



NETWORKED SYSTEMS VISION

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Overview

The purpose of this paper is to provide an overview of the Networked Systems Research Theme Strategic Plan. The complete plan is at **Attachment A**.

Networked Systems Strategic Plan

Networked Systems are technologies that interconnect “smart objects” to enable the transfer of data to the appropriate end devices in a timely manner. The focus of today’s networked systems is primarily the transfer of information between two human users, or between human users and computers (servers). However, with the development of more powerful portable computing devices and intelligence being embedded in most products, future networked systems will have to transfer of information between highly mobile end devices. These future networked systems will thus differ from the current systems in scale both in terms of the number of devices that will need to be interconnected and amount of traffic that that will need to be transported. Furthermore, they will be based on new technologies that will interconnect the end devices, and will have to support a myriad of new applications.

NICTA already has developed or has the potential to develop world leading capability in the three areas of Networked Systems:

Storage, retrieval & distribution architectures for mobile data systems: The capability is being used and is being extend through the work being carried out in the Universal Storage Systems and the Peer to Peer projects as well as within the networking system theme at the Australian Technology Park Research Laboratory (ATPRL). This technology will allow exploitation of the power of portable computing devices and will scale to handle the increase in the number of devices that will be interconnected.

Key researcher leaders and project leaders – Raymond Wong, Santosh Kulkarni, and Max Ott. In addition, there is significant capability in the Victoria Research Laboratory (VRL) with Rao Kotagiri, Aaron Harwood, and Egemen Tanin.

Major achievements include the development of XML representation that optimizes the size and processing requirements for data storage and a decentralised network engine for virtual worlds that was licensed to VastPark Pty Ltd.

Protocol mechanisms for supporting dynamic delivery infrastructure: The capability is being used and is being extended through the work being carried out within a joint project with Ericsson Research, the Context Aware Mobility Project (CAMP), Smart Applications for Emergencies (SAFE) networking, Smart Traffic and Roads (STaR) Communication, National Security Science and Technology (NSST) Mesh Networking projects and the activities associated with spin out company 7iP.

Key research and project leaders – Aruna Seneviratne, Max Ott, Jaga Indulska, Roksana Boreli, Marius Portman and Bjorn Landfeldt.

Major achievements – new higher layer mobility management, and the use of context information for system configuration. This work has been instrumental in attracting funding from NSST and Ericsson Research, and the development of the technology that has led to the NICTA spin-out company 7iP.

The optical physical layer: The NICTA capability is in monitoring the health and performance of optical networks. This capability was extended by the work on the Monitoring and Managing the Internet (MAMI) project.

Key researcher leaders – Nirmalathas Ampaluanapillay, Peter Farrell and Trevor Anderson.

Major achievements – breakthrough advances in measuring multiple impairments through a single measurement. This technology breakthrough underpins the NICTA spin-out company Monitoring Division Inc.

NICTA will continue to strengthen these core capabilities by drawing on the expertise from some of the other NICTA research themes, especially Managing Complexity and Making Sense of Data to create a world class capability in the above three areas of network systems by 2018. Also, significant linkages are being established with major initiatives around the world, namely NSF Future Internet Design (FIND) and European Union Future Internet programs to ensure that NICTA Networked System research activities will have a significant impact.

NICTA Research Theme Strategic Plan

Networked Systems

Summary

Networked Systems are technologies that interconnect “smart objects” to enable the transfer of data to the appropriate end devices in a timely manner. The focus of today’s networked systems is primarily the transfer of information between two human users, or between human users and computers (servers).

However, with the development of more powerful portable computing devices and intelligence being embedded in most products, future networked systems will have to transfer information between highly mobile end devices. Moreover, there will be a significantly greater number of end devices that will need to be interconnected, which will produce and consume vast amounts of information. These future networked systems will differ from the current systems in scale both in terms of the number of devices that will need to be interconnected and the amount of traffic that that will need to be transported. Furthermore, they will be based on new technologies that will interconnect the end devices, and will support a myriad of new applications. This gives rise to a number of fundamental research challenges.

