NeSI, the Power Behind Researchers

Our purpose…

to multiply the computing capability of New Zealand researchers to ensure our future prosperity

NeSI 2 Business Case 2014

Document Control

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Name	Location
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MBIE	National Science Development Team

1. Executive Summary

1.1 Overview

This business case supports the renewal of Crown funding for the National e-Science Infrastructure (NeSI) collaboration that has successfully enhanced NZ Research capabilities over the past 4 years since its inception. The funding sought in this proposal totals $27,173,800, matched by Investor and Subscriber contributions of $26,490,962, over 3.75 years.

In accordance with the original intent, this second phase (NeSI 2), will further lift the skills of NZ researchers to better exploit an advanced computing infrastructure to address their increasingly complex research challenges, both now and in the future. It will both optimize the use of existing infrastructure, and provide for future investment in new capabilities. It will also encourage wider investment and institutional participation by the introduction of a subscription service to complement the investment model.

NeSI 2 will be reoriented to deliver national service lines from a unitary organization direct to end users, rather than from three collaboratively aligned HPC facilities as has been the case with NeSI 1.

The NeSI 2 strategy (and approach) will continue to be informed by New Zealand's research priorities, and will measure its success against regular KPI's, but ultimately on the value delivered to New Zealand researchers.

1.2 About NeSI

The NeSI Investors are the Universities of Auckland, Canterbury & Otago, and CRIs NIWA and Landcare. NeSI's first phase (NeSI 1) was established in July 2011 on the basis of using High Performance Computing (HPC) and data storage infrastructure primarily at Auckland, NIWA and Canterbury for a national purpose, and developing a national team of specialists in high performance computing and eResearch services. This approach has been successful in enabling high quality research.

NeSI was established on the principle of co-investment in infrastructure and services supporting research. NeSI is a new provider that over the past three years has established a track record of enabling research. In the words of MBIE's expert review panel, NeSI has provided *"users with a support network second to none across a range of disciplines."*

As a high-tech infrastructure, NeSI delivers advanced technologies to researchers to enhance research outcomes. Building on the original intent, this second phase (NeSI 2) seeks to optimise the fit between infrastructure and research needs, and lift the skills of researchers to exploit infrastructure capabilities to address challenging research questions.

1.3 NeSI Objectives and indicators of success

The NeSI Investors and the Crown agreed to the following objectives for NeSI 1 (the NeSI Objectives), with associated indicators of success alongside:

NeSI Objectives	Indicators of success in NeSI 1
a) **NeSI Infrastructure**. To create an advanced, scalable computing infrastructure to support New Zealand's research communities.	• Procurements and commissioning for all platforms met milestones and established operational national infrastructure services within NeSI's first 9 months • Maturing to achieving >98% availability of platform services during 3 of 4 quarters of 2013 and all quarters to date in 2014 • Managing performance across a set of key performance indicators (MBIE Review)
b) **Related Services**. To provide the grid middleware, research tools and applications, data management, user-support, and community engagement needed for the best possible uptake and return from the Crown Contributions, the Collaborator Contributions and the Merit User Contributions.	• Establishing capabilities in computational science and delivering specialist skills collaboratively into research projects of national priority (MBIE Review) • Training events held across New Zealand supporting new PhD students, onboarding of new users, and adoption of advanced technologies. • Sponsoring and running the annual national eResearch NZ conference series with 2015 marking the 5th. This event annually brings together 120+ leaders of eresearch practice and service provision as a national community of practice. • Hosting national road shows, conferences, and workshops to promote NeSI and build an understanding of the HPC requirements of researchers (MBIE Review) • Sustaining high utilisation across platforms • Providing users with a support network second to none across a range of disciplines (MBIE Review)
c) **Research Cooperation**. To encourage a high level of coordination and cooperation around the research sector.	• Success in building a high quality national "virtual" team operating across five institutions (MBIE Review) • Initiating strategic discussions with non-investors on how NeSI can deliver greater value (e.g. through institutional subscriptions) (MBIE Review) • Initiating sector-wide research infrastructure partnerships and strategy formation (e.g. eResearch 2020, e-Infrastructures Joint Working Group) (MBIE Review)
d) **Contribution to Research Outputs**. To contribute to high quality research outputs from the application of advanced computing and data management techniques and associated services, which support the Government's published priorities for science.	• Over 77 research publications supported by NeSI from first year of operations (a lag indicator due to the significant lead time required for publications) • Majority of user base have skills to make fit for purpose use of NeSI's platforms • 10 case studies produced per year highlighting NeSI's impact on research projects • Growing to 50 researchers per year who receive on average an order of magnitude scale up in their computations

The NeSI Investors remain committed to these NeSI Objectives in NeSI 2, with the following improvements:

b) **Related Services**. To provide consistent access across HPC platforms, and research tools and applications, supported by basic data management tools, user-support, and sector engagement.

In NeSI 1 sector awareness has grown and identified a capability gap in research data management. NeSI Investors see the "Related Services" objective operating in a supporting role to NeSI's primary focus on HPC. The significantly larger scope required of a national capability in research data management would require support for data curation, registration and discovery, and preservation.

1.4 NeSI 2 Strategy

Our strategy is informed by New Zealand's research priorities and the needs of our researchers. We support science outcomes in key research areas for New Zealand; agriculture and horticulture, the natural environment, society and economy, human health, and natural hazards.

NeSI measures success through fit for purpose platforms that are highly utilised and enable researchers to produce quality research. NeSI services and supports researchers through the following strategic principles:

Alignment – aligning with NZ's Research Priorities supporting growth in innovation, skills, and high-tech infrastructure – through supporting the needs of key researchers who provide the best research outcomes for New Zealand.
Partnership – working with MBIE to implement New Zealand's eResearch strategies across the sector.
Collaboration – enabling researchers to more easily collaborate on research within cross-institutional research project teamwork.
Capability – building the capability of researchers to think bigger and address more complex problems, and to utilise specialised research infrastructure to support their needs.
Capacity – national planning of fit for purpose infrastructure and advisory services to support researchers to grow skills and build capacity that meets NZ's research needs.
Customer Facing – embedding support resources as geographically close to researchers as possible to improve connectivity and service delivery to researchers.
Investment and Risk Sharing – enabling national co-investment in research infrastructure and advisory services for research institutions through membership or subscriptions.
Efficiency, Effectiveness & Excellence – operate a national service that makes the best use of public money and provides continuously improving service experience.
Resilience – Providing resilient infrastructure and services to support research.

1.5 Business Case Rationale

The NeSI 2 business case is based on continuation of current services, being the NeSI Infrastructure and Related Services, in areas where we have a track record of success. Our emphasis is on service enhancement and capability building. We will use our existing investment to support current science capabilities, and enhance NZ's capability to do new science in the future. We will continue to align our efforts with New Zealand's priorities for science and innovation.

All NeSI Investors will sustain their on-going investment levels with the exception of Canterbury, because of spending reductions arising from their post-earthquake situation. This includes a commitment to fully provide for investment of the depreciation in NeSI's initial period through a combination of CAPEX and OPEX.

We will focus on achieving consistency of service delivery and common standards across NeSI's historically independently operated sites, with a strong focus on value delivered to end users. The organisation will be reoriented to focus on delivering via national service lines directly to end users, moving from operating as three collaborating sites to a well-coordinated national team.

We have experienced growth in the demand for these services, and expect to see continued growth. We will use our own and external infrastructure to meet our researchers' needs, including use of Cloud services, and potential partnerships with international facilities and research services. We will move from exploiting local resources for researchers during the first two years to implementing national planning. We will plan for research support services aligned with the needs of New Zealand and the research sector via a new investment planning tool, the National Platforms Roadmap (Table A3). This Roadmap will support major procurements for Platforms suitable for NeSI users, and likewise open up avenues for accessing on and off shore facilities.

We will move from access schemes based on researcher financial contributions to subscription-based cost recovery models with institutions to increase uptake by NZ researchers and return on investment in NeSI. This incorporates enhancing our delivery to researchers by partnering with institutions to improve support to scale their research and to transition them to the most fit-for-purpose platform. NeSI Investor and Subscriber institutions' access rights will be consistent across the whole system with a common pricing scheme incentivising shared risk and investment. Based on our risk assessment this is the best option to grow a sustainable income base for NeSI 2.

The allocations model will be expanded to incorporate allocation of people in a professional services model. This will allow for the specialist computation and analytics expertise within the NeSI team to be more widely applied to increase NeSI's impact across the sector. These same experts will lead a national training and capability development programme, to ensure researchers can acquire the skills needed to operate HPC to meet their research needs.

1.6 Planning of Infrastructure and Services

Infrastructure and Services planning has three components:

- Optimising the use of New Zealand's existing research infrastructure
- National planning for our infrastructure, which will be funded via the Platform Acquisition Fund
- Planning for new services, which will be funded through future bids.

Existing Assets and Services

Our strategy is to exploit the assets that we have, and to develop a broader set of services using the above principles.

Early in NeSI 2, alongside NZGL, we intend to establish a common access and allocations approach to improve uptake and fit for purpose use of both NeSI and NZGL services.

National planning for our infrastructure

We have included a Platform Acquisition Fund in our bid to enable the Board to support acquisition of / access to the most fit for purpose platforms, via the National Platforms Roadmap (Table A3).

The National Platforms Roadmap proposes fewer, but more strategic investments. Over the course of NeSI 2 (by 2017) we will consolidate on two national HPC platforms at Auckland and NIWA, each specialised to support a particular segment of research needs. During these investment processes we will review options for access to international facilities to optimise the value each investment delivers.

Planning for new services

Engagement across the sector during NeSI 1 highlighted a significant gap in current research infrastructure capabilities, primarily in the area of support for researchers actively working with complicated data, and for research data curation and preservation. As the National Science Challenge and CoRE proposals have evolved, and the NZ Data Future Forum has completed its work, these insights have been confirmed as essential future needs.

We anticipate working alongside others in the sector to contribute to future on-demand business cases for strategic investments over the next two years, drawing on appropriate sources of investment and in partnership with relevant groups, in support of:

- Data curation and annotation.
- Data analytics and visualisation.

1.7 In Summary

NeSI 2 provides the most effective fit for purpose solution for New Zealand's eResearch Infrastructure and support for 2014 – 2018. NeSI has delivered value to the New Zealand research system, from day one and throughout the past three years. NeSI has proven an adaptable partnership of Investors. Building on this foundation, we will continue to further enhance NeSI through the following plans:

Objective	Action Plan	Annual Key Performance Indicator
Support New Zealand's research priorities	1. Revise Access Policy in Q4 2014 to remove cost recovery for Merit users 2. Implement Engagement programme 3. Establish Research Reference Group to advise on strategy and policy	≥ 20 case studies that describe accepted projects which align with Government priorities
Grow advanced skill base that can apply high-tech capabilities to challenging research questions in a fit for purpose way	4. Implement a national training programme early in 2015 5. Deliver 6 training events nationwide each year	≥ 50 NeSI users who get on average an order of magnitude scale up
Increase fit-for-purpose use of national research infrastructure	6. Implement a programme of project-led delivery practice across NeSI's internal and customer facing activities aligned with annual planning cycle 7. Scope a service delivery partnership with NZGL in 2014	≥ 80% Utilisation of Platforms
Make fit for purpose investments aligned with sector needs	8. Define the Platform Acquisition Fund and National Platforms Roadmap and related processes during Q4 2014, with annual Roadmap reviews thereafter aligned with annual planning cycle	≥ 80% of researchers who indicate in a survey that NeSI's services fit their needs
Enhance national service delivery consistency and performance to position NeSI for growth	9. Reorient NeSI into a Service Line delivery structure in Q4 2014 10. Define a programme of service delivery improvement, starting with baselines in Q3/4 2014 and evolve through annual maturity assessments aligned with annual planning cycle	≥ 98% Availability of Services
Realise financial contributions and revenue targets to enhance NeSI's sustainability	11. Achieve budgeted Investor investment levels each year 12. Agree a consistent pricing and allocation model to provide equity across Investors and Subscribers 13. Implement institutional subscriptions in Q4 2014 and add 1 additional subscriber annually	≥ 76% Co-investment Ratio

The NeSI Board has confidence that this case will continue to deliver value to New Zealand's researchers while significantly improving the professionalism of the organisation, the effectiveness of its service delivery, and therefore the strategic nature and value of the investment.

2. Business Case Context

2.1 About the Business Case

NeSI was established in July 2011 to provide supercomputing infrastructure and advisory services to support researchers to better use advanced computation and data facilities. NeSI was established on the principle of co-investment in infrastructure and services supporting research. The NeSI Investors are the Universities of Auckland, Canterbury & Otago, and CRIs NIWA and Landcare.

NeSI is a national research infrastructure meeting the needs of researchers for specialist High Performance Computing (HPC) and eResearch platforms and skills. The organisation provides an efficient vehicle for research institutions and government to jointly invest in this essential infrastructure. In turn NeSI supports and enables the whole sector to apply these capabilities to research.

This business case seeks investment from the Crown of $27,173,800 with investment from the NZ eScience Infrastructure (NeSI) Investors and subscribers of $26,490,962 over 3.75 years to support NeSI in its second phase (NeSI 2.) This investment will enable NeSI to continue to provide advanced computing services to enable researchers to enhance our national prosperity.

2.2 What NeSI 1 Achieved

NeSI's first phase (NeSI 1) achieved what it set out to do. NeSI is a new provider, but over the past three years has established a track record of enabling research outcomes. In the words of MBIE's expert review panel, NeSI has provided "*users with a support network second to none across a range of disciplines.*"

NeSI 1 was established on the basis of using supercomputing and data storage infrastructure at Auckland, NIWA and Canterbury for a national purpose, and developing a national team of specialists in high performance computing and eResearch services. This approach has been successful in enabling high quality research.

Utilisation: NeSI saw significant growth over 2012/13 outside of the NeSI Investors, particularly new investors Landcare and the University of Otago, along with wider sector growth at Callaghan, ESR, and Victoria University.

Availability: NeSI has established national platforms across three investor institutions (Auckland, NIWA and Canterbury), meeting its 98% availability target in three of four quarters in 2013 and all quarters in 2014 to date.

Sustained user growth: During 2013 630 researchers accessed NeSI's services, almost doubling from 2012 when NeSI supported 334 researchers.

Research impact: 2013 saw the first acknowledgements of NeSI within the research literature due to the lag between research project completion and publication. Over the course of the year over 70 papers were identified that acknowledged NeSI. More than 200 other outputs were also recorded, including seminars, conference proceedings, and talks.

Support reputation: Researchers commended NeSI's support, with 98% of respondents to customer surveys indicating satisfaction with their support experience.

2.3 Aligning with New Zealand research priorities

Alignment is one of NeSI's core strategic principles (refer Section 2.4). We have aligned NeSI's future focus to take account of the following:

- MBIE's Business Growth Agenda.
- MBIE's draft National Statement of Science Investment.
- The findings of our eResearch 2020 study, through interviews with key NZ researchers.
- The needs of Centres of Research Excellence (CoREs) and National Science Challenges.
- The on-going conduct of research from NeSI's customers.
- Enhancing synergies within the eResearch sector providers through establishment of a joint working group between REANNZ, New Zealand Genomics Limited (NZGL) and NeSI.
- MBIE's review of NeSI (February 2014.)

