p>e-asTTle tests are marked online relieving individual teacher interpretation therefore gaining more</p>

	<p>used e-asTTle without access through the advanced network.</p>	<p>consistent, valid assessment data.</p> <p>Students enjoyed this type of assessment more than the paper-based approach, and results are used within their e-portfolios to establish learning outcomes and set future goals.</p> <p>e-asTTle reports are an excellent tool for examining and reviewing progress and teaching strategies with teachers. Reports and results are used to discuss performance and the steps to take with students, parents, and boards of trustees to improve teaching and learning.</p>
<p>IPTV</p>	<p>For Christ's College to distribute IPTV beyond the College it has been essential to be on KAREN, allowing them to put out more data streams without congestion on their network. Schools connected to KAREN through the National Education Network can tap into high speed and high quality delivery of IPTV. Six schools are currently accessing IPTV via Christ's College and KAREN.</p>	<p>Capturing and rebroadcasting multi-language IPTV opens up a world of learning to languages students. It means that students are learning languages from native speakers plus exploring the culture and current events of the countries where the studied language is spoken.</p>

Activities	KAREN's Contribution	Benefits
High definition video conference music lessons and performance. ("musicGrid")	<p>Enabled students in remote locations to learn, practice and to play an ensemble together.</p> <p>Speed advantages enable participation in HD video conferencing, and capacity advantages of being able to involve large numbers of simultaneous users.</p>	<p>Provision of specialist teaching for students who would otherwise not have access.</p> <p>Raising the profile and level of performance of music in schools.</p>
National Library schools advisory services.	<p>Provides high quality video conference interactions with teachers (and students).</p> <p>Enables sharing of print, video and web-based resources during through the presentation.</p> <p>Ability to record sessions for later review by teachers who were unable to attend live sessions.</p> <p>Resources available to schools as part of REANNZ's on-net content partnership.</p>	<p>Cost efficiencies to National Library advisory services.</p> <p>Opportunities to expand the services provided as a result of reduced time involved in travel etc.</p> <p>Greater number of schools having access to and awareness of the services, collections, and online catalogues appropriate for their students and subject areas, leading to greater use of NZ's digital resources.</p>
Use of Google Earth to provide virtual learning experiences.	<p>Speed advantages on KAREN when accessing and refreshing and updating Google Earth was more immediate</p> <p>The capacity advantage is that a large number of concurrent users were able to access Google Earth</p>	<p>Large numbers of students were able to access Google Earth with more immediate response.</p> <p>The ability to utilise the advanced features of Google Earth in a real time environment.</p> <p>High level of student engagement through participation in virtual tours.</p>

The outcomes of some of the educational outcomes achieved with this project can be accessed by following the link below:

<http://www.core-ed.net/karen/>

Appendix 7: Content and Service Providers on the PoC

Overview

As part of the National Education Network trial it was planned to connect a number of content and service providers. The Ministry of Education identified a number of content services that they want to see in the trial. One such example was the MoE Video Conferencing (VC) bridge.

The project evaluated and costed these options as discrete connections to KAREN. The problem was linear and amounted to a significant cost. Most content providers requiring connection to KAREN were in a similar position. This would include MoE's e-asTTle and E-cast, etc.

The NEN PII project required a significant additional budget to connect up the desired participants on a bespoke basis.

Existing MoE Presence

The Ministry of Education has an established presence at the Wellington Internet Exchange (WIX) in Wellington. A number of potential service participants also appear at WIX in Lambton Quay Wellington. Some examples being Zero One, ASNET (refer CityLink webpage).

KAREN also has an Access Aggregation Point at the same location.

A solution for the trial

It was proposed that the Ministry becomes a limited aggregator for the purposes of the trial in order to cost effectively give access to the required content and service partners. This arrangement would not be used to aggregate schools or other Members and Associates. This would involve the MoE contractually signing up as an Aggregator with REANNZ and providing the necessary router interfaces at KAREN locations in Wellington and central Auckland.