NICTA has world class research capability in several areas of network systems that can be used to address some of these research challenges. These will have a significant impact on the storage, retrieval & distribution architectures for mobile data systems, protocol mechanisms for supporting dynamic delivery infrastructures and monitoring the health and performance of optical networks.

NICTA will build on its capabilities over the next 10 years to become recognised as one of the top ten research groups working in these three areas. This will be achieved by developing detailed plans for large scale projects in the next twelve months by drawing on NICTA’s business areas and other themes and partnering with selected research groups in Australia and overseas, especially the US National Science Foundation (NSF) Future Internet Design (FIND) and European Union Future Internet programs. By 2018, networked systems research will lead to the development of a significant IP portfolio as well as consistent publications in a targeted list of most prestigious conferences and journals. In the next twelve months, the networked systems research team will develop the detailed plans for the large scale strategic projects in the above areas.

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1. Vision

By 2018, for NICTA Networks Systems group will be recognized as one of the top 10 research groups which will make significant contributions to the science underpinning developments in the areas of storage, retrieval & distribution architectures for mobile data systems, protocol mechanisms for supporting dynamic delivery infrastructures, and monitoring and management techniques for optical networks. Through this activity NICTA will develop a significant IP portfolio which will lead to the creation of a number of successful start-up companies. In addition, we will develop a coherent graduate training program in networking, which will be the preferred choice for local and international students.

2. Context

Networked Systems are technologies that interconnect “smart objects” to enable the transfer of data to the appropriate end-points in a timely manner. The focus of today’s networked systems is primarily the transfer of information between two human users, or between a human user and computers (servers). Over the past decade, human users have become increasingly mobile with the development of more powerful portable computing devices and networked intelligence being embedded increasingly in new products. Future networked systems will have to transfer information between highly mobile end devices.

These future networked systems will differ in scale from current systems in terms of the number of devices that will be interconnected and the amount of traffic that they will carry, the technologies that will be used to interconnect them, and the applications that they will need to support. This will require fundamental changes to several areas of networked systems. For example, it will require the development of

- New wireless communications techniques which increase the available bandwidth and reliability and decrease the power consumption of end devices
- Novel networking subsystems that adapt themselves taking into account the type of information being transported, the needs of the applications and the operating environment
- New networking architectures such as peer to peer systems that will be able to cope with significant increases in the volume and types of data that will be generated, stored and accessed from the edges of the network
- Techniques for better utilization and management of the existing networking infrastructure.

This gives rise to a myriad of fundamental research challenges. This has been recognized around the world, and several significant initiatives including the NSF Future Internet Design (FIND) and European Union Future Internet have been launched. The objective of the networked system research theme strategic plan is to identify sub areas in the networked systems research landscape in which NICTA has

the opportunity to become one of the top 10 research groups by 2018 by building on its current capabilities.

3. Capability within NICTA

NICTA currently has internationally recognized capability in four areas of networked systems

1. Physical layer wireless communications techniques
2. Network monitoring at the optical physical layer
3. Higher layer protocols for handling mobility and dynamic network reconfiguration
4. Techniques for information distribution, storage and search

1. NICTA has a strong capability in wireless physical layer design and implementation including RF chip design and baseband signal processing techniques. The RF chip research is part of our Embedded Systems theme. The wireless signal processing capability is spread over both the Networked Systems and Embedded Systems themes. However, the major new project undertaken in this area, BANESH led by Leif Hanlen, is squarely focused on embedded applications and will move to the Embedded Systems theme. The remaining signal processing effort is in the Interferex project. The theoretical research in this project is all but complete and has yielded breakthrough algorithms that deliver substantial improvements in wireless network coverage and capacity. The focus of this work is now on implementation and speeding towards commercialisation.

2. NICTA's optical physical layer capability is in monitoring the health and performance of optical networks. This capability was extended by the work on the Monitoring and Measurement of the Internet (MAMI) project. Research to date has made breakthrough advances in measuring multiple impairments through a single measurement. This technology underpins the products of NICTA spin-out company Monitoring Division Inc. The lead researchers include Nirmalathas Ampaluanapillay, Peter Farrell and the founder of Monitoring Division Inc, Trevor Anderson. NICTA's group is among the world's top 5 groups, which includes Teralink, the University of Southern California and Aegis.