Focus on New Zealand's Priorities

This focus supports research outcomes in key research areas for New Zealand across a broad range of disciplines and institutions, increasingly focusing on research underpinning New Zealand's social and economic wellbeing. Key research communities supported are highlighted below:

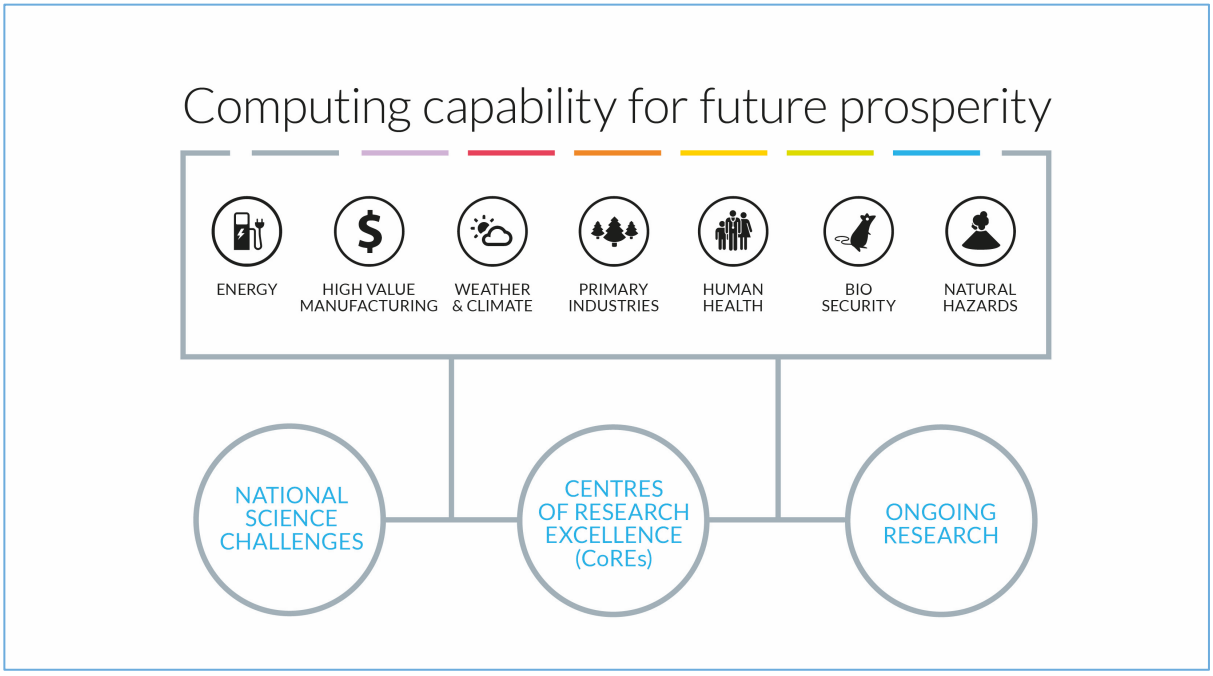


Figure 1 – NZ's Key Research Communities

New Zealand aims to be in the first world of developed economies and societies in terms of the quality of our research and the impact of data on our society and economy. This will be achieved through cross-institutional initiatives supported by organisations such as NeSI.

NeSI is a key investment supporting the Government's Business Growth Agenda. The advanced skills of the team are being applied to accelerate research and are shared to grow researcher capability through NeSI's skills training and capability development initiatives.

Building on top of the significant performance enhancements achieved in partnership with the REANNZ advanced research network both nationally and internationally, NeSI is positioned to support international research collaborations. A focus of this case is on growing relations with infrastructure investments internationally. For example, NZ is improving support for our researchers accessing the Australian Synchrotron, and NeSI is exploring access arrangements with the peak regional HPC facilities at NCI at ANU in Canberra, and the Pawsey Centre in Perth, Western Australia. This builds on existing collegial and research linkages established with the world leading HPC facilities at the Argonne Leadership Computing Facility in Chicago.

eResearch 2020: Focus on the Needs of New Zealand's Researchers

NeSI's alignment is supported by eResearch 2020, a forum coordinated by NeSI, NZGL and REANNZ. eResearch 2020 focuses on future eResearch capability and skills needs across the New Zealand research system. This provides integrity to NeSI's planning for the future. In eResearch 2020 we asked lead researchers what they thought, and their contributions suggest that there are immediate activities that researchers need/want NeSI to help with. Institutions are indicating that they do not wish to operate in isolation. NeSI will help align organisations on standards, policies, tools, and strategies, and take a lead nationally on the development of data infrastructure and related capabilities.

Key themes arising from eResearch 2020 are discussed below:

Research Quality: Evidence and methodology in research will become digital. Research quality will be assessed through visibility and repeatability of research methods and evidence in the public domain. Open access to publications and data will put researcher's methods on display and play an increasing role in research impact assessment, leading to enhanced researcher skills and infrastructure services. Researchers who do not transition to a digital centric approach to evidence and methodology risk falling behind in collaboration, international funding, and research quality.

Research Data Communities: Data infrastructure will be designed for both institutions and research communities, in partnership with institutions. Data communities will have a wide variety of maturity – some communities will need significant development while advanced communities will demand advanced analytics and data management infrastructure.

Infrastructure Governance: Sustained engagement and linkages are in place between governance of research and governance of institutions. We are supporting integrated planning groups across NSCs and CoREs to support research strategy, institutional development and infrastructure strategy.

National Capability: More and more, data and compute that is tightly coupled to and interacted with through data visualisation will play a role in how we understand real-time systems such as urban systems, pastures and farming systems, demographic systems and a myriad of macro and micro socio-economic system-level drivers. This supports addressing important problems to NZ such as weather, climate, hazards and agriculture.

2.4 NeSI 2 Strategy

Our strategy is informed by New Zealand's research priorities and the needs of our researchers.

NeSI measures success through fit for purpose platforms that are highly utilised and enable researchers to produce quality research aligned to New Zealand's needs. NeSI services and supports researchers through the following strategic principles:

Alignment – aligning with NZ's Research Priorities supporting growth in innovation, skills, and high-tech infrastructure – through supporting the needs of key researchers who provide the best research outcomes for New Zealand.
Partnership – working with MBIE to implement New Zealand's eResearch strategies across the sector.
Collaboration – enabling researchers to more easily collaborate on research within cross-institutional research project teamwork.
Capability – building the capability of researchers to think bigger and address more complex problems, and to use specialised research infrastructure to support their needs.
Capacity – national planning of fit for purpose infrastructure and advisory services to support researchers to grow skills and build capacity that meets NZ's research needs.
Customer Facing – embedding support resources as geographically close to researchers as possible to improve connectivity and service delivery to researchers.
Investment and Risk Sharing – enabling national co-investment in research infrastructure and advisory services for research institutions through membership or subscriptions.
Efficiency, Effectiveness & Excellence – operate a national service that makes the best use of public money and provides continuously improving service experience.
Resilience – Providing resilient infrastructure and services to support research.

Vision

NeSI's Vision is to support New Zealand to be among the worlds' leading nations in accelerating research to advance prosperity.

To enable NeSI to achieve its Vision, it has the following values:

Supportive — NeSI cooperates with researchers by providing superior computer power, support systems and training to underpin the integrity of their research.

Pathfinding — NeSI leads the way in formulating innovative future strategies, and achieving better alignment of institutions and methodologies (data, standards, tools and investments). It is an active and influential voice for positive change.

Collaborative — NeSI brokers deeper collaborative ties at both management and operational levels between institutions, researchers and government.

Understandable — NeSI makes sense of science by clearly articulating its objectives, activities and research project outcomes in ways that can be more easily understood by a wider audience.

Purpose

NeSI's purpose is to multiply the computing capability of New Zealand researchers to ensure our future prosperity.

Planning of Infrastructure and Services

Infrastructure and Services planning has three components:

- Optimising the use of NeSI's existing research infrastructure
- National planning for our infrastructure, which will be funded via the Platform Acquisition Fund
- Planning for new services, which will be funded through future bids.

Existing Assets and Services

We will exploit the assets that we have, and develop a broader set of services using the above strategic principles.

Early in NeSI 2, alongside NZGL, we intend to establish a common access and allocations approach to improve uptake and fit for purpose use of both NeSI and NZGL services.

National planning for our infrastructure

We have included a Platform Acquisition Fund in our bid to enable the Board to support acquisition of / access to the most fit for purpose platforms, via the National Platforms Roadmap (Table A3).

The National Platforms Roadmap proposes fewer, but more strategic investments. Over the course of NeSI 2 (by 2017) we will consolidate on two national HPC platforms at Auckland and NIWA, each specialised to support a particular segment of research needs. With significant growth occurring on the more general use platform at Auckland, an upgrade will take place in late 2014 with further upgrades possible to meet demand. After this a major capability investment is scheduled on the Roadmap in late 2016/early 2017. By this stage NeSI's Platforms are likely to be based on x86 chipsets and run Linux operating environments, providing ease of access and broader suitability to the research software applications required by researchers. During these investment processes we will review options for access to international facilities to optimise the value each investment delivers.

Planning for new services

Engagement across the sector during NeSI 1 highlighted a significant gap in current research infrastructure capabilities, primarily in the area of support for researchers actively working with complicated data, and for research data curation and preservation. As the National Science Challenge and CoRE proposals have evolved, and the NZ Data Future Forum has completed its work, these insights have been confirmed as essential future needs. Our experience in delivering HPC and associated data management services has us well placed to contribute in this area.

We anticipate working alongside others in the sector to contribute to future on-demand business cases for strategic investments over the next two years, drawing on appropriate sources of investment and in partnership with relevant groups, in support of:

- Data curation and annotation.
- Data analytics and visualisation.

3. About NeSI

3.1 How NeSI Works

From 2011 NeSI 1 established the foundations of the infrastructure by building on the specialist capabilities at investing institutions and growing these to be available nationally.

The diagram below illustrates the relationships between NeSI Investors and Subscribers, and their access to services:

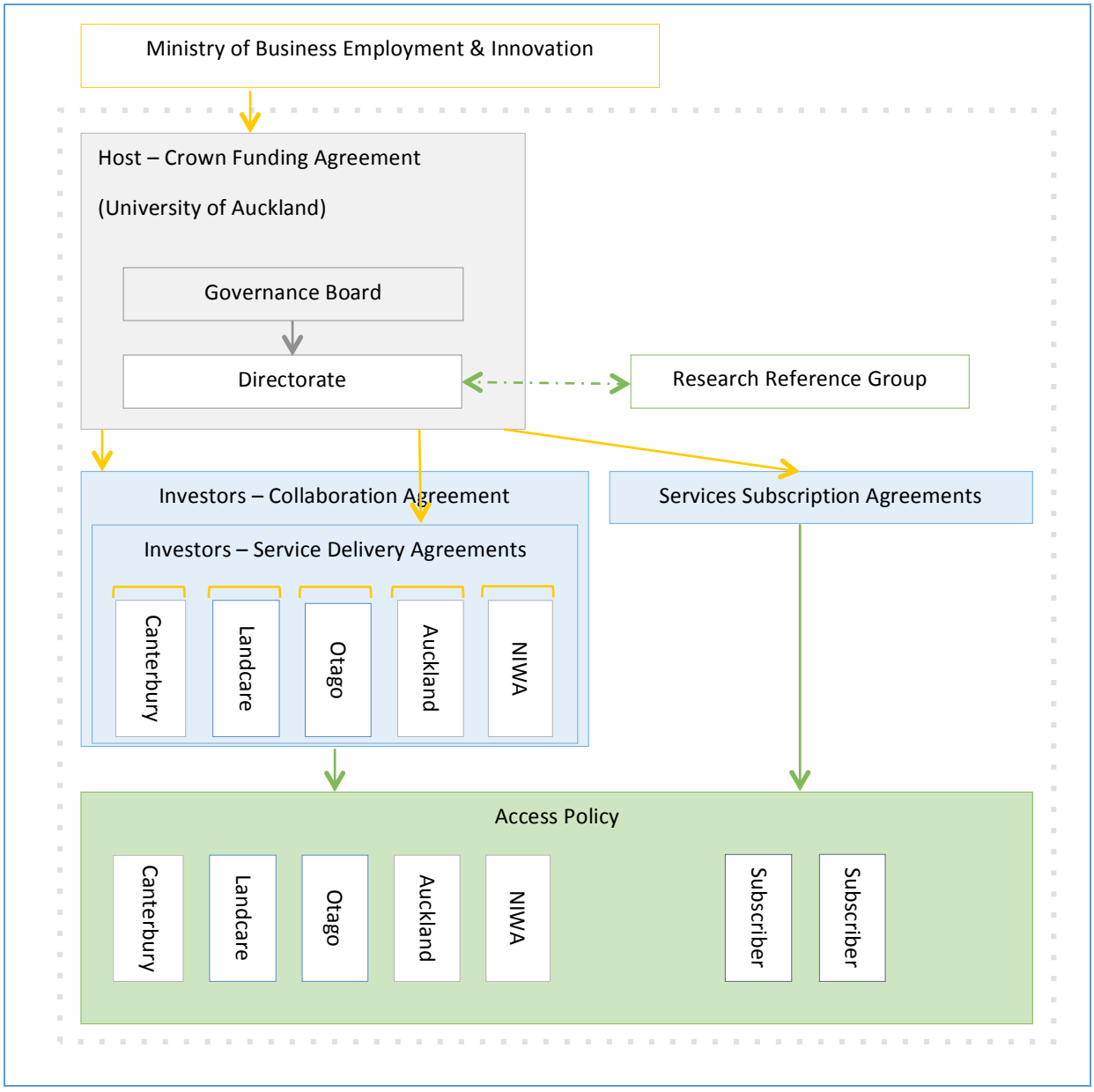


Figure 2 – Relationship Between NeSI Investors and Subscribers

Results in this short timeframe have been significant, and to date include:

- A national organisation delivering High Performance Computing (HPC) services, and a team of specialists in HPC and eResearch services.
- A track record of enabling research outcomes evidenced by the over seventy publications acknowledging NeSI's support (most attributed to the first of two years of operations.)
- Supporting researchers across a wide range of disciplines.
- Investing institutions receiving more than their anticipated return on investment.
- Initiating sector-wide research infrastructure partnerships and strategy formation alongside NZGL and REANNZ through eResearch 2020.
- Building community around applying advanced ICT practitioners to meet research needs, including hosting the annual eResearch NZ conference.
- Enhancing sector research practices through skills training workshops at all levels.
- Sector recognition and integration. For example, through participation in sector initiatives such as the steering committee for the Lincoln Hub data management and information architecture initiative, and the National Science Challenge 10 steering committee.

