The SkyNet: Harnessing the Power of the Community for Radio Astronomy Research

Andrew Buttsworth[1], Rhys Newman[2], Pete Wheeler[3]

[1]Curtin University, Perth, Australia, a.buttsworth@curtin.edu.au

[2] eMediaTrack Ltd/Oxford University rhys.newman@physics.ox.ac.uk

[3]The International Centre for Radio Astronomy Research, Perth, Australia, pete.wheeler@icrar.org

INTRODUCTION

The International Centre for Radio Astonomy Research (ICRAR) is a joint venture between Curtin University and The University of Western Australia (UWA). ICRAR initiated theSkyNet project to engage the community and raise awareness of radio astronomy. The initial proposal was inspired by the many citizen science projects that have gained from making science accessible to the broader community; this community engagement enabled these projects to have access to resources which would have been impossible to fund by normal means. In many cases these donated resources have been critical to the viability of the research project. Examples of this can be seen in the success of SETI@home, in which the australian public were the highest contributors per head of population. These types of distributed computing projects allow users to contribute the idle cycles from their computers to conduct analysis of a discrete "work unit" of data. This allows thousands of users to contribute directly in groundbreaking research.

By dramatically increasing public engagement in the field of radio astronomy research, theSkyNet plans to design and deliver an Australian based outreach initiative that delivers significant research outcomes, and attracts the attention and participation of the rest of the world. In the long term, theSkyNet project also hopes to promote and contribute to the scientific outcomes of the Square Kilometre Array (SKA) project in some way.

theSkyNet ENVIRONMENT

The backend component of theSkyNet is bassed on Nereus-V; which is a an open-source pure Java™ desktop cloud distributed computing technology. Curtin University have completed the setup of the infrastructure, and commenced a rollout of the client onto a large subset of their desktop computers; with a target of around 2500 student lab computers, plus staff computers. Figure 1 shows how the system is setup across the internal Curtin network; taking advantage of the high-speed campus network and Curtin's enterprise private cloud infrastructure. It also shows how the Nereus clients around the world link to the Nereus servers to process the data "work units", with all code being restricted to the Java security sandbox. The nereus servers forward information on what is being processed by clients to the theSkyNet application management server, which in turn then publishhes this information to theSkyNet web portal in the form of statisitics and leaderboards. This engourages particpants to become part of theSkyNet community, and allows them to be involved and engaged in the outcome of their contributions.
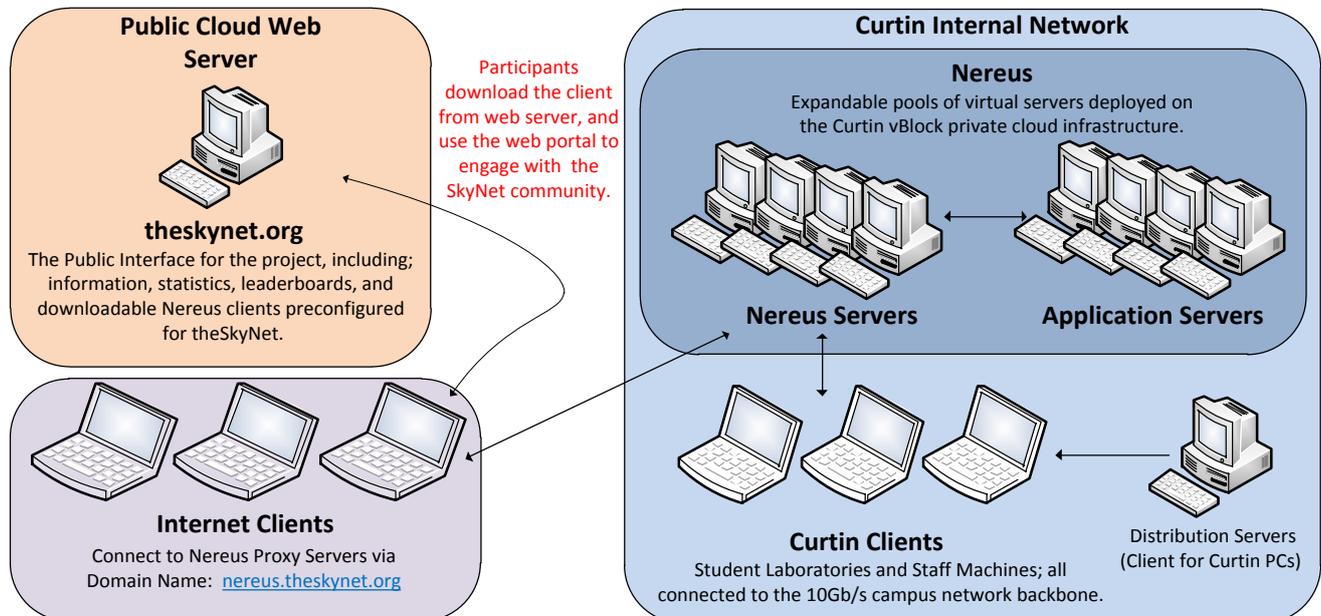

Figure 1: System Architecture

A number of potential issues were identified during the plannig phase, and mitigation stratagies developed. Scalability was of primary concern, because the system had to be designed for an unknown and expanding number of clients. Potential clients include over 5000 computers at Curtin, as well as substantial participation from UWA. The system would also need to cope with a variety of clients participating from around the world (universities, schools, and

general public). With potential for the project to be listed on significant citizen science sites such as www.zooniverse.org, international uptake could be significant. It was for these reasons that the use of Curtin's private cloud "virtual server" infrastrucutre was such a good fit. It allows for both the application and proxy servers to templated, and deployment to be potentially automated depending on system load; therefore as the client base increases more servers can be seamlesly brought on line. The system is also easily migrated or expanded onto commodity public cloud infrastructure. This combination offers an almost limitless ability for increasing capacity.