3. NICTA researchers were part of the group which proposed the handling of mobility at higher layers of the communication protocol stack. This capability is being extended through work in a joint project with Ericsson Research, the Context Aware Mobility Project (CAMP). The senior researchers are Max Ott and Aruna Seneviratne. There are also a number of young researchers, including Lavy Libman and Sebastien Ardon, who are very well regarded internationally. This group is highly regarded and is among the top 10 groups in the world along with INRIA, MIT, UC Berkeley, Dartmouth and industrial research labs at Microsoft, Nokia and Thomson.

NICTA also has a significant capability in the development and implementation of communication protocols. This capability has been developed through the SAFE networking, STaRComm, and National Security Science and Technology (NSST)

project on Mesh Networks as well as the activities associated with spin out company 7iP. The research leaders and project leaders in this area include Jaga Indulska, Roksana Boreli, Marius Portman, Bjorn Landfeldt and Zainib Zaidi. This work has resulted in the development of a new higher layer mobility management scheme, and the use of context information for system configuration. This capability by its very nature is applied and is difficult to compare. We however believe that NICTA can build on this capability by combining with expertise from the managing complexity theme to create a world class capability by 2018.

4. Information distribution, storage and search capability is in three areas. In the area of storage and search outstanding expertise in the storage of XML documents is being extended in the Universal Storage Systems project. In the case of distribution, expertise is being extended through a range of theme based research at the ATP and through the peer to peer networking activities at ATP, QRL and VRL.

Major achievements include the development of an XML representation that optimizes the size and processing requirements for data storage, and a decentralised network engine for virtual worlds that was licensed to VastPark. The lead researchers are Raymond Wong, Santosh Kulkarni, and Max Ott. The NICTA group working on information storage and search is among the top 5 groups worldwide, which includes groups from University of Washington - Seattle, University of Waterloo, and IBM Research Aylmerton. Similarly, the group working on content distribution is among the top 10 groups which include Helsinki Institute for Information Technology, UC Berkeley, the University of Colorado and Eurecom. The peer to peer work is gaining national and international recognition. Moreover there is significant capability in this area within VRL, namely with Rao Kotagiri, Aaron Harwood, and Egemen Tanin. We believe that combining the peer-to-peer expertise across NICTA will create a world class capability by 2018.

4. NICTA Positioning and Competitive Advantage

NICTA's expertise in the above areas is uniquely placed. The projects either have extremely good customer engagement or/and very good commercialisation potential.

The SAFE Communications and STaR Communications, BANESH and CAMP projects have very strong customer engagement. The Universal Storage Systems and Peer to Peer projects have strong commercialisation opportunities. The optical monitoring research and the higher layer protocol work have resulted in two start-up companies: Monitoring Division Inc., and 7iP.

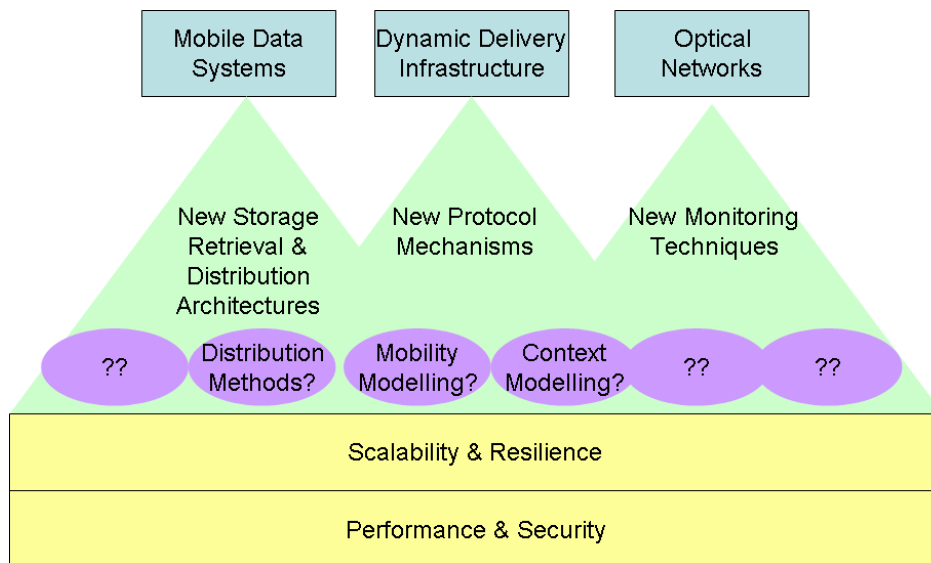
The researchers also have a good combination of research and commercialisation experience. The lead researchers, Nirmalathas Ampaluanapillay, Raymond Wong, Max Ott, Aruna Seneviratne and Jaga Indulska are internationally recognised for their research work. Max Ott is the co founder of Semandex, Raymond Wong was the founder of Greenpea Pty Ltd, Aruna Seneviratne was the co-founder of e-Move AB and Roksana Boreli is the founder of NICTA spinout company 7iP. This combination of commercial and research experience is unique and is recognised as one of the major competitive advantages.