3.2 How NeSI Measures Success

NeSI measures success through utilising fit for purpose platforms that are highly utilised and enable researchers to produce quality research aligned to New Zealand's needs. Attributes NeSI measures include:

- Utilisation of platforms – hours of compute time, % utilisation.
- Breadth of uptake across NZ's research Institutions.
- The number and alignment of research outputs enabled by NeSI.
- NeSI stakeholder and customer feedback.
- Capability building for enabling higher scale research.
- Financial performance.

Section 6.4 defines the key success measures and Appendix 2 defines KPIs for NeSI 2, based on the lessons learnt from NeSI 1, which are described next.

3.3 NeSI 1 Lessons Learnt

Overview

NeSI 1 included a start-up period from which we have learnt a great deal. These learnings, and MBIE's review findings have been factored into our approach to NeSI 2. Learnings included:

- Revising arrangements for access to improve non-NeSI Investor uptake. This will include introduction of a subscription model to allow more institutions to participate in NeSI, and to broaden NeSI's income base. This is described in further detail under "Improving Uptake of NeSI" below.
- Taking a NZ wide focus to annual planning of the acquisition and/or utilisation of NeSI's infrastructure, rather than exploiting individually purchased equipment for national use. This incorporates options such as the adoption of Cloud services or making use of international facilities, e.g. Australia.
- Following from the above point, establishing a Platform Acquisition Fund (PAF) of $16.7M within our bid. A prioritisation program called National Platforms Roadmap (Table A3), introduced in Section 4.3 below and outlined in Appendix 1, will inform this.
- The need to strengthen NeSI's national leadership, as the NeSI 1 bid underestimated the support requirements for a shared services organisation like NeSI.

We are also enhancing NeSI's efficiency and effectiveness measures as described in section 6 below.

Improving Uptake of NeSI

Institutions outside of the NeSI Investors have used less of NeSI's services than anticipated, given the barrier of charging individual researchers for "Merit access[i]". A user charge for Merit access was a condition of NeSI 1.

NeSI provided Merit access without charge during its establishment. In Q2 of 2013, when Merit access charges were introduced, access to the service substantially reduced as shown by the following figure:

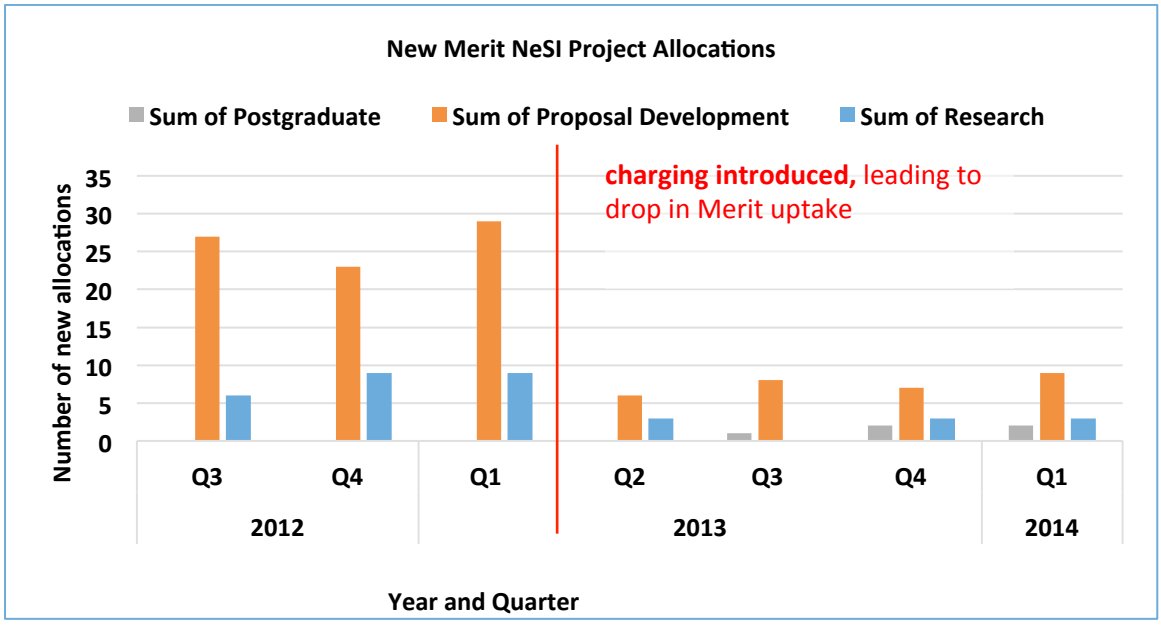


Figure 3 – Impact of Charging for Merit Access

[i] Merit access in NeSI 1 was a mechanism for researchers to access computing platforms and services outside of their own institutions. Institutions with NeSI compute facilities had access to 60% of their own platforms for no user charge.

NeSI 2 proposes substituting user charges for access with an institutional subscription model. This will enable research institutions to co-invest in NeSI, rather than relying on user charges for individual researchers; individual researchers will be supported based on research merit alone. Access to NeSI HPC, data and advisory services will be allocated as follows:

- NeSI Investors 60%
- Subscribers 20%
- Free Merit Access 20%

This means that under NeSI 2, 80% of the access to HPC, data and advisory services is based on co-investment.

Subscribers

We note that several institutions outside the current NeSI Investors purchased small-scale research computing clusters during the last 24 months, namely GNS, Victoria University Wellington, Plant & Food Research and the University of Waikato. Massey University and AgResearch are both understood to be considering future investments.

The proposed NeSI 2 subscription model would enable better use of public money by allowing institutions the option to invest in NeSI instead. While most of these resources aren't of the same scale as NeSI's platforms, the opportunity cost of not having this engagement with NeSI is that researchers constrain their research to the scale of their local resources. It also means that their collaboration with both NZ and international research partners is potentially jeopardised.

Free Merit Access

We have allocated 20% of NeSI 2 HPC, data and advisory services as free merit access for research of the highest importance for New Zealand. NeSI will ensure that these merit access services are allocated based on New Zealand's research priorities through a bid process.

This free merit access process operates effectively in Australian facilities, namely at NCI in Canberra and at the Pawsey Centre in Perth. It is used widely internationally.

3.4 MBIE Requirements

Below we have summarised our response to the MBIE review recommendations and the implementation considerations outlined in Paul Stocks letter to Rick Christie dated 7 April 2014.

Recommendations from the 2013 Review of NeSI

Recommendations from MBIE Review That NeSI…	Responses outlined in this business case
KPI Review	
1. in conjunction with MBIE, undertakes a review of its key performance indicators, priorities and milestones to streamline and rationalise them into a small and relevant set of 'key' measures 2. includes availability and utilisation rates as key performance measures	• Revised KPIs are proposed (Appendix 2: Performance Measures) which include availability and utilisation rates • A joint NeSI-MBIE KPI review will be scheduled during the NeSI Transition Programme, prior to completion of the NeSI 2 head contract.

Business models	
3. considers and further develops other business models such as the subscription-based block allocation and broker models for the future	• The subscription-based allocation model is core to several sections of the case, including engagement, risk analysis, sustainability, and financial analysis. • The broker model has been incorporated into the National Platforms Roadmap, as defined in this case.
Governance and organisation	
4. reviews its governance and considers formalising its organisational form once its future strategy and funding arrangements have been established	• The Board commit to a review of Governance during 2014, as outlined in this case. • Governance over major procurements has been strengthened through the newly defined Platform Acquisition Fund and National Platforms Roadmap. • The organisation is being reoriented around national Service Lines.
Future plans	
5. finalises its plan (submits a revised business case) around the AgResearch unallocated funding 6. develops its strategy for post-June 2014 infrastructure and services and presents to MBIE accordingly 7. develops cloud and data management strategies that integrate with the existing HPC investment and that advance the national capability for data-intensive research 8. develops a strategy for international engagement around HPC facilities	• The AgResearch unallocated funding was released back to MBIE during Q2 2014. • This case represents NeSI's strategy for the post-June 2014 period, including major enhancements to services and investments into infrastructure. • The National Platforms Roadmap outlines a brokerage approach to adopting Cloud services. A joint Cloud strategy is to be developed by the e-infrastructures via the Joint Working Group • The case highlights the strategic importance and perceived value of data analytics, visualisation, and research data management capabilities, framing them as out of scope of the current investment due to the significant additional resources such a strategy requires. • The National Platforms Roadmap defines the development of a strategy for international engagement around HPC facilities.

Implementation considerations

This case also considers the following implementation considerations:

Implementation consideration	In response, this case
value proposition of continued HPC investment to deliver outcomes in national benefits	demonstrates significant demand for HPC and resulting impact on research, increased degrees of collaboration and sharing of investment and risk, and proposes an enhanced investment approach focused on increased effectiveness and improved efficiency
alignment with national priorities for science and innovation	outlines how sector demand maps to Platform utilisation, and how future planning will ensure strong fit-for-purpose (section 4.3)
governance, management and funding arrangements	analyses risk (section 5) of various governance and funding arrangements, and outlines the proposed structure (section 7)
management of the assets (including depreciation and reinvestment)	presents detailed financial analyses articulating depreciation and reinvestment treatment (section 8)
an increased cost recovery from users and transparent pricing policy and structure	adopts the subscription model with the aim to increase cost recovery over time (section 8.5)
outcome-level KPI's addressing utilisation and availability of services	proposes revised KPIs (Appendix 2: Performance Measures) which includes availability and utilisation rates
provide for coordination and leadership alongside REANNZ and NZGL, for data infrastructure and services	clarifies the intent to contribute to business cases for data infrastructure and services over the coming 2 years
viability of the infrastructure and services beyond the term of the investment	reviews risks (section 5) of funding and organisational models to establish a sustainable path forward.

4. Business Case Rationale

4.1 Principles

The NeSI 2 business case is based on continuation of current services, being the NeSI Infrastructure and Related Services, in areas where we have a track record of success. Our emphasis is on service enhancement and capability building. We will focus on achieving consistency of service delivery and common standards across NeSI's historically independently operated sites, with a strong focus on value delivered to end users. We will use our existing investment to support current science capabilities, and enhance NZ's capability to do new science in the future. We are aligning our efforts with New Zealand's priorities for Science and Innovation.

All NeSI Investors will sustain their on-going investment levels with the exception of Canterbury, because of spending reductions arising from their post-earthquake situation. This includes a commitment to fully provide for investment of the depreciation in NeSI's initial period through a combination of CAPEX and OPEX.

This business case is based on continuing to support the infrastructure and advisory services NeSI has established, which are both focused on NeSI's HPC Platforms and the skills and tools required to efficiently use them. We have experienced growth in the demand for these services, and expect to see continued growth. The organisation will be reoriented to focus on delivering via national service lines directly to end users, moving from operating as three collaborating sites to a well-coordinated national team.

We will use our own and external infrastructure to meet our researchers' needs, including use of Cloud services, and potential partnerships with international facilities and research services. We will move from exploiting local resources for researchers during the first two years to implementing national planning. We will plan for research support services aligned with the needs of New Zealand and the research sector via a new investment planning tool, the National Platforms Roadmap (Table A3). This Roadmap will support major procurements for Platforms that make sense for NeSI to operate, and otherwise open up avenues for accessing on and off shore capacities on suitable facilities.

We will move from access schemes based on researcher financial contributions to subscription-based cost recovery models with institutions to increase uptake by NZ researchers and return on investment in NeSI. This incorporates enhancing our delivery to researchers by partnering with institutions to improve support to scale their research and to transition them to the most fit-for-purpose platform. NeSI Investor and subscribing institutions' access rights will be consistent across the whole system with a common pricing scheme incentivising shared risk and investment. Based on our risk assessment in Section 5, this is the best option to sustain an income base for NeSI 2.

The allocations model will be expanded to incorporate allocation of people in a professional services model. This will allow for the specialist computation and analytics expertise within the NeSI team to be opened up and to increase NeSI's impact across the sector. These same experts will lead a national training and capability development programme, to ensure researchers can acquire the skills needed to operate HPC to meet their research needs.

4.2 Sustainability

We have already discussed our commitment to manage our resources and infrastructure across the NeSI Investors efficiently and effectively. This will maintain the financial stability of NeSI.

There is no international precedent demonstrating an effective market model for specialist eResearch support. Equipment capable of supporting complex research is extremely expensive, and hence needs to be shared across institutions. Likewise, the support skills to support advanced computation are rare. In the New Zealand context, our full cost funding model for research contains no coordination mechanism to gather together research overheads and invest efficiently into shared HPC resources. Without such a coordinated approach, researchers choose to simplify the research questions posed, and fragment their investments into small scale local computing clusters that aren't shared and in aggregate are costly to maintain. Therefore, internationally and in New Zealand the funding of resources for advanced science is necessarily a partnership between research institutions and the Crown.

NeSI is continuing to annually document the quantity, quality of the research outputs NeSI supports and their alignment to NZ's research priorities. This information will help MBIE to better evaluate the contribution research infrastructure makes to New Zealand's research outputs.

At the end of this investment period, NeSI is committed to review the levels of NeSI Investor and Crown co-investment with MBIE, which will be informed by the above.

4.3 Planning of Infrastructure and Services

Infrastructure and Services planning has three components:

- Optimising the use of New Zealand's existing research infrastructure
- National planning for our infrastructure, which will be funded via the Platform Acquisition Fund.
- Planning for new services, this will be funded through future bids. Refer Section 2.4.

Existing Assets and Services

Our strategy is to exploit the assets that we have, and to develop a broader set of services using the above principles.

Early in NeSI 2, alongside NZGL, we intend to establish a common access and allocations approach to improve uptake and fit for purpose use of both NeSI and NZGL services.

National planning for our infrastructure

We have included a Platform Acquisition Fund in our bid to enable the Board to support acquisition of / access to the most fit for purpose platforms, via the National Platforms Roadmap (Table A3).

The National Platforms 'Roadmap' defines the major milestones for platform acquisition and describes standards for coordinated procurement. This National Platforms Roadmap will be led by the NeSI Board of Directors and anticipate the needs of New Zealand researchers, taking account of:

- National science strategies and initiatives such as the National Science Challenges and research in sectors that have been identified by the New Zealand government as 'priority industries'.
- Research sector needs identified by such initiatives as eResearch 2020 and emerging research infrastructure trends including Cloud, big data and analytics as a service.
- Emerging opportunities for innovation, productivity and competitiveness enhancements within New Zealand's industries.

This Roadmap will be supported and informed by:

- HPC and data science software directions and capabilities, captured as software benchmarks for codes relevant to priority research needs.
- Historical utilisation trends for compute and data platforms captured directly from the nationwide NeSI platforms.
- Current and anticipated technology market trends and developments across hardware, software and connectivity.

Appendix 1 – Table A3 contains the current National Platforms Roadmap. The Roadmap will be reviewed annually, as part of the NeSI planning cycle. The National Platforms Roadmap proposes fewer, but more strategic investments. Over the course of NeSI 2 we will:

1. Continue to support the current HPC platforms across the three major facilities through to each platform's end-of-life with planned decommissioning activities across all platforms completing in 2017.
2. Support significant growth occurring on the more general use platform at Auckland by making an upgrade in late 2014 to increase capacity by 20%, at a cost of $.5m. Further subsequent upgrades are possible to meet demand.

3. By 2017, consolidate on two national HPC platforms at Auckland and NIWA, each specialised to support a particular segment of research needs - carry out platform replacements in late 2016/early 2017 delivering capacity of around 12,000 to 15,000 CPU cores depending on configuration – this activity will access the Platform Acquisition Fund, at a cost of $9.7m.

By 2017 all of NeSI's Platforms are likely to be based on x86 chipsets and run Linux operating environments, providing ease of access and broader suitability to the research software applications required by researchers. During these investment processes we will review options for access to international facilities to optimise the value each investment delivers.

The Board are confident that the strategy led processes for these investments will deliver high quality and high value platforms that are fit-for-purpose. NeSI has a track record of successful procurements and commissioning across three major HPC facilities during the last three years, hence associated risks are low.

Research Needs Informing NeSI's High Performance Computing Planning

The analysis of our user and research patterns has informed our planning of future High Performance Computing platforms for NeSI.

Analysis of utilisation of NeSI's platforms in Figure 4 shows high levels of usage (measured in CPU core hours) across a broad range of research areas. The figure illustrates this use by research discipline, highlighting how these disciplines use NeSI's existing HPC platforms (Fitzroy at NIWA, Foster at Canterbury, and Pan at Auckland) segmented by HPC platform profile (A, B, and C):

A / Peak: A small number of users consume significant levels of HPC/Data and/or require high levels of solutions specialisation and customisation. These are usually users supporting programmatic research activities such as weather and climate, or individual investigators at the leading edge of computational techniques within specific fields such as cellular biology or physics.

B / Breadth: A wide range of users who have moderate performance and specialisation needs. These represent the most significant opportunities for growth and NeSI platform adoption, and users are distributed across many varied research disciplines.

C / Capacity: Large numbers of users with little requirement for specialised solutions. These represent users that could be brokered out to Cloud infrastructure services, and currently provide a backfill, filling the gaps between other workloads to improve the efficiency of NeSI's platforms.

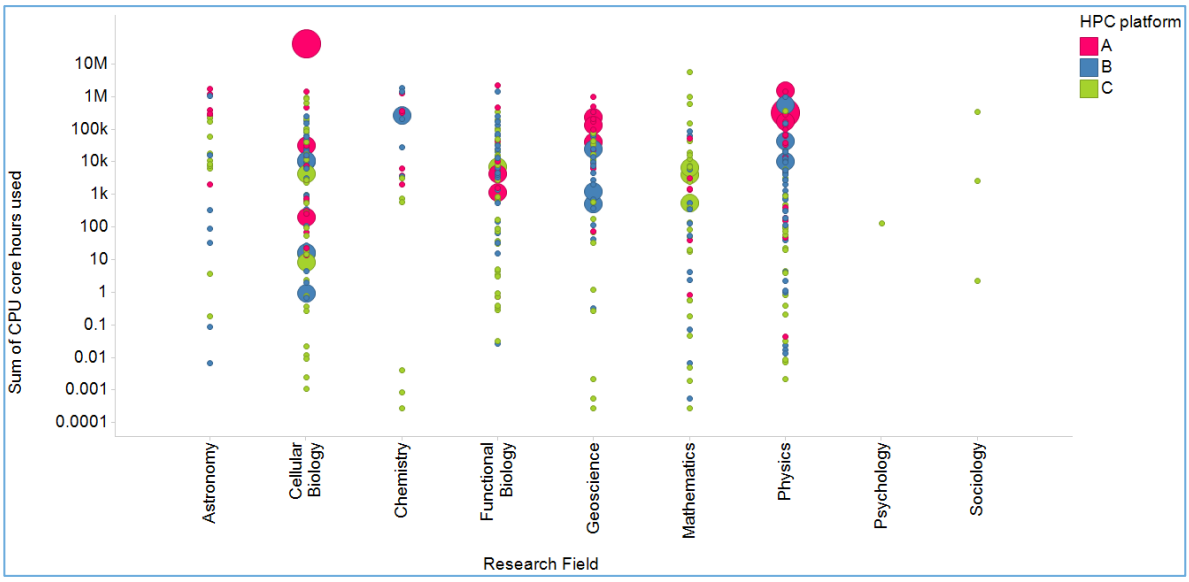


Figure 4 – NeSI HPC Users across Research Disciplines, 2012 – Q1 2014

A mix of HPC platforms is required to support the diversity of research undertaken across the sector. The graph below draws out the relationship between the scales of use of NeSI's platforms, and the profiles of platform, named left to right as capacity, breadth, and peak.

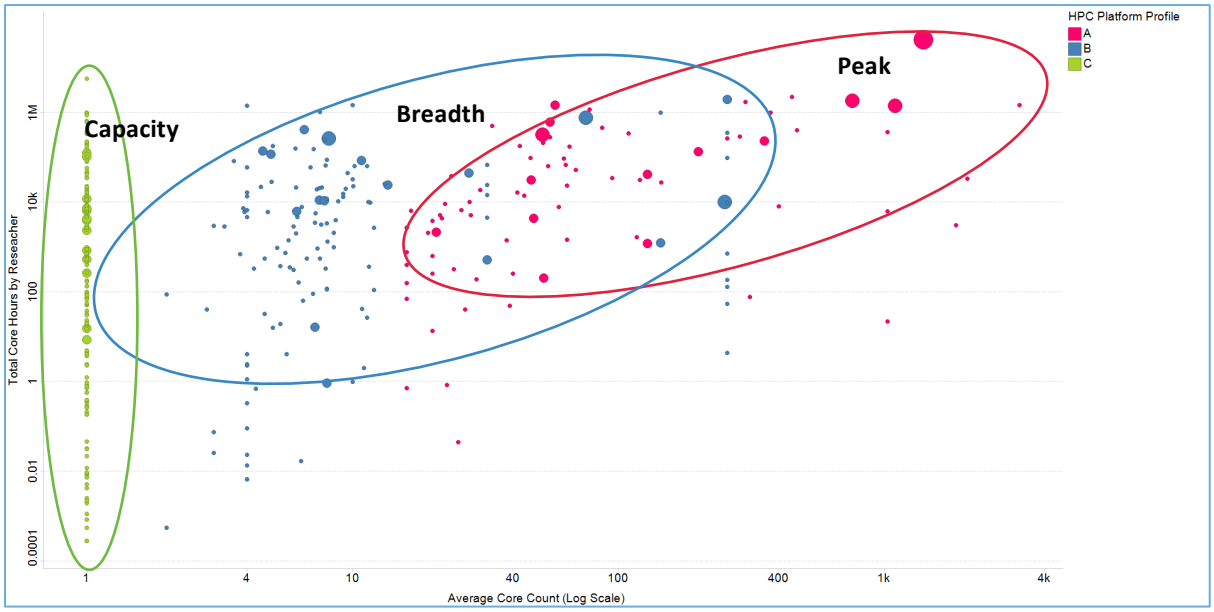


Figure 5 – Profiles of HPC Use, 2012 – Q1 2014

NeSI proposes to use Cloud services to support users in the bottom left hand corner of Figure 5 – i.e. those utilising single cores with low volumes. Figure 5 shows that NeSI utilises all its platforms. Currently we have greater capacity available on our specialist platforms at NIWA and Canterbury. Our generalist HPC platforms are close to fully utilised. Our National Platforms Roadmap (Table A3) will take into account the demand profile and platforms required to support the different types of users across NZ.

4.4 Customer Engagement

NeSI engages with the following key communities:

- MBIE and Government. MBIE are observers on our Board.
- Investor Institutions, including discussing their long term infrastructure planning. This occurs with their local Facility Directors and with their senior management and Board Members.
- Other Universities and CRIs, with respect to their potential use of NeSI facilities and advisory services.
- Research communities where they exist. Recent examples include National Science Challenges and CoREs to jointly consider their eResearch support requirements.

Operationally, NeSI's team maintains engagement with customers through the following research project arrangements:

- NeSI appoints an advisor to each research project, ensuring that researchers have an approachable and accessible contact point to guide the delivery of their research.
- NeSI maintains research institution relations providing feedback and advice on researcher needs for and utilisation of NeSI's platforms.

NeSI also regularly conducts customer surveys, and supports sector fora such as the eResearch New Zealand conference.

Enhancements to engagement in NeSI 2

NeSI's new Engagement, Training and Capability Development activities will enhance our delivery to all researchers in partnership with their institutions, enhancing institutional research support and research advisory strategies. We will work proactively with institutions to identify researchers that need support to scale their research and to transition them to the most fit-for-purpose platforms. The goal is to increase uptake by NZ researchers and return on investment in NeSI.

To support this enhancement, an institutional engagement approach is proposed that treats all investing and subscribing institutions consistently, and provides for information sharing on researcher use and joint planning on infrastructure capabilities and skills development.

5. Risks

In this section we review the risks related to options for:

1. Delivering eResearch support for New Zealand through NeSI or other vehicles.
2. NeSI Income and Membership Model.

We then cover off the organisational, technical, and operational risks for NeSI.

5.1 NZ's Delivery Options for eResearch

We consider NeSI 2 to be the best option for provision of eResearch support for NZ. We have reviewed risks for options in the preparation of this bid:

- NeSI 2 as proposed in this case.
- Devolving eResearch infrastructure and support back to research institutions (the "do nothing" option.)
- Choosing a lead research institution to support NZ's eResearch requirements.
- Outsourcing infrastructure and support to commercial provider(s.)
- Using offshore non-commercial entities for all infrastructure and support arrangements.

Our conclusions are to enhance the current NeSI model, with international providers complementing our highly targeted NZ offerings. An overview of our risk assessment of options is presented below:

Table 1 – eRESEARCH DELIVERY OPTIONS RISK ASSESSMENT

Option	Risk Type	Comment	Residual Risk H/M/L	Overall Residual Risk H/M/L
A NeSI 2	Financial RoI	Complex model to maintain.	M	M
	Financial – E&E	Complex model, but buy-in from sector.	L	
	Financial – Sustainability	Dependent on appetite of government and co-investment.	M	
	Political & Reputational	Refinement of existing model, but still maturing.	M	
	Organisational	Making structural improvements to a complex embedded model.	M	
	Compliance & Legal	Model in place for 3 years.	L	
	Research Outputs	Known quantity. Researchers have experience of working within framework.	L	
B Do nothing – return to individual institution model	Financial – RoI	"Reinvention of the wheel" will lead to reduced outcomes.	L	H
	Financial E&E	"Reinvention of the wheel." Sector alignment complexity.	H	
	Financial – Sustainability	Dilution of effort and conflicting local priorities.	H	
	Political & Reputational	May be seen as a step backward. More complex for government to demonstrate aligned investment. Higher administration cost.	H	

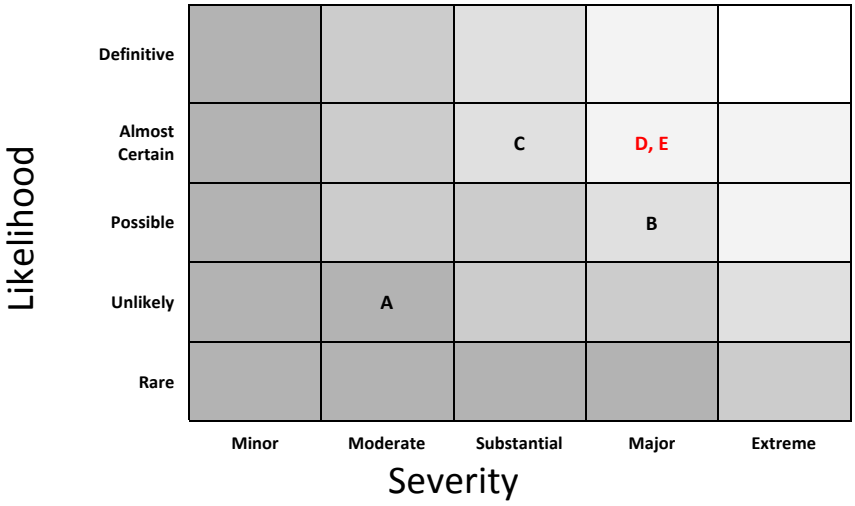
Table 1 – eRESEARCH DELIVERY OPTIONS RISK ASSESSMENT				
Option	**Risk Type**	**Comment**	**Residual Risk H/M/L**	**Overall Residual Risk H/M/L**
	Organisational	Startup risks. Difficulty attracting scarce capability.	H	
	Compliance & Legal	Varying approaches, depending on institution.	M	
	Research Outputs	"Reinvention of the wheel" will lead to reduced outcomes.	H	
C Lead Institution – University or CRI	Financial – RoI	Tensions between institutions and potential for capture.	H	H
	Financial – E&E	Fitness for purpose to cover a broad sector, and to partner for NZ's benefit. Buy in from sector.	H	
	Financial – Sustainability	"Eggs in one basket."	H	
	Political & Reputational	Contentious re choice of institution.	M	
	Organisational	Start-up and capability issues.	H	
	Compliance & Legal	Start-up issues.	M	
	Research Outputs	Uncertainty about access rights could jeopardise research programs. Potential for capture or perceived bias.	H	
D Outsource Commercially	Financial – RoI	Market Forces. No high-end track record in this context.	H	H
	Financial – E&E	Market Forces. Lack of sector buy-in. Less transparency on delivery.	H	
	Financial – Sustainability	Potential for commercial failure or conflicting commercial priorities.	H	
	Political & Reputational	Negative view from sector. Profit perception – absence of public good priority.	H	
	Organisational	Lack of control.	M	
	Compliance & Legal	New commercial model.	H	
	Research Outputs	Uncertainty about access rights could jeopardise research programs. Commercial operators more concerned with their own ROI than research outcomes for NZ.	H	
E Offshore	Financial – RoI	Can partner with experienced players, but issues in retaining local skillsets.	M	H
	Financial – E&E	Dependant on international support being maintained. Events beyond NZ's control.	H	
	Financial – Sustainability	Potential conflicting priorities. Retention of local skillsets. Market and investor confidence may be an issue.	H	
	Political & Reputational	Absence of public good. Potential negative implications for NZ's reputation. Mixed signals to research & innovation sector, Sovereignty issues.	H	
	Organisational	Start-up, lack of control.	M	
	Compliance & Legal	Complexity with different international jurisdictions. Sovereignty issues.	H	
	Research Outputs	Uncertainty about access rights could jeopardise research programs. Beyond NZ's control.	H	

Key: RoI = Return on Investment, E&E = Efficiency and Effectiveness.

Note: a non-research Crown owned entity has a similar risk profile to "Lead Institution" above, with the added complexity of being disconnected from the research sector and researchers.