Methodology

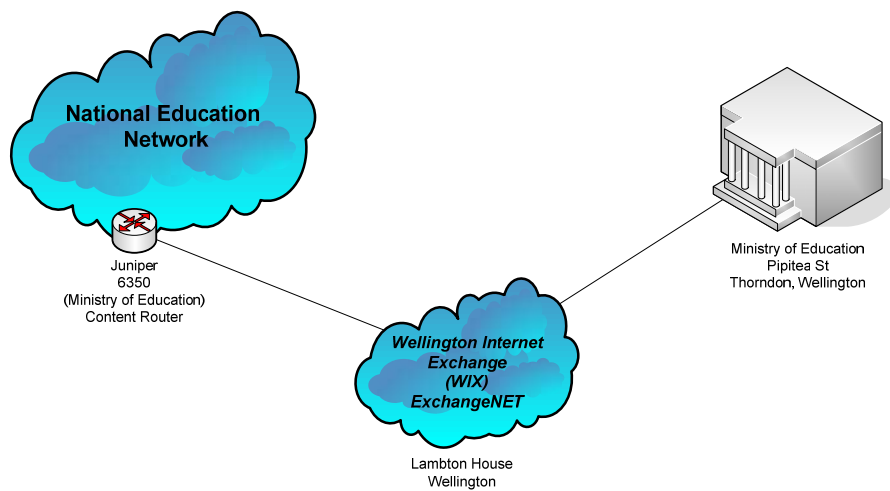
The following steps were taken to connect up the MoE as an Aggregator:

- MoE provided with two compliant routers sourced by REANNZ.

- MoE signed a contract as an aggregator with REANNZ and a connection fee of \$x was paid (out of project budget). Aggregators do not pay any ongoing fee to REANNZ.
- ABC provided a quote to provide the connections from KAREN PoPs to WIX and the Auckland Peering Exchange (APE) for a fee of \$x for an APE & a WIX connection at 100Mb for 6 months.

The adopted configuration is shown below:

National Education Network
(Ministry of Education as a Content Partner)



Appendix 8: Illustrative Wireless NEN connection – Pt England School

Description

The Pt England School is part of an ICT PD cluster consisting of 7 primary schools in the eastern suburbs of Central Auckland - Glenbrae, Glen Innes, Panmure Bridge, Pt England, St Patricks, St Pius X and Tamaki Primary. These are decile 1a schools and are no more than 5 km apart in a densely populated area where the housing is predominately state owned and the community groups are mostly Maori and Pasifika.

These primary schools are part of a larger cluster in the district, the Tamaki Achievement Pathway, and have been working together for schooling improvement. Communication and collaboration between schools was seen as essential to achieving improved learning outcomes for students and ICT has been recognised as an important conduit to stimulate this collaboration.

Pt England are using ICT to deliver schooling improvement by sharing and collaborating at all levels of administration, teacher, student, board, community.

Current Situation:

Pt England is a school that is currently serviced by School Zone. It currently has a 512Mb/s connection and is a user of the Video Conferencing service accessed through School Zone.

After the announcement of the National Education Network (NEN) Proof of Concept REANNZ were approached by a company called TorqueIP. This company had a relationship with PT England School that had been developed during the Ministry of Education schools upgrade project. TorqueIP had upgraded the IT infrastructure of PT England as a result of this project and had developed a lot of respect for what the school was doing and their involvement and use of IT.

TorqueIP approached REANNZ proposing that PT England be part of the NEN. They proposed a radio network picking up all Schools of the eastern suburbs ICTPD cluster.

This was considered too ambitious for the NEN PoC but it was agreed that TorqueIP put up a proposal to connect only Pt England. This was duly

received and the project agreed to fund the labour cost of creating the PT England radio link.

Connecting Pt England was considered as useful as:

It tested a radio / fibre link to TelstraClear as an aggregator of KAREN service.

- It would motivate TCL to commission their aggregation service.
- PT England had an upgraded IT infrastructure
- It would seed the potential for the rest of this east Auckland cluster.
- PT England would benefit as a School. It is already considered as one of the most advanced state schools for the utilization of ICT.

Observations:

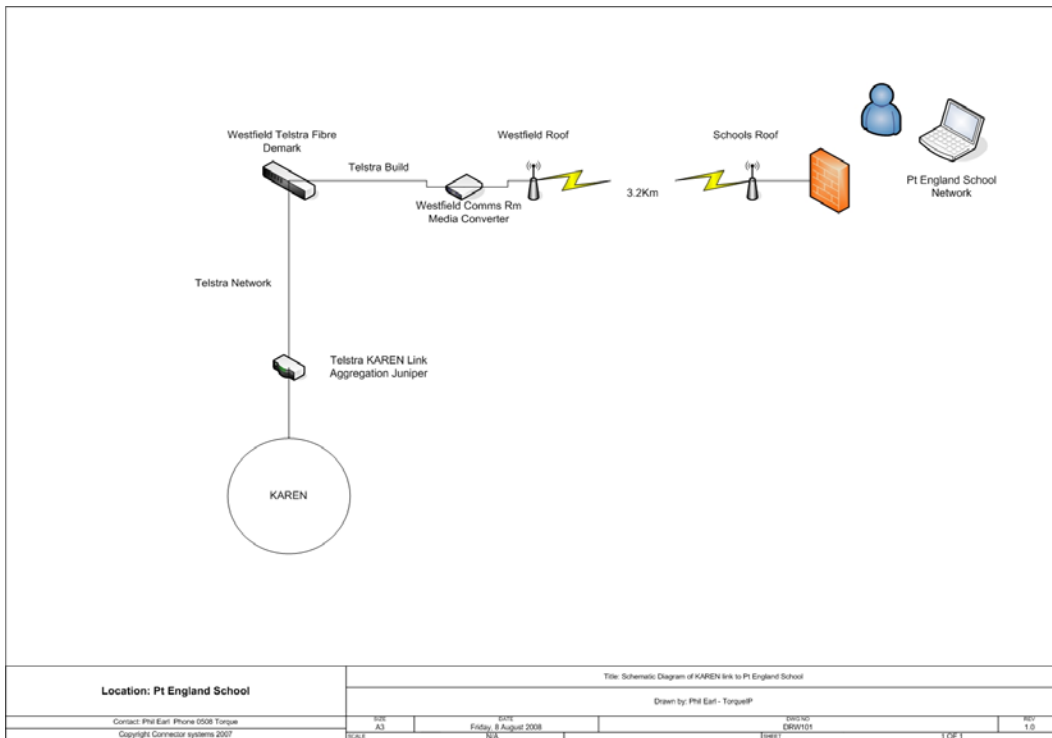
The connection of PT England to the NEN was always seen as a timing risk. The mix of technologies, TCL as an aggregator and the School zone connection all added to the complexity.

The project agreed to accept this risk after receiving an assurance that the connection would be completed by the end of August. Unsurprisingly the connection was completed November 2008. The main hold-up appeared to be the TCL acceptance of this connection as a production model and able to be treated as business as usual in terms of their operations.

The radio link (less the capital equipment cost was in the order of \$x).

One key finding was that TCL and Torquelp each did their component in isolation. Notification was received during November that the link was commissioned however PT England couldn't use it until internal IT configurations were made. It cost approximately \$x to move their video conferencing end point onto the NEN.

PT England Configuration:



Appendix 9: Illustrative Fibre NEN Connection – Huntermville

Description

Huntermville School is a primary school with 196 students located on SH1 approximately 55 Km north of Palmerston North.

Inspire Net of Palmerston North offered to connect Huntermville as an aggregated school for the NEN Proof of Concept. The NEN aggregated connection is achieved with a 10Mb/s radio link to a fibre optic connection point. The fibre optic cable runs down the railway corridor. It is leased by FX networks. Inspire Net rent the fibre from FX networks and charge, anecdotally, Huntermville school \$x a month for connectivity back to Inspire Net for ISP and NEN services.

This is a market disruptive price.

Architecture

Huntermville is connected to Inspire Net by a 10Mb/s radio linking into a fibre optic cable. The access to the NEN is through Inspire Net as an accredited aggregator.

Connecting Huntermville was considered attractive as:

- It tested a range of technologies
- The quality of the local internal IT infrastructure was ranked as 1.60 by a Ministry of Education survey, close to the national average, of 1.46
- Huntermville was keen to trial a Desktop video conferencing service both on a PC using a Mirial licence provided by REANNZ and through freeware on the existing Mac computers.

REANNZ visited Huntermville School on the 5th September 2008. This was the day Huntermville was to be connected to the NEN.

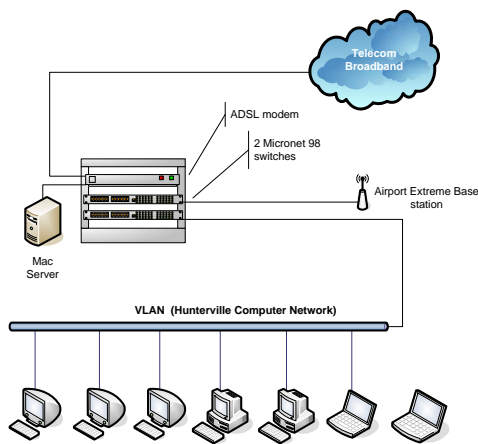
A number of observations were made as follows:

The configuration:

- The internal Cat 5 structured cabling was 10 years old.
- The existing Micronet distribution switches were 10 years old and giving error indications. These were immediately changed out by Inspire Net.