5. Strategies for Achieving

Given NICTA's expertise, the focus of the wireless physical layer research activities and the input from the Business Areas Strategic Plans, NICTA Networked Systems researchers have the potential to make a significant impact in both scientific contributions as well as commercially by concentrating their activities into three target areas:

- Storage, Retrieval & Distribution Architectures for mobile data systems: Technologies that enable exploitation of the power of portable computing devices as well as the scale to handle the increased amount of traffic from an increasing number of interconnected devices;
- Protocol Mechanisms for supporting dynamic delivery infrastructure: Technologies that enable the efficient operation of mobile end devices operating in dynamic environments by exploiting the power of end devices and the availability of diversity networking possibilities; and
- Monitoring and Management techniques for optical networks: Technologies that enable the efficient operation of backbone networks to enable them to deal with the increased traffic that needs to be transported

Research impact will be obtained by developing the theoretical basis for design and developing particular aspects of the three areas as shown in the figure below. The specific aspects will be elaborated through individual research project strategic plans and should build on NICTA's current capabilities. As indicated in the figure, scalability, resilience, performance and security will be taken into consideration in all cases.



Through the resulting set of focused research activities, our aim is to have made a significant contribution

- To the next generation mobile content storage, retrieval and distribution architecture for supporting new mobile social networking applications
- To providing communication mechanisms that will enable the deployment of networks that support traffic management and emergency situation management systems
- The management and maintenance of high speed optical networking infrastructure

Through its networked systems activities NICTA aims to have significant spin out companies and licensing agreements by 2018, and to be recognised internationally for our research contributions.

This will be achieved by addressing the following by 2009:

5.1 People

For each of the areas determine the skill set needed (theoreticians, experimental scientist, and engineers), and where appropriate develop a plan for attracting outstanding staff to new appointments.

Develop a succession plan with HR to deal with the loss of key personnel to the commercialisation activities

5.2 Education

- Increase the number of PhD students who are fully engaged by
 - Developing a plan for teaching courses at the Universities
 - Offering more interesting honours and masters projects
 - Making the work environment dynamic, exciting, purposeful and fun

5.3 Strategic Linkages

Establish a small number of linkages including the European Union Future Internet and NSF Future Internet Design initiatives and others to be determined by identifying the top 3 groups that are working in each of the target areas.

Complement the above by developing a targeted visiting researcher program, where NICTA will become hosts of visitors through programs such as the Fulbright and Marie Curie Fellowships, and additionally by becoming strategic partners in selected Erasmus Mondus 2 programs.

5.4 Publications Strategy

For each of the areas, identify the three top journals, conferences and workshops. The choice needs to take into account the CORE rankings, acceptance rates, and impact ratings. Once these are identified, devise a plan to get publications accepted consistently in these venues.

In addition, attract a Tier 1 conference in each of the areas to Australia.

5.5 Continual benchmarking

Have an annual informal review where progress is assessed by comparing outputs/outcomes of the identified top 3 competing groups.

6. Risks

Still being developed.