Probability and Impact analysis for eResearch delivery options

A summary of risk probability and impact for the above options follows:



5.2 Income and Membership Options

Table 2 below assesses the risk relating to NeSI income and membership options. Options considered are:

- An Investor plus subscriber model (NeSI 2.)
- An investor plus user charges model.
- A membership model (which is effectively a full subscription model.)

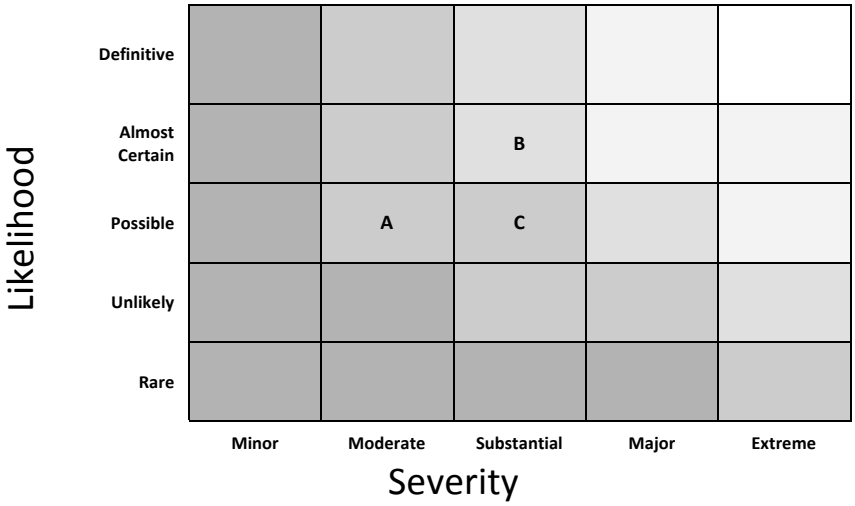
Table 2 – NeSI INCOME & MEMBERSHIP RISK ASSESSMENT				
Option	**Risk Type**	**Comment**	**Residual Risk H/M/L**	**Overall Residual Risk H/M/L**
A Investor plus Subscriber Model	Financial RoI	Supports mix of large co-investors with smaller institutional investment.	L	M
	Financial – E&E	Allows smaller institutions to co-invest via subscription. Adds complexity re equity between subscribers and investors.	M	
	Financial – Sustainability	Still difficult to obtain subscriptions, but opportunities re CoREs and NSCs.	M	
	Political & Reputational	Model suited to infrastructure and services embedded in institutions.	L	
	Organisational	Requires customer base of research institutions, NSCs and CoREs.	M	
	Compliance & Legal	More complex model.	M	
	Research Outputs	Familiar model for investors.	L	
B Investor	Financial – RoI	Researchers rely on institutions to support infrastructure, introducing part charges has resulted in few merit applications.	H	H

Table 2 – NeSI INCOME & MEMBERSHIP RISK ASSESSMENT				
Option	**Risk Type**	**Comment**	**Residual Risk H/M/L**	**Overall Residual Risk H/M/L**
plus researcher user charges	Financial E&E	More individual smaller transactions.	M	
	Financial – Sustainability	Few customers beyond investors.	H	
	Political & Reputational	Model will have a focus on investor use, rather than national uptake.	H	
	Organisational	No significant change.	L	
	Compliance & Legal	More complex model.	M	
	Research Outputs	Researchers rely on institutional support, and don't put NeSI costs in grant applications.	H	
C Member model (all subscribers)	Financial – RoI	More difficult to gain co-investment and funding of locally embedded services.	H	H
	Financial – E&E	More difficult to demonstrate equity across the system.	M	
	Financial – Sustainability	More difficult to gain co-investment in equipment and local support.	H	
	Political & Reputational	Change and uncertainty of new model may deter existing investors.	M	
	Organisational	More difficulty for local support models, and how to fund them.		
	Compliance & Legal	Simpler model.	L	
	Research Outputs	Unfamiliar model, including where platforms and resources are located.	H	

Key: RoI = Return on Investment, E&E = Efficiency and Effectiveness.

Probability and Impact analysis for income and membership options

A summary of risk probability and impact for the above options follows:

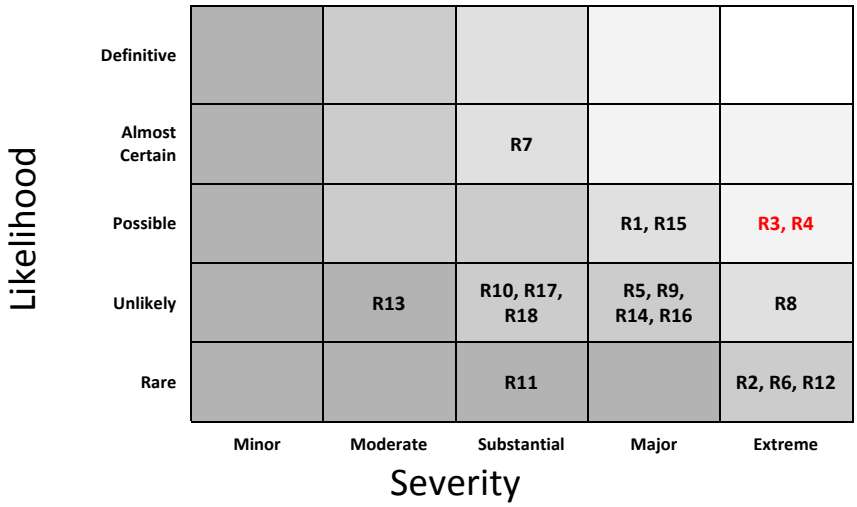


5.3 Organisational, Technical and Operational Risks

In delivering the NeSI services, we face the following organisational, technical and operational risks.

Risk Probability and Impact Matrix

A high level summary follows of key risks, their probability and impact:



Risks

Type	ID	Risk	Likelihood/Severity	Mitigating Action
Organisational	R1	Ineffective delivery on planned services	Possible/Major	• Review the range of projects committed to and ensure proper focus and resourcing can be applied to the development of services. • Implement a project-based approach that focuses on realising benefits and follows development lifecycle best practices.
	R2	Failure of the NeSI partnership structure to work effectively	Rare/Extreme	• Establish appropriate agreements, including the NeSI Collaboration Agreement and Services Agreements. • Unified (national) positioning and operations of NeSI. • Appropriate overview by Board and government (funding) agencies.
	R3	Loss of key staff	Possible/Extreme	• Build in redundancy by sharing knowledge, skills and practices widely across members of the national team. • Investors undertake to provide appropriate support and training, and recruit at the appropriate level. • Establish a strong and supportive culture and team environment.

Type	ID	Risk	Likelihood/Severity	Mitigating Action
	R4	Lack of awareness of NeSI and engagement with researchers or institutions	Possible/Extreme	• Develop visibility with the governance and management at institutions. • Seek active participation from senior representatives and leaders of the research sector. • Align the capabilities, capacities and support with needs of the research community.
	R5	Unsuccessful collaborations with eResearch infrastructure providers	Unlikely/Major	• Help develop and lead eResearch 2020, a national strategy that will include agreed approaches to collaboration between NZ eResearch infrastructure providers. • Develop key collaborative projects with eResearch infrastructure providers as the identified needs of specific research institutions become known. • Work with NZGL to explore joint business development opportunities that reduce costs and enhance value provided to sector institutions and researchers.
	R6	Change to (reduction in) government or partner contributions	Rare/Extreme	• Investors underwrite the risk for their individual components of the system, and commit to provisions through Services Agreements. • Adopt good faith approach to resolving any changes to investors or investment levels. • Strong engagement with senior management teams at all partner institutions.
	R7	Failure to achieve sufficient user revenue	Almost certain/Substantial	• All at-risk capital is isolated in the budget so any shortfall will not cause the partnership to fail. • Work with institutions to implement a subscription model for block allocations.
	R8	Failure to get through head contract renewal process	Unlikely/Extreme	• Honest and transparent dialogue across NeSI stakeholders and MBIE
Technical	R9	Data Transmission risks	Unlikely/Major	• Work closely with REANNZ and institutional ITS divisions to ensure close integration with REANNZ research network to meet the traffic demands of the research sector.
	R10	Security is breached, leading to exposure of sensitive or private data	Unlikely/Substantial	• Best practices used throughout to mitigate risks of compromised systems, and appropriate levels of data security and identity management used.
	R11	Computational infrastructure (e.g. power) failure	Rare/ Substantial	• Partners contract to provide the appropriate support with recovery plans via services agreements • Build strong partnerships with hosting institutions to ensure appropriate provisioning of relevant core central infrastructure e.g. data centres, power.

Type	ID	Risk	Likelihood/Severity	Mitigating Action
	R12	Natural hazards	Rare/Extreme	• The distributed nature of the system provides isolation of each facility from the other. • Multiple communication links exist through REANNZ and the Internet to increase resilience for nationwide users.
Operational	R13	Limited researcher "buy in" to improve the efficiency of their codes on NeSI's compute platforms	Unlikely/Moderate	• Aid in researcher "buy in" through outreach and relationship management activities. • Build track record with research communities that leads to references and enhanced reputation for NeSI. • Increasing awareness and sharing experience through publishing case studies and promoting code efficiency.
	R14	User requirements not met, computationally or for robust services	Unlikely/Major	• Future investments are made once the overall usage, demand and available funding have been assessed • Ensure strong and ongoing alignment with the needs of the research sector. • Avoid experimental or first-of-type to be included in infrastructure until externally validated. • Reliability to be assessed prior to purchase. • Investors provide appropriate support and training for systems and applications to up-skill users
	R15	Ineffective use of the computational science human resource	Possible/Major	• Conduct reviews of the current implementation of the resource to ensure it aligns with the agreed Terms of Reference. • Improve resource coordination with outreach activities.
	R16	Poor computational performance for users	Unlikely/Major	• Board responsible for approving procurement of fit-for-purpose systems. • Benchmarking of computational performance of relevant user software in the tendering and acceptance testing phases of procurement. • Team established capable of supporting migration and refinement of new and existing codes onto suitable platforms.
	R17	Users not satisfied with resource allocation	Unlikely/Substantial	• Access Policy Advisory Committee to advise on appropriate resource allocation policy. • Resource allocations made via the Technical Qualification Panel.

6. Efficiency and Effectiveness

6.1 Overview

Our major initiatives to enhance the organisational efficiency and effectiveness of NeSI are:

- Further refinement of NeSI's organisational structure and administrative processes through implementing nationally facing service lines of Management, Engagement, Solutions and Platforms.
- Enhancing the standardisation and quality of our service offerings through applying principles of continuous improvement.
- Modifying the merit access scheme to reduce barriers to use of NeSI infrastructure and services.
- Introduction of Cloud and use of international facilities to broaden NeSI's fit for purpose offerings.

To improve on effectiveness and efficiency of our platforms and services NeSI will also:

- Sustain and optimise the use of current HPC platforms, improving the efficiency of platform management and services.
- Enhance project support capabilities, thereby improving the consistency and quality of delivery.
- Road-map future technology trends in consultation with the sector, review market offerings, and establish each case for investment to ensure platforms and related support personnel are focused on addressing needs and gaps in the market.

To enhance researcher capability, NeSI will:

- Focus more of our investment on support resources. This includes investing more in skills training and capability development to enable our scientists to better realise the potential of supercomputing to enhance research outputs.
- Support increased researcher literacy in computational and data intensive methods and tools.

6.2 Building Capacity

The breadth of HPC and e-research solutions required by researchers varies depending on the scale and scope of problems being approached. Research communities will need to work with a broad array of software solutions to meet their needs within any one project, across a spectrum from handcrafted to production oriented scalable solutions:

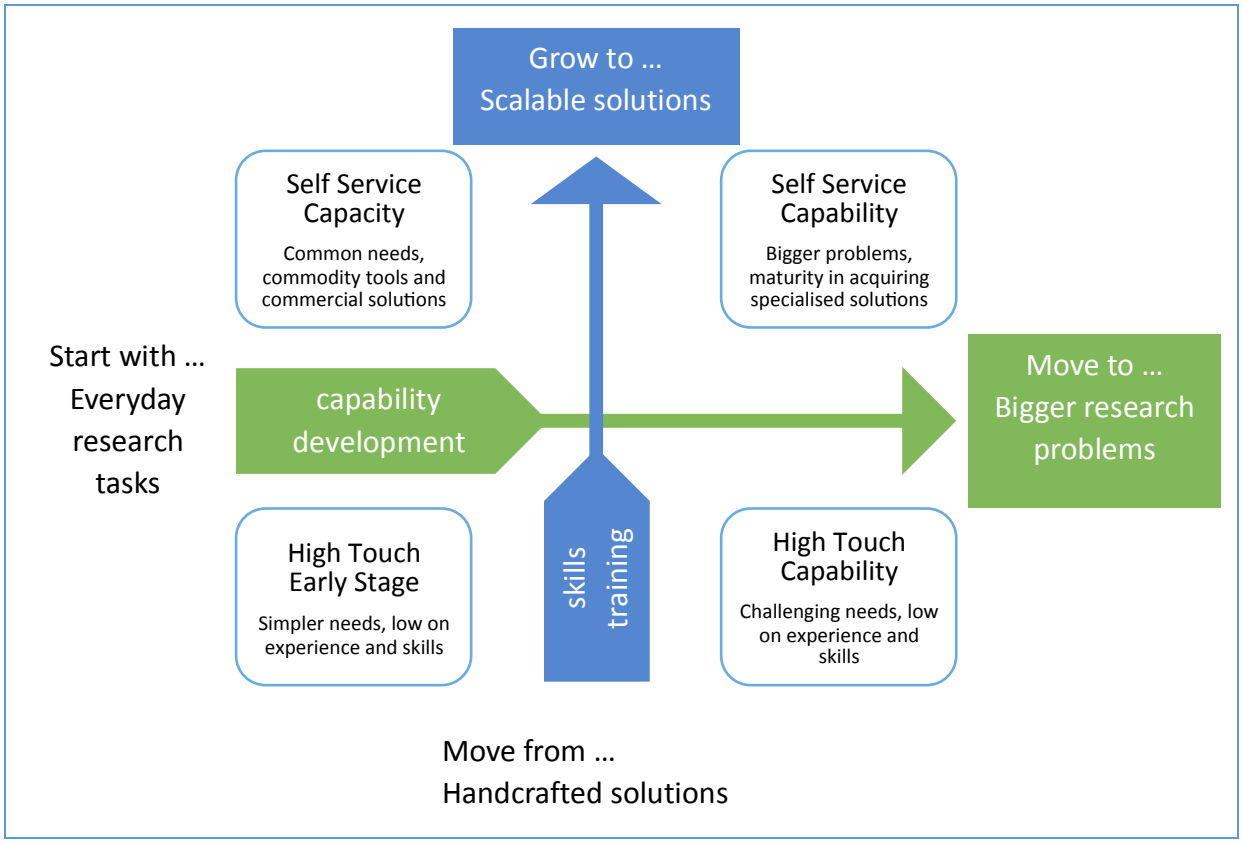


Figure 6 – Outcomes of NeSI's Capacity & Capability Building

As Figure 6 shows, NeSI is focussed on:

- Capability development to support researchers to think bigger and address more complex issues.
- Skills training to enable a greater degree of self-service and access to higher scale tools.

6.3 National Leadership

NeSI 2 proposes strengthening NeSI's national leadership, as the NeSI 1 bid underestimated the support requirements for a shared services organisation like NeSI. This includes the following refinements:

- Strengthening NeSI's delivery approach by adopting a service line management model, and by lifting capability and experience levels in the national management team.
- Strengthening and standardising NeSI's service offerings across different sites and building a common culture.
- Strengthening NeSI's customer engagement capability and capacity, both with existing investors and new subscribers.
- Delivering a nationally coordinated procurement strategy, being the National Platforms Roadmap.
- Establishing NeSI as a project-led organisation.

Implementing this approach requires an increase in budget for the Directorate in NeSI 2. To mitigate this impact on the budget, some management positions have been devolved into the site located teams, and have been co-invested in by NeSI Investors.

6.4 Performance & Reporting

We have established KPIs based on NeSI's strategy and key measures of success, further described in Appendix 2. These include:

Table 3 – NeSI's Key Success Measures

Strategy supported	Objective	Action Plan	Annual Key Performance Indicator
Alignment, Capability, Capacity, Customer Facing, Collaboration, Partnership	Support New Zealand's research priorities	1. Revise Access Policy in Q4 2014 to remove cost recovery for Merit users 2. Implement Engagement programme 3. Establish Research Reference Group to advise on strategy and policy	≥ 20 case studies that describe accepted projects which align with Government priorities
Alignment, Capability, Capacity, Customer Facing, Collaboration, Partnership	Grow advanced skill base that can apply high-tech capabilities to challenging research questions in a fit for purpose way	4. Implement a national training programme early in 2015 5. Deliver 6 training events nationwide each year	≥ 50 NeSI users who get on average an order of magnitude scale up
Alignment, Capability, Collaboration, Customer Facing Efficiency, Effectiveness & Excellence	Increase fit-for-purpose use of national research infrastructure	6. Implement a programme of project-led delivery practice across NeSI's internal and customer facing activities aligned with annual planning cycle 7. Scope a service delivery partnership with NZGL in 2014	≥ 80% Utilisation of Platforms
Alignment, Collaboration, Partnership, Risk & Investment Sharing	Make fit for purpose investments aligned with sector needs	8. Define the Platform Acquisition Fund and National Platforms Roadmap and related processes during Q4 2014, with annual Roadmap reviews thereafter aligned with annual planning cycle	≥ 80% of researchers who indicate in a survey that NeSI's services fit their needs
Alignment, Capability, Capacity, Customer Facing, Resilience	Enhance national service delivery consistency and performance to position NeSI for growth	9. Reorient NeSI into a Service Line delivery structure in Q4 2014 10. Define a programme of service delivery improvement, starting with baselines in Q3/4 2014 and evolve through annual maturity assessments aligned with annual planning cycle	≥ 98% Availability of Services
Alignment, Collaboration, Partnership, Risk & Investment Sharing	Realise financial contributions and revenue targets to enhance NeSI's sustainability	11. Achieve budgeted Investor investment levels each year 12. Agree a consistent pricing and allocation model to provide equity across Investors and Subscribers 13. Implement institutional subscriptions in Q4 2014 and add 1 additional subscriber annually	≥ 76% Co-investment Ratio

To recap, NeSI 2 strategies included:

Alignment – aligning with NZ's Research Priorities supporting growth in innovation, skills, and high-tech infrastructure – through supporting the needs of key researchers who provide the best research outcomes for New Zealand.
Partnership – working with MBIE to implement New Zealand's eResearch strategies across the sector.
Collaboration – enabling researchers to more easily collaborate on research within cross-institutional research project teamwork.
Capability – building the capability of researchers to think bigger and address more complex problems, and to use specialised research infrastructure to support their needs.
Capacity – national planning of fit for purpose infrastructure and advisory services to support researchers to grow skills and build capacity that meets NZ's research needs.
Customer Facing – embedding support resources as geographically close to researchers as possible to improve connectivity and service delivery to researchers.
Investment and Risk Sharing – enabling national co-investment in research infrastructure and advisory services for research institutions through membership or subscriptions.
Efficiency, Effectiveness & Excellence – operate a national service that makes the best use of public money and provides continuously improving service experience.
Resilience – Providing resilient infrastructure and services to support research.

For reporting, NeSI provides the following to MBIE:

- Annual Plan.
- Annual Report.
- Annual "Washup" Report.
- Regular Board updates (MBIE have Board observer status.)

7 Structure and Commitment

7.1 NeSI Investors

NeSI 2 will have the same NeSI Investors as NeSI 1; the University of Auckland, Landcare, NIWA, University of Canterbury and the University of Otago. In NeSI 1 Otago and Landcare were subcontractors to the University of Auckland. In NeSI 2 they will contract directly with NeSI.

All NeSI Investors will sustain their on-going investment levels, with the exception of Canterbury, due to their post-earthquake situation.

We are proposing a co-investment ratio of 76% between the Crown and NeSI Investors, with a consistent ratio between NeSI Investors.

7.2 University of Canterbury

Exceptional events due to the earthquakes in the Canterbury region have left the University of Canterbury unable to sustain their previous levels of co-investment into NeSI. The case for Canterbury therefore describes an initial level of investment focused on sustaining their highly skilled team, and defers potential future investments into HPC platforms. Given that Canterbury has no current capital budget capacity, we will continue to exploit Canterbury's current specialist BlueGene platform, whilst reviewing longer-term options including consideration of migrating users to other NZ or international platforms.

The current earthquake recovery situation that the University of Canterbury faces continues to present challenges in redeveloping its infrastructure while working alongside both government and the Tertiary Education Commission. NeSI 2 incorporates the level of investment that the University of Canterbury is able to sustain. This means that this business case does not include the re-investment obligations for the University of Canterbury from NeSI 1. Accordingly, the share of the University of Canterbury's investment in NeSI has decreased from 37% of the NeSI 1 budget to a 10% share in NeSI 2 (refer Section 8.9.)

With their post-earthquake constraints, the Canterbury investment requires separate authorisation from their Council, which will be sought in September 2014. The University of Canterbury components of this business case are therefore subject to Canterbury's Council approval.

The other NeSI Investors are conscious of Canterbury's circumstances, and are supportive.

7.3 Governance and Management

The current Board structure is an independent chair, an independent supercomputing expert, and representatives from the three major NeSI Investors. We will review the Board membership by year-end 2014, taking in to account the level of investment from NeSI Investors and the skills and competencies we require.

Our considerations will include:

- A balance of skills, including supercomputing and research related information technology, research and research sector knowledge, and commercial & business acumen.
- An appropriate balance of independent board members
- Representation across the NeSI investors

MBIE has observer status on our Board, consistent with our philosophy of no surprises.

The key organisational units within NeSI include the NeSI Board, Research Reference Group, Senior Management Team, and the service line teams.

Table 4 – NeSI Organisational Units

Organisational Unit (Role)	Description ***Commentary on NeSI 2 enhancements***
Board (Governance)	Sets strategic direction for NeSI, sets budgets and agrees plans, and is designated with making decisions in the areas of reinvestment into services and platforms, including in new areas of investment and services provision. ***Board membership and composition will be reviewed during 2014, to assess the balance of skills and representation required for Governance.***
Research Reference Group (Advisory)	Provides advice to the NeSI Director on strategies, policies, and plans. Membership is based on expertise across all key aspects of NeSI's services and activities. ***This is a new advisory committee, where previously the Director took advice within the Access Policy Advisory Committee (including representatives of Marsden, MBIE, HRC and a senior researcher skilled in the use of HPC), and from the three NeSI Facility Directors. Membership and scope will be broadened beyond these existing advisory groups and focus on national interests.***
Senior Management Team (Leadership & Management)	Supports the Board in defining strategic direction, plans and initiatives, and delivers on Board directions by providing leadership and management across the national team including service lines and sites. ***The management team will be focused on service lines.***
Service line teams (Operational Delivery)	NeSI will deliver value to its target customers in a "Service Line Management / Reporting" model. Functional teams oriented around specific capabilities will operate nationally across the sites to provide either specific computational and/or data services that help shape, design, optimise and implement the services to research projects. They will also provide support to existing, industry or emerging researchers in the patterns and practices of using computational and data intensive infrastructures within their research projects and programmes. ***Depth will be increased in each of these core functional areas of the investment, to enhance strategic stakeholder engagement, increase impact through project-led delivery of researcher and capability development projects, and improve efficiency across platform operations.***

This sector centric approach to NeSI planning and performance helps maintain a focus on developing capabilities and resources most valuable to the New Zealand research sector. The following table outlines the core activities for each service line and the activities where these service lines add the most value.

Table 5 – NeSI Service Lines

Service line	Activities	Description of service line
Platforms	Delivering national HPC and Data infrastructure platforms	A functional group comprising the HPC/Data Platforms (Machines, Storage, Networks) and their associated services and support functions, required to deliver computational and data intensive capability and capacity to researchers.

Solutions	Designs and helps shape how value can be delivered to researchers/research projects, and oversees implementation	A functional group that provides the development, design, computational science, high performance work-flow and analytics expertise to design, develop, and optimise HPC/Data services with researchers and their research projects.
Engagement	Engages with the sector and stakeholders to identify opportunities for alignment and integration	A functional group that engages with the various sector audiences (research areas, National Science Challenges, CoREs, CRIs, government, industry.) It also works with Institutions, Agencies and Organisations to identify, realise and benchmark the benefits, return on investment and economic impacts of NeSI platforms and services.
Management	Provide leadership and support the service lines of platforms, solutions and engagement, on a national basis	A functional group executing national leadership and providing support to the platform, solutions and engagement service lines.

In NeSI 2, accountability for KPIs will reside within each service line as appropriate.

7.4 Human capability

We intend to lift the skill and experience levels and competencies of the NeSI team to meet increasingly sophisticated researcher needs. At the start of NeSI 2 we will carry out a nationally coordinated recruitment and placement programme, based on a nationally standardised human resources approach.

The challenges being faced by researchers are increasingly complex, moving towards systems level analyses that require new skills, methods, and technologies. NeSI's team already support up-skilling of researchers through ad-hoc training and support. During NeSI 1 we implemented a team approach to supporting researchers from within the Computational Science team, which in NeSI 2 becomes Application Engineering.

Improving on this approach in NeSI 2, a professional services consultancy model will be defined in 2014 and established early in 2015. Given the unique and high value nature of these skills in New Zealand, we intend to build up a successful and well-regarded professional services arm during NeSI 2. The impacts of this activity will initially be focused on extending the scale and scalability of researcher computational workloads. We believe that as delivery standards improve, this will become an attractive offering for commercial clients.

The below organisational structure outlines the key roles in the NeSI 2 team:

<table>
<tr><th>Engagement</th><th colspan="3">Solutions</th><th>Platform</th><th colspan="2">Management</th></tr>
<tr><th>Engagement</th><th>Computational Science</th><th>Applications Engineering</th><th>Integration & Collaboration</th><th>Platform Support</th><th>Senior Management</th><th>Administration</th></tr>
<tr><td>Engagement Manager</td><td colspan="3">Solutions Manager</td><td>Platform Manager</td><td colspan="2">Director</td></tr>
<tr><td>Community Coordinator</td><td>Scientific Programmer</td><td>Application Engineer</td><td>Analyst Programmer</td><td>Systems Engineer</td><td>Engagement Manager</td><td>National Coordinator</td></tr>
<tr><td></td><td>Scientific Programmer</td><td>Application Engineer</td><td>Analyst Programmer</td><td>Systems Engineer</td><td>Solutions Manager</td><td>Project Manager</td></tr>
<tr><td>Directorate</td><td>Scientific Programmer</td><td>Application Engineer</td><td>Analyst Programmer</td><td>Systems Engineer</td><td>Platform Manager</td><td>Executive Assistant</td></tr>
<tr><td>Auckland</td><td>Scientific Programmer</td><td>Application Engineer</td><td>Analyst Programmer</td><td>Systems Engineer</td><td></td><td>Site Manager</td></tr>
<tr><td>NIWA</td><td></td><td>Application Engineer</td><td>Analyst Programmer</td><td>Systems Engineer</td><td></td><td>Site Manager</td></tr>
<tr><td>Canterbury</td><td></td><td>Application Engineer</td><td>Systems Integrator</td><td>Systems Engineer</td><td></td><td>Site Manager</td></tr>
<tr><td>Landcare</td><td></td><td></td><td>Solutions Architect</td><td>Systems Engineer</td><td></td><td>Site Manager</td></tr>
<tr><td>Otago</td><td></td><td></td><td>Analyst Programmer</td><td>Systems Engineer</td><td></td><td>Site Manager</td></tr>
</table>

8 Financial Analysis

8.1 Assumptions

NeSI 2 Business Case assumptions include:

- Meeting a **76% co-investment ratio** between the NeSI Investors and the Crown.
- The share of co-investment will be normalised across NeSI Investors to a standard.
- The share of funds can be adapted from NeSI 1 to NeSI 2.
- That **no more than $1 million of Crown investment is held** by the host organisation.
- That each NeSI 2 investor will **balance their investment portfolio** across operational items including people alongside capital expenditure and depreciation.
- That **NeSI Investors will reinvest the depreciation accumulated** in their local accounts against the assets purchased and use this depreciation as re-investment in the national infrastructure.

8.2 NeSI Budget 2014 – 2018

The budget set out in sections 8.6 – 8.10 articulates the NeSI budget for 2014 – 2018. The budget defines both the funding received by way of investment, and how this funding is then translated into expenditure supporting national services delivery via infrastructure and activities, to be defined within Service Agreements.

These budgets are based on solid assumptions across the Investors and informed by the first three years of operations during NeSI 1. NeSI 2 budgets are built up from each of NeSI's Service Lines, incorporating capital equipment requirements alongside the people necessary to deliver related services to the sector.

8.3 Stable Operating Budgets and the Platform Acquisition Fund to Manage Change

A critical aspect of developing a national investment approach is agreement that investing institutions commit to balancing their investments across both operational and capital expenditure budgets. To ensure that NeSI expenditure effectively and efficiently continues to give researchers access to platforms and to services that optimise their use of those platforms, as well as building systems to meet future needs, the expenditure budget has been split into two distinct parts.

To sustain current levels of support and effective access across national platforms an **Operational Budget** of $36.9M has been established for the Service Lines (Engagement, Solutions, Platforms) and the National Management team.

A **Platform Acquisition Fund** of $16.7M has been established which will support the implementation of the National Platforms Roadmap (Table A3). Decisions on the best mix of access to and/or new equipment will be made through a business case driven process that will provide detailed information to support purchasing decisions – which may or may not include the resetting of on-going operational budgets.

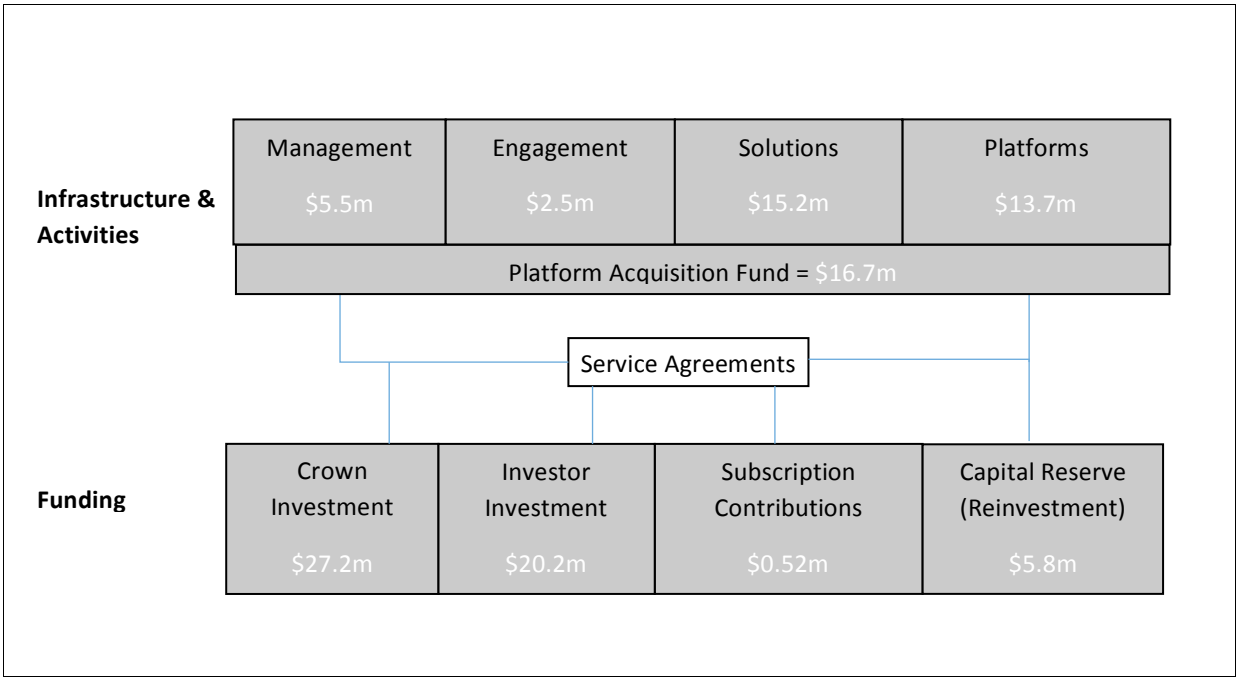


Figure 7 – NeSI 2 Funding & Expenditure Arrangements

NeSI 2 requests $27.2m of Crown contributions. All NeSI Investors will sustain investment into NeSI, with the exception of Canterbury due to their post-earthquake situation.

8.4 Ratios and Reinvestment

The Investors & Subscribers make the following commitments:

- A commitment to a total combined ratio of 76% between Investors & Subscribers, and the Crown, plus the commitment by Investors to reinvestment.
- The ratio each investor will contribute, as a percentage of the Crown Funding they receive, will be similar for every investor (previously these ratios varied significantly.)

The Crown and Investor Investment will cover all costs equally per the predetermined Investor/Crown ratio. In NeSI 2, the Investor to Crown ratio is calculated by including Subscriber revenues in the Investor component of the ratio, in recognition that these revenues represent a sector contribution to NeSI 2 funding.

8.5 Access and Allocations for NeSI 2

Allocations of capacities are made from within two researcher-facing services (Total activity cost in 2014-2018): Solutions ($7.6m[ii]) and Platforms ($13.7m). Solutions delivers NeSI's people into research projects in either a training or capability development capacity, managed within a professional services model. Platforms delivers well supported computational applications and computing capacity into research projects, measured by the hour.

Capacities on future platforms funded by the Platform Acquisition Fund ($16.7m) aren't included until those investments become operational.

Access will be based on the allocation rights set out in Table 6:

Table 6 – NeSI 2 Allocation Rights 2014-2018

Access scheme	Share of Capacity	Pricing Accounting model	Service Line	Total activity cost in $m
Merit researchers Any researcher who has received a Merit grant for their research project	20%	**Free** Project based allocation to a research project	Platforms	2.74
			Solutions	1.52
Subscribers Institutions and research programmes or initiatives needing a block allocation to support their research projects	20%	**~50 - 80%[iii] of Cost price** Block Allocation to an institution based on subscription with utilisation tracked against each Service's cost price	Platforms	2.74
			Solutions	1.52
Investors Institutions and research programmes or initiatives needing a block allocation to support their research projects	60%	**~80%[iv] of Cost price** Block Allocation to an institution based on investment with utilisation tracked against each Service's cost price	Platforms	8.22
			Solutions	4.56
Commercial Individuals or organisations needing allocations to support commercial research projects	On demand	**Cost-plus price** Project based professional services and Platform allocation	Platforms	TBD
			Solutions	TBD

Merit researchers

Researchers receiving a Merit grant will not be charged in NeSI 2 for their access – these allocations are based on research merit, requiring NeSI to track associated research grants and outputs to demonstrate research impact. This segment is available to support the highest quality research in New Zealand.

Pricing for Merit is consistent with merit-based allocation models internationally, all of which operate on a free/resource grant basis. While New Zealand operates a full cost funding system, the scale of resources typified by fit for purpose HPC use is beyond affordability within research grants. To devolve these costs to input funding would lead to the coordination failure highlighted in section 4.2.

For researchers to make use of advanced computational techniques requires significant investment in up-skilling themselves or their students. Such an investment contains substantial risk as it represents a change in

[ii] For the Solutions services, of the total cost of $15.2m, 50% of the capacity in this service is focused on building infrastructure capabilities and 50% focuses on direct researcher-facing services. Hence the activity cost for researcher-facing services is based on 50% of capacity.
[iii] Each Subscriber is offered a discount for the first two years of continuous subscription.
[iv] Investors pay an effective price of ~80% for their block allocation across NeSI services.

research methods. NeSI supports researchers to make these essential changes, building capacity to meet the computational challenges of future system-level analyses.

NeSI's proportion of access is limited to 20% to support the best research while incentivising institutions to form a direct subscription or investment relationship with NeSI to meet institutional needs.

We anticipate strong uptake of this Merit scheme, as shown in NeSI 1 before pricing on Merit access was introduced. Merit access capacity on the Platform service is targeted at approximately NZ$1.1 million per annum (for internal accounting purposes) at current computing and service costs and based on the 2015 year.

Platform Subscriptions Model

The subscription model was developed towards the end of NeSI 1, and will be matured early in NeSI 2.

20% of total national Platform service capacity is available for allocation in blocks to subscribers. Pricing is set at 50 - 80% of the Cost price set at 50% for the first two years of any subscription before lifting to 80%, providing parity between Subscribers and Investors.

Table 7 shows subscription capacity is measured via the 'direct cost' of the CPU Core Hours per Platform:

Table 7 – Subscriptions Model

Machine	Direct Cost per CPU Core Hour *
Pan	**0.07**
FitzRoy	**0.15**
Foster	**0.02**
* Direct Costs are based on the 2015 budget for Platform Services Line	

Table 8 below outlines the current capacity by platform for the full year 2015:

Table 8 – Current Capacity by Platform per annum

Platforms	Total Capacity (CPU Core Hours) *	@ $ per CPU Core Hour	Total Subscription Access Per Annum
Pan	6,944,760	$0.07	$459,419
FitzRoy	3,028,717	$0.15	$454,133
Foster	11,252,269	$0.02	$172,519
Totals	**21,225,746**		**$1,086,071**
* Total Capacity (CPU Core Hours) is the total effective CPU Core Hour capacity available for Allocations, calculated as 98% expected uptime and 80% queuing efficiency for 8760 hours per year			

Planned subscription revenues are based on a ramp of up-take, outlined in Table 9 below:

Table 9 – Planned Platform Subscription Revenues

Year of Contract	$ Subscription Revenue Target	% of Total Subscription Capacity $
2014 (3 months)	$6,788	5%
2015	$54,304	10%
2016	$95,031	18%

2017	$206,353	28%
2018 (6 months)	$153,408	37%
Total Subscription Revenue	**$515,884**	

We predict conservative uptake of subscriptions during 2014 – 2018 due to a number of factors, including:

- Several institutions have purchased smaller HPC clusters over the last two years so subscriptions will become viable during their replacement cycles in another two to three years.
- Investment into transitioning researchers to use HPC capabilities is required before growth in research project utilisation occurs. This creates lags between initial investment into HPC and subsequent growth in use of two to three years as has been demonstrated at Auckland and Landcare Research.
- Leaders of NSCs and CoREs have indicated that as their programmes grow the subscription model will become an attractive means for supporting their research.

We anticipate that establishing a base of subscribers in NeSI 2 will contribute to the on-going viability of NeSI in subsequent periods through increasing sector contributions to NeSI. Currently negotiations are progressing with first subscribers Massey and Plant & Food.

We aim to build uptake as quickly as we can. We will enhance NeSI's engagement activities and focus training and capability developments to support subscription opportunities that drive uptake across the sector.

Commercial access

The investment into NeSI and specifically into HPC services stems from a market failure. NeSI has achieved well in the first period, coordinating investments into a risk and investment sharing model that is returning significant value to the research sector. Meanwhile the commercial demand for HPC services from New Zealand organisations is limited – developing the capabilities to apply such complex resources is beyond the investment limits for most organisations.

NeSI 2 aims to build on these foundations and establish NeSI is a viable provider of services to commercial interests. We will build service maturity to ensure commercially attractive service levels are consistently achieved.

We anticipate NeSI being ready late in NeSI 2 to attract and retain early commercial customers, positioning NeSI 3 to have a strong commercial customer focus.

Pricing and Access Policy

NeSI has a current Access Policy that addresses contention between significant demand from existing users and future users, across allocation classes. The effectiveness of the policy is reviewed routinely and revisions made to enhance delivery of value from the investment. As Merit allocations are made to support high quality research these projects are prioritised above others. Priority is then given to Subscribers or Investors who have yet to receive their fair share of capacity. Policy advice is currently received from an external committee of sector representatives, comprising research leaders and funding providers. In NeSI 2 policy advice will be incorporated into a newly established Research Reference Group.

8.6 Summary of Proposed Financial Budget for NeSI 2014 – 2018 by NeSI Investor

The following table summarises the budget for NeSI 2014 – 2018 by NeSI Investor.

	TOTAL	Directorate	Auckland	Landcare	Otago	Canterbury	NIWA
FUNDING / EXPENDITURE	-						
Crown	**27,173,800**	6,643,767	6,823,415	1,075,940	1,690,913	2,688,958	8,250,807
Investors	**20,196,079**		6,712,421	1,058,438	1,663,407	2,645,218	8,116,594
Investors Capital Reserve	**5,778,999**	-	2,872,479	-	1,416,000	-	1,490,520
Sector Revenue	**515,884**	515,884					
TOTAL NESI 2	***53,664,763***	***7,159,652***	***16,408,315***	***2,134,379***	***4,770,320***	***5,334,176***	***17,857,922***
Investors/Crown Ratio	76.2%	8%	98%	98%	98%	98%	98%

8.7 Summary Operational and Platform Acquisition Fund Budgets by Year

The following tables show summary operational and Platform Acquisition Fund budgets by year.

	TOTAL PROJECT	three months to Dec 2014	2015	2016	2017	six months to Jun 2018
NeSI 2 FUNDING						
Crown	**27,173,800**	1,729,304	7,014,645	6,209,669	8,977,519	3,242,663
Investors	**20,196,079**	1,308,398	5,184,569	4,365,903	7,053,874	2,283,334
Investors Capital Reserve	**5,778,999**	542,467	328,533	2,686,680	1,977,720	243,600
Sector Revenue	**515,884**	27,152	81,455	135,759	162,911	108,607
TOTAL NeSI 2 FUNDING	***53,664,763***	***3,607,320***	***12,609,203***	***13,398,011***	***18,172,024***	***5,878,205***
Investor/Crown Ratio	*76.2%*	*77.2%*	*75.1%*	*72.5%*	*80.4%*	*73.8%*
TOTAL NeSI 2 EXPENDITURE						
Contracted Expenditure						
People	**24,740,681**	1,591,904	6,580,224	6,589,147	6,608,878	3,370,528
Operating Expenses	**2,499,751**	164,883	659,530	659,530	672,721	343,088
Platform Operating Expenses	**5,370,675**	530,338	2,124,998	1,866,143	722,028	127,168
Capital Reserve - Existing Assets	**4,323,899**	750,578	2,507,474	765,848	200,000	100,000
Total Contracted Expenditure	**36,935,006**	**3,037,702**	**11,872,226**	**9,880,668**	**8,203,627**	**3,940,783**
Platform Acquisition Fund[v]						
Possible Additional Platform People	**679,094**	-	109,850	224,094	228,576	116,574
Possible Additional Platform Operating[vi]	**1,884,304**	-	68,000	136,721	1,039,731	639,852
Possible Additional Capital Reserve[vii]	**2,861,996**	-	149,139	334,089	1,549,979	828,788
Possible Platform Access & Acquisition[viii]	**11,304,363**	569,618	409,989	2,822,439	7,150,111	352,207
Total Platform Acquisition Fund	**16,729,757**	**569,618**	**736,977**	**3,517,343**	**9,968,397**	**1,937,421**
TOTAL NeSI 2 EXPENDITURE	***53,664,763***	***3,607,320***	***12,609,203***	***13,398,011***	***18,172,024***	***5,878,205***

Refer to Appendix 1 – Table A3, National Platforms Roadmap, for details on anticipated expenditure from the Platform Acquisition Fund.

[v] The segmentation of the fund is based on assumptions of the proportion of the fund that will be spent on capital versus that which will be spent as operating. Flexibility is required to ensure the best fit-for-purpose platforms can be accessed or acquired, whether in the cloud, offshore, or commissioned locally.
[vi] This will cover operational costs for future platform investments, such as power/cooling, and hosting.
[vii] This will cover depreciation costs related to future platform investments.
[viii] This will cover future platform investment capital costs or costs associated with procuring platform services from other providers (including commercial/cloud or international facilities).

8.8 Service Line Budgets by Year

NeSI's delivery model is shifting to include Service Lines and the Platform Acquisition Fund, with budgets for each shown below, by year.