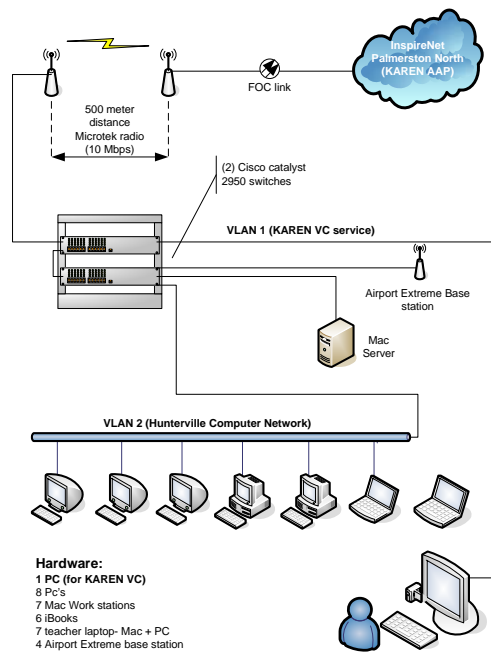
- Inspire Net loaned them a late model PC for video conferencing as their existing equipment did not meet the required specification.
- InspireNet staff spent approx 2 full days setting up the Hunterville connection.
- The Hunterville preferred technical support technician spent 6 hours on site.

Hunterville Consolidated School Computer Network



Hardware:
 8 Pc's
 7 Mac Work stations
 6 iBooks
 7 teacher laptop- Mac + PC

**Old Access
Via Telecom**



Hardware:
 1 PC (for KAREN VC)
 8 Pc's
 7 Mac Work stations
 6 iBooks
 7 teacher laptop- Mac + PC
 4 Airport Extreme base station
 Throughput – approx. 8Mbps

**New Access via
KAREN**

Total 'real' cost of Hunterville connection onto NEN estimated

Getting Hunterville connected was undertaken as a social good by Aggregator InspireNet. Our assessment of the real costs incurred by this Aggregator illustrate why certainty over a national level commitment and investment across the connection process is required for success.

Appendix 10: Illustrative Loop NEN Connection – Nelson Loop

Description:

The Nelson Loop is a Schools project that uses Ethernet, over a predominately fibre optic network, to connect up Schools in the Nelson Marlborough area. The fibre optic network is owned by Network Tasman. The Loop began as an offer from Network Tasman Limited (NTL) to schools for them to utilise excess capacity on its fibre optic network. The Loop vision extends to connecting up all eighty schools in this region. The current number of connected Schools is in the mid twenties.

The Loop is a 1Gb/s to 10Gb/s network operating at layer 2 of the OSI model. Each school is provisioned with a 100Mb/s connection depending on where they are. Some rural schools use a point-to-point radio connection to link to the fibre network.

The Nelson Loop is connected to the Wellington Internet Exchange (WIX) for its internet service.

Current Situation:

The very existence of the Nelson Loop was a major achievement. A number of independent reports have commented on the dedication and contribution of Nayland College and its personnel. A number of suppliers have also generously supported the Nelson Loop endeavours. This is a network that has been created through the good will of people.

The Nelson Loop seemed reluctant, initially, to participate with the National Education Network Proof of Concept. The Nelson Loop seemed nervous about additional costs and the potential for class room disruption that could occur as a result of coming onto the NEN. This, along with the fact that the NEN was a time bound trial, was seen as a real disincentive to participate.

After some discussions the Nelson Loop committed to connecting four Schools to the NEN. These schools were; Nayland College, Collingwood Area School, Appleby school, and Nelson Girls school.

These schools were connected after a number of attempts. It is considered that the experience of these four NEN connected schools has been positive

and inquiries have been made from the Nelson Loop about connecting all schools onto the NEN. These discussions are ongoing.

Observations:

The connection of the four Nelson Loop schools onto the NEN was a slow process. A number of issues arose that seemed to be fundamentally the coordination of people issues.

In summary, the connection to the NEN required coordination between Schools using volunteers, an external contractor appointed by the Nelson Loop, and REANNZ. All parties seemed to have conflicting requirements. Schools were eventually connected and once connected seemed to have few problems.

A log of issues and a summary of advice from the Nelson Loop are contained in the NEN wiki.

http://www.wiki.karen.net.nz/index.php/National_Education_Network

Nelson Loop Configuration:

