Radio Astronomy and eVLBI using KAREN

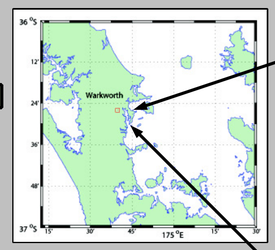
S.D.Weston*, T. Natusch and S. Gulyaev
Institute for Radio Astronomy and Space Research
AUT University

*stuart.weston@aut.ac.nz

Abstract

Kiwi Advanced Research and Education Network (KAREN) has been used to transfer large volumes of radio astronomical data from the AUT Radio Astronomical Observatory at Warkworth, New Zealand.

Here we report on the current status of connectivity with the international organisations we are collaborating and conducting observations with and on the results of testing different data transfer protocols. We investigate new UDP protocols such as "tsunami" and UDT and show that the UDT protocol is a more efficient one. We report on our initial steps towards real-time Very Long Baseline Interferometry (eVLBI) and the attempt to directly stream data from the radio telescope receiving system to the correlation centre without intermediate buffering/recording.



Warkworth 12m Patriot Dish

Warkworth 30m Dish ex Telecom

Background

With the connection of KAREN to the AUT Radio Telescope we wish to optimize the use of KAREN for transferring large volumes of observational data to our partners in Australia, the United States and Europe and for conducting eVLBI.

Our research and collaboration can be conditionally broken into three major areas:

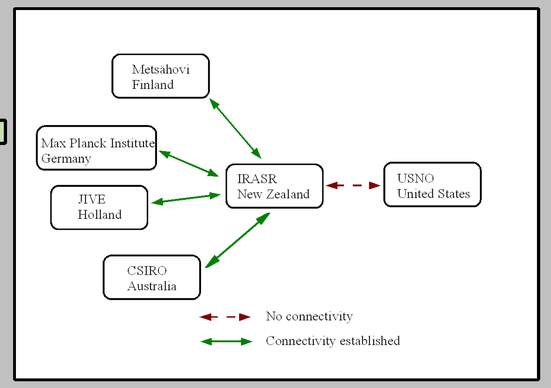
1. Observation and navigation of inter-planetary missions and spacecraft
2. International VLBI Service (IVS) for Geodesy and Astrometry
3. Astrophysical VLBI observations with the Australian Long Baseline Array of extragalatic and galactic radio sources

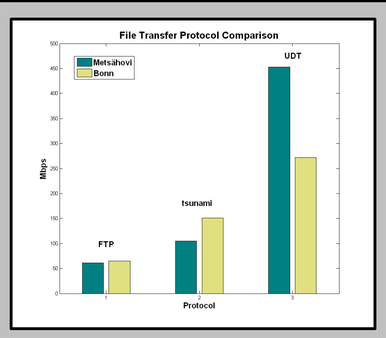
Point to point with no hops FTP is efficient, but as the number of hops in the route and the incidence of lost packets and collisions increase, the TCP congestion avoidance algorithm becomes a severe limitation to the throughput that can be achieved.

We have compared the use of FTP over TCP/IP for sending these files to Australia, as well as new file transfer mechanisms which are being used by our partners such as tsunami [1] and UDT [2] (UDP-based Data Transfer) via the network protocol UDP.

[1] J. Wagner *Tsunami UDP Protocol* [Online]. http://tsunami-udp.sourceforge.net/ (2010, Sep. 23)

[2] *UDT UDP-based Data Transfer* [Online]. Available: http://udt.sourceforge.net/index.html (2010, Sep. 23)





Results

Over June and July 2010 tests were conducted transferring actual VLBI file (16 bit) produced by the AUT Radio Telescope during our VLBI observations:

Route	Protocol	Bytes	Time (s)	Throughput (Mbps)
AUT – Bonn	Ftp	65G	8016	65
AUT – Bonn	Tsunami	65G	3466	151
AUT – Bonn	UDT	65G	1920	273

Route	Protocol	Bytes	Time (s)	Throughput (Mbps)
AUT – Metsähovi	Ftp	3.1G	7458	61
AUT - Metsähovi	Tsunami	65G	4979	105
AUT - Metsähov	UDT	65G	1157	453

Please see the histogram bottom centre of this poster to see a comparison of these results.

Another set of experiments was conducted in September 2010 aiming to test the tsunami protocol for streaming VLBI data directly from the radio telescope receiving system via KAREN to Metsähovi. This test is an important step towards real-time eVLBI. When streaming data from Warkworth to Metsähovi many thousands of lost packets occurred and a sustainable rate of 350 Mbps was achieved. This is significantly lower than the rate of 512Mbps required for the real-time eVLBI streaming of 8bit data to Metsähovi.

Conclusion

It was clearly demonstrated that the use of the UDT protocol for radio astronomical data transfer has a number of advantages compared to the protocols currently used for VLBI and eVLBI. In particular, UDT has some advantages over tsunami:

- UDT is a better citizen on the network leaving bandwidth for TCP and other UDP protocols, which is very important on a shared network such as KAREN.
- UDT has an application programming interface (API) allowing easy integration with existing or future applications.

We have found KAREN to be a very useful tool for transmitting data to our international partners, and our Institute will be extending its use over the coming months. The next challenge will be to establish the IVS regular observational sessions and transmit the even larger volumes of data to the correlation centres, such as Bonn and USNO.

Of future benefit to our work to stream data real-time to the correlation centres would be the ability to reserve bandwidth as a logical pipe within the KAREN bandwidth for the duration of an experiment.

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