	TOTAL PROJECT	three months to Dec 2014	2015	2016	2017	six months to Jun 2018
NeSI 2 FUNDING						
Crown	**27,173,800**	1,729,304	7,014,645	6,209,669	8,977,519	3,242,663
Investors	**20,196,079**	1,308,398	5,184,569	4,365,903	7,053,874	2,283,334
Investors Capital Reserve	**5,778,999**	542,467	328,533	2,686,680	1,977,720	243,600
Sector Revenue	**515,884**	27,152	81,455	135,759	162,911	108,607
TOTAL NeSI 2 FUNDING	***53,664,763***	***3,607,320***	***12,609,203***	***13,398,011***	***18,172,024***	***5,878,205***
Investor/Crown Ratio	*76.2%*	*77.2%*	*75.1%*	*72.5%*	*80.4%*	*73.8%*
TOTAL NeSI 2 CONTRACT EXPENDITURE						
Engagement Services						
People	**2,072,218**	104,182	548,046	559,007	570,187	290,795
Operating Expenses	**444,211**	29,300	117,200	117,200	119,544	60,967
Platform Operating Expenses	**-**	-	-	-	-	-
Capital Reserve - Existing Assets	**-**	-	-	-	-	-
Platform Access & Acquisition	**-**					
Total Engagement Services	**2,516,429**	**133,482**	**665,246**	**676,207**	**689,731**	**351,763**
National Management Service						
People	**4,625,588**	295,540	1,205,804	1,229,920	1,254,519	639,805
Operating Expenses	**901,385**	59,455	237,820	237,820	242,576	123,714
Platform Operating Expenses	**-**	-	-	-	-	-
Capital Reserve - Existing Assets	**-**	-	-	-	-	-
Platform Access & Acquisition	**-**					
Total National Management Service	**5,526,973**	**354,995**	**1,443,624**	**1,467,740**	**1,497,095**	**763,519**
Platform Services						
People	**3,618,837**	270,594	1,066,297	964,941	872,188	444,816
Operating Expenses	**400,056**	26,388	105,550	105,550	107,661	54,907
Platform Operating Expenses	**6,322,674**	769,711	2,657,254	2,046,513	722,028	127,168
Capital Reserve - Existing Assets	**3,371,900**	511,204	1,975,217	585,478	200,000	100,000
Platform Access & Acquisition	**-**					
Total Platform Services	**13,713,467**	**1,577,897**	**5,804,319**	**3,702,482**	**1,901,877**	**726,891**
Solution Services						
People	**14,424,038**	921,587	3,760,077	3,835,278	3,911,984	1,995,112
Operating Expenses	**754,098**	49,740	198,960	198,960	202,939	103,499
Platform Operating Expenses	**-**	-	-	-	-	-
Capital Reserve - Existing Assets	**-**	-	-	-	-	-
Platform Access & Acquisition	**-**					
Total Solution Services	**15,178,136**	**971,327**	**3,959,037**	**4,034,238**	**4,114,923**	**2,098,611**
TOTAL CONTRACT EXPENDITURE	**36,935,006**	**3,037,702**	**11,872,226**	**9,880,668**	**8,203,627**	**3,940,783**
PLATFORM ACQUISITION FUND	**16,729,757**	**569,618**	**736,977**	**3,517,343**	**9,968,397**	**1,937,421**
TOTAL NeSI 2 EXPENDITURE	***53,664,763***	***3,607,320***	***12,609,203***	***13,398,011***	***18,172,024***	***5,878,205***

8.9 Site Variances from NeSI 1 to NeSI 2

The tables below show variances between NeSI 1 and NeSI 2 by Site, representing the six contractual budgets that comprise NeSI 2.

Due to the following differences in funding arrangements between NeSI 1 and NeSI 2 these figures should be used as an indicative guide only:

- Different time periods, funding envelopes and cashflow profiles.
- In NeSI 1, Otago and Landcare were included with Auckland as subcontractors, whereas in NeSI 2 they are separated out.

	NeSI 1	NeSI 2	*Variance on NeSI 1*	*% increase on NeSI 1*
% SHARE of CROWN FUNDING				
Directorate	16%	24%	*9%*	*56%*
Auckland	22%	25%	*3%*	*14%*
Landcare	2%	4%	*2%*	*101%*
Otago	7%	6%	*-1%*	*-13%*
Canterbury	36%	10%	*-26%*	*-72%*
NIWA	18%	30%	*13%*	*72%*
TOTAL	*100%*	*100%*	*0%*	

% of TOTAL BUDGET				
Directorate	9%	13%	*4%*	*46%*
Auckland	23%	31%	*8%*	*34%*
Landcare	3%	4%	*1%*	*17%*
Otago	8%	9%	*1%*	*18%*
Canterbury	37%	10%	*-27%*	*-73%*
NIWA	20%	33%	*13%*	*67%*
TOTAL	*100%*	*100%*	*0%*	

8.10 Changes from NeSI 1 to NeSI 2

The following tables show budgets and changes by line item between NeSI 1 and NeSI 2.

NeSI Total	NeSI 1	NeSI 2	*Variance on NeSI 1*
FUNDING			
Crown	27,446,510	21,913,580	(-$5,532,930)
Investor	20,738,136	15,021,425	(-$5,716,711)
Sector Revenue	102,880	-	(-$102,880)
CONTRACTED FUNDING	***48,287,526***	***36,935,006***	***-11,352,521***
Crown PAF - Opex	-	5,260,220	$5,260,220
Investor PAF - Opex	-	5,174,654	$5,174,654
Investor PAF - Platform Access & Acquistion[1]	-	5,778,999	$5,778,999
Sector Revenue	-	515,884	$515,884
PAF FUNDING	-	***16,729,757***	***16,729,757***
TOTAL FUNDING	**48,287,526**	**53,664,763**	**$5,377,237**
Investor/Crown Funding Ratio	75.6%	76.2%	0.7%
EXPENDITURE			
People	16,410,251	24,740,681	$8,330,429
Operating Expenses	1,081,421	2,499,751	$1,418,329
Platform Operating Expenses	7,143,206	5,370,675	(-$1,772,531)
Capital Reserve Fund - Existing Assets	13,077,656	4,323,899	(-$8,753,757)
Platform Access & Acquisition	10,574,990	-	(-$10,574,990)
CONTRACTED EXPENDITURE	***48,287,525***	***36,935,006***	***-11,352,519***
People	-	679,094	$679,094
Platform Operating Expenses	-	1,884,304	$1,884,304
Capital Reserve Fund - New Assets	-	2,861,996	$2,861,996
Platform Access & Acquisition	-	11,304,363	$11,304,363
PAF EXPENDITURE	-	***16,729,757***	***16,729,757***
TOTAL EXPENDITURE	**48,287,525**	**53,664,763**	**$5,377,238**

1. Represents reinvestment by Investor only, including Reinvestment Obligations

Appendix 1: Current & Future Platforms

National Data Platforms

The primary data platforms for HPC are the parallel file systems that supporting HPC data access, a core component of an HPC system. Focusing on a broader scope of research workflows and drawing on prior work done within the sector, NeSI supports e-research platforms for data transfer, staging, storage and sharing services. These platforms are specified below:

Table A1 – National Data Platforms

Platform location	Platform resources	Services supported
Auckland	4 x IBM x3850 M5 4 core servers, each with 512 GB of memory, and two 146 GB hard drives 20 TB Block Storage	Data Fabric Data Transfer Hosting service
Otago	4 x IBM x3550 servers, each with 128 GB of memory, and one 300 GB hard drive 42 TB Block Storage	Data Transfer Data Fabric
Canterbury	1 x IBM x3650, with 96 GB of memory and 1 TB hard drive 20 TB Block Storage	Data Fabric Data Transfer

National HPC Platforms

NeSI's national HPC platforms deliver in excess of 120 million core hours annually, with over 95% of this delivered via the three major platforms of Fitzroy (NIWA), Foster (Canterbury) and Pan (Auckland). These platforms are specified below:

Table A2 – National HPC platforms

Platform	**Hardware**	**Operating Environment**
Foster **BlueGene/P** **@ BlueFern, University of Canterbury**	8,192 cores @ 0.8 GHz/core with 8 TB RAM, 1 GB/core 3D Torus interconnect User data store: 182 TB	Linux GPFS parallel file system LoadLeveller workload scheduler TSM-SM Hierarchical Storage Management (HSM)
FitzRoy - **P575/POWER6** **@ High Performance Computing Facility, NIWA**	3,392 cores @ 4.7 GHz/core with 8.375 TB RAM Infiniband interconnect User data store: 530 TB	AIX GPFS parallel file system LoadLeveller workload scheduler TSM-SM Hierarchical Storage Management (HSM)
Pan **Intel Cluster** **@ Centre for eResearch, University of Auckland**	3,705 cores @ 2.7 GHz/core with 30.875 TB RAM 968 cores @ 2.8 GHz/core with 8.25 TB RAM 57 cores @ 2.8 GHz/core with 1.5 TB RAM 42 GPGPUs & 4 Xeon Phi devices Infiniband interconnect User data store: 400 TB	Linux GPFS parallel file system LoadLeveller workload scheduler TSM-SM Hierarchical Storage (HSM)

National Platforms Roadmap

A high level Roadmap for the period 2014-18 is shown in Table A3 below. The Roadmap will be reviewed annually, as part of the NeSI planning cycle. The National Platforms Roadmap proposes fewer, but more strategic investments. Over the course of NeSI 2 we will:

1. Continue to support the current HPC platforms across the three major facilities through to each platform's end-of-life with planned decommissioning activities across all platforms completing in 2017.
4. With significant growth occurring on the more general use platform at Auckland, an upgrade will take place in late 2014 to increase capacity by 20%, at a cost of $.5m. Further subsequent upgrades are possible to meet demand.
2. By 2017, consolidate on two national HPC platforms at Auckland and NIWA, each specialised to support a particular segment of research needs - carry out platform replacements in late 2016/early 2017 delivering capacity of around 12,000 to 15,000 CPU cores depending on configuration – this activity will access the Platform Acquisition Fund, at a cost of $9.7m.

By 2017 all of NeSI's Platforms are likely to be based on x86 chipsets and run Linux operating environments, providing ease of access and broader suitability to the research software applications required by researchers. During these investment processes we will review options for access to international facilities to optimise the value each investment delivers. Planning for data platforms will be covered through the Platform Acquisition Fund described earlier and relevant proposed future bids.

Table A3 – National Platforms Roadmap	
2014	**Optimise and sustain** fit-for-purpose use of the existing infrastructure i. Establish plans for supporting growth e.g. researcher support on Pan at Auckland ii. Establish migration path for effected researchers to support decommissioning plans **Data & Cloud Strategies** including **International Collaborations** i. Establish NeSI's Data strategy – in partnership across the sector ii. Establish NeSI's Cloud strategy – brokering out to appropriate Cloud services iii. Establish partnerships and solutions to enable use of off-shore (e.g. Australian) HPC centres iv. Pilot users on these services – e.g. commercial Cloud services, international HPC centres
2015	**Optimise and sustain** fit for purpose use of the existing infrastructure **Data & Cloud Strategies** including **International Collaborations** i. Review pilots and move successes to production for ongoing optimisation and sustaining **Planning starts for replacement platforms** in mid 2015 i. Identify science directions and needs (software, hardware, services)
2016	**Optimise and sustain** fit for purpose use of the existing infrastructure **Decommissioning activities** i. TBC[ix]: FitzRoy P6, Pan x86 and Foster BG/P decommissioning **Platform acquisitions and commissioning** i. TBC: Commissioning, acceptance testing & user migration
2017	**Optimise and sustain** fit for purpose use of the existing infrastructure **Decommissioning activities** i. TBC: FitzRoy P6, Pan x86 and Foster BG/P decommissioning **Platform acquisitions and commissioning** TBC: Commissioning, acceptance testing & user migration
2018	**Optimise and sustain** fit for purpose use of the existing infrastructure **Review platform investments** to inform future investment plans

[ix] In reference to the "to be confirmed" timing of the 2016 / 2017 acquisitions, chip vendor Intel indicates significant changes in core HPC technology late in 2016 or early in 2017, which will provide a step change in performance and cost considerations for HPC. NeSI's roadmap will track these developments and time major procurement activities accordingly (currently indicated as TBC below.)

Appendix 2: Performance Measures

The below performance measures will be mapped to service lines, with accountability devolved into each service line as appropriate.

Table A4: NeSI's Key Success Measures & KPI's

Strategy supported	Objective	Action Plan	Annual Key Performance Indicator	Supporting Metrics
Alignment, Capability, Capacity, Customer Facing, Collaboration, Partnership	Support New Zealand's research priorities	1. Revise Access Policy in Q4 2014 to remove cost recovery for Merit users 2. Implement Engagement programme 3. Establish Research Reference Group to advise on strategy and policy	≥ 20 case studies that describe accepted projects which align with Government priorities	≥ 50 research outputs associated with contestable funding programmes (Marsden, MBIE rounds, NSCs, CoREs, NHRP, Institutional, Scholarships, Fellowships, etc)
Alignment, Capability, Capacity, Customer Facing, Collaboration, Partnership	Grow advanced skill base that can apply high-tech capabilities to challenging research questions in a fit for purpose way	4. Implement a national training programme early in 2015 5. Deliver 6 training events nationwide each year	≥ 50 NeSI users who get on average an order of magnitude scale up	≥ 6 training events by organisation % of CPU core hours used by top 30 software applications
Alignment, Capability, Collaboration, Customer Facing Efficiency, Effectiveness & Excellence	Increase fit-for-purpose use of national research infrastructure	6. Implement a programme of project-led delivery practice across NeSI's internal and customer facing activities aligned with annual planning cycle 7. Scope a service delivery partnership with NZGL in 2014	≥ 80% Utilisation of Platforms	# of CPU core hours used per organisation user retention and growth rates by allocation class and organisation
Alignment, Collaboration, Partnership, Risk & Investment Sharing	Make fit for purpose investments aligned with sector needs	8. Define the Platform Acquisition Fund and National Platforms Roadmap and related processes during Q4 2014, with annual Roadmap reviews thereafter aligned with annual planning cycle	≥ 80% of researchers who indicate in a survey that NeSI's services fit their needs	Platform acquisition time and cost % of CPU core hour utilisation by platform threshold (Peak & Breadth & Capacity Users - refer Section 4.3 and Figure 5)

Alignment, Capability, Capacity, Customer Facing, Resilience	Enhance national service delivery consistency and performance to position NeSI for growth	9. Reorient NeSI into a Service Line delivery structure in Q4 2014 10. Define a programme of service delivery improvement, starting with baselines in Q3/4 2014 and evolve through annual maturity assessments aligned with annual planning cycle	≥ 98% Availability of Services	% of total allocated CPU core hours used by allocation class and organisation ≥ 80% users who completed their support ticket closer survey and indicated satisfaction with NeSI's support service maturity measures

Alignment, Collaboration, Partnership, Risk & Investment Sharing	Realise financial contributions and revenue targets to enhance NeSI's sustainability	11. Achieve budgeted Investor investment levels each year
		12. Agree a consistent pricing and allocation model to provide equity across Investors and Subscribers
		13. Implement institutional subscriptions in Q4 2014 and add 1 additional subscriber annually
			≥ 76% Co-investment Ratio	% of use of entitlements by Investor, Subscriber
				$ revenue by Subscriber
				$ revenue by Commercial