Other potential issues include optimisation of the data transfer/processing given the network bandwidth capacity, and client/donor system stability. These would be explored further during the presentation.

COMMUNITY ENGAGEMENT AND THE USER EXPERIENCE

One of the biggest challenges will be getting that first large wave of uptake. This will be achieved through a large launch event in mid September where we hope for good media coverage locally, nationally and internationally. One of the drivers of this will be the name 'theSkyNet', the links to pop culture (The Terminator movies) will help with news of the launch going viral. Once we have sufficient numbers signing up to particpate we hope to reach a tipping point, beyond which the community will be self-sustaining, in that existing users will encourage the uptake of others.

Users visiting the site for the first time will be able to allow their machines to contribute by just having the website active in a browser. As such the user experience has to be engaging, failing to succeed in this aspect will result in users visiting, looking and leaving without coming back. Once comfortable with the site we hope users will download an applet which will work in the background thus avoiding the need for users to come specifically to the site to particpate.

To achieve an engaging experience:

- The website will act as a communal hub for those participating in theSkyNet initiative and interested in the development of big science projects like the SKA.
- Digital achievements will be awarded as individuals and alliances contribute to the project. These achievements will feature on theSkyNet website in a news stream and via the social networking news feeds of users (like facebook and twiter) where permitted.
- Users will be incentivised to form 'alliances' in order to process more and therefore improve league table rankings, and the rate of their rewards.

RESEARCH OUTCOMES

The data currently being proccessed has come from the HI Parkes All Sky Survey (HIPASS) carried out by the Australia Telescope National Facility's Parkes telescope. This survey covers the whole southern sky as well as northern declinations up to +25 degrees. It is being used, with a pure Java version of the DuChamp source finder, automatically compiled from C/C++/Fortran source code using the Proteus system developed at eMediaTrack.

This is important as it shows the software can produce reliable and scientifically credible results, and still execute "native code" entirely within the Java sandbox and at 85% of the original native code speed. More data for processing will be identified along with potential research projects as we build towards the launch and get the project up and running, with the hope that data coming from radio telescopes such as the Australian Square Kilometre Array Pathfinder (ASKAP) and the Murchison Widefield Array (MWA) can eventually be processed by theSkyNet as these instruments come online.

FUTURE WORK

Between now and the public launch of the site, a select group of BETA testers will be enlisted to try out the experience and feedback on what they liked or didn't like. Using this information we will refine the site, so that at time of launch we engage and maintain our initial wave of users. In parallel with the refining of the web portal, the Nereus system is currently being tested, expanded, and benchmarked, using data from the Parkes radio telescope in a source finding capacity. We hope to have over 2000 clients online for the testing phase. If we can achieve a client base of approximately 10,000 workstations in the higher education sector around Perth, we would have a distributed compute network capable of approximately 100 TFLOPS. Discussions are also currently underway to secure other data sources and research projects that theSkyNet can be used for, and it is hoped that by the launch date of the site we are processing data from the ASKAP and/or the MWA.

The official launch of theSkyNet will be in mid-September, and will be conducted by John Day the WA Minister for Science and Innovation, accompanied by other VIP guests. This has the potential to have a significant impact on the Australia/New Zealand bid to host the SKA. We will discuss these future developments during the presentation.

REFERENCES

1. SKA Cloud Computing Report: http://www.skatelescope.org/uploaded/8762_134_Memo_Newman.pdf

ABOUT THE AUTHOR(S)

Andrew Buttsworth

Andrew Buttsworth graduated from Curtin University with a BSc in Applied Science and a GradDip in Computing, before starting work in the Australian higher education IT sector in 1996. After working at the University of Western Australia for 4 years, Andrew started work at Curtin University in 2000 for the Faculty of Science & Engineering, as an IT systems administrator. He is currently working as the Team Leader for Curtin IT Service's eResearch Support team, with a focus on enabling researchers to enhance their research outcomes through the use of ICT.

Rhys Newman

Rhys Newman obtained a BSc(Hons) and MSc in Applied Mathematics from the University of Western Australia, before winning several scholarships to study at Oxford University in Computer Vision. Completing his DPhil in 1998, Dr Newman since worked in internet startups and city finance houses but in 2004 returned to Oxford (Physics) to develop desktop cloud computing technology. In 2010 he became CTO of a spin-out company "eMediaTrack" which aims to commercialise the award winning NereusV desktop cloud and JPC emulation technologies. Dr Newman maintains an active research profile including building the backend systems at the heart of the "theSkyNet" outreach project.

Pete Wheeler

After graduating from Leeds University in 2001 with a BSc in Physics Pete Wheeler worked in London as a Test Engineer for a company called Electron Tubes. In late 2002 Pete immigrated to Western Australia and began working for Scitech, Perth's Science Discovery Centre, as an Outreach Presenter honing his skills as an effective science communicator. After a series of roles involving the development of education resources for WA teachers, managing Perth's first Planetarium and coordinating state wide education and outreach initiatives, Pete now calls himself a Science Communicator, a job type that's becoming more and more recognised by science based organisations seeking to engage the outside world. As such Pete now performs the role of Outreach and Education Manager for the International Centre for Radio Astronomy Research (ICRAR), a joint venture of Curtin University and The University of Western Australia.