Real-time e-transfer and recording of IVS R1/R4 observations

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Auckland University of Technology

The Objectives

IVS Rapid Sessions (R1) : The aim is timely distribution of post-correlation analysis results, e.g. the group delay

To shorten the time-to-product: first steps were undertaken to make a real-time copy of the 12m Warkworth (New Zealand) dish's data in real-time to Bonn (Germany)

NOTE: This recording mode is in direct contrast to e-VLBI, where, if something goes awry with the real-time transfer, science data is immediately lost. In this mode the recorded science data can always be re-transferred at a later time.

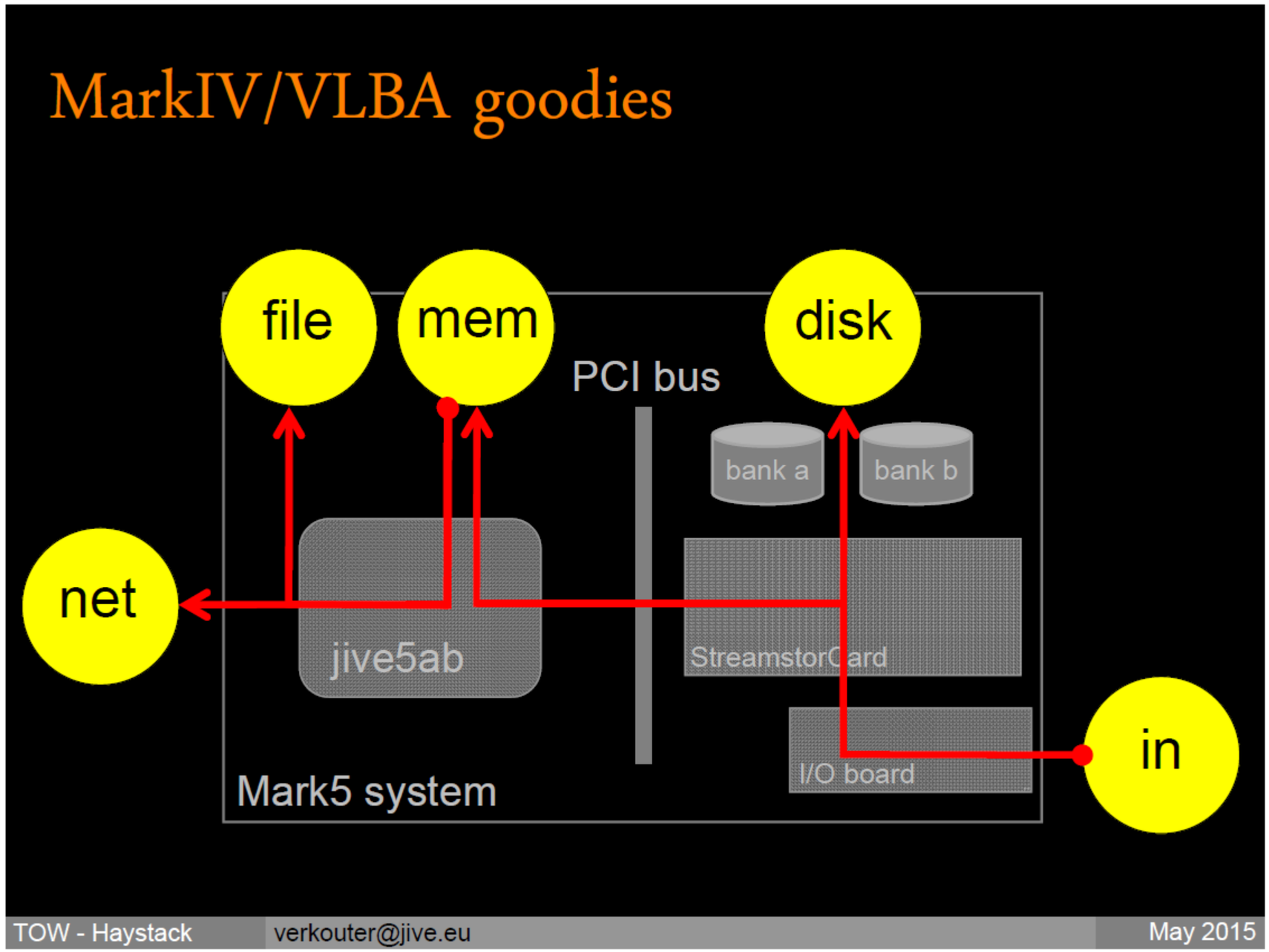
Modify an R1's observing schedule : to insert commands to set-up and tear-down the real-time transfer at both ends

This is made possible by software created at JIVE. The 'jive5ab' software, produced under the succesful EXPReS and NEXPReS projects

The Experiment

On August 24th/25th R1709 was observed in this mode at 256 Mbps data rate. The recorded data was transferred separately after the observation, to be able to compare the real-time data with the recorded data.

The Tool & The Glue : **jive5ab**



Modify FS prc and snp after drudg

snp file

```
scan_name=316-1830b,r4713,Ww,60,60
source=1144-379,114701.37,-381211.0,2000.0,neutral
ready_disk
setupsx
!2015.316.18:29:50
preob
!2015.316.18:30:00
disk_pos
disk_record=on
disk_record
data_valid=on
midob
!2015.316.18:31:00
data_valid=off
disk_record=off
disk_pos
postob
```

prc file

```
scan_name=316-1830b,r4713,Ww,60,60
source=1144-379,114701.37,-381211.0,2000.0,neutral
ready_disk
setupsx
etsetup
!2015.316.18:29:50
sy=mk5command 198.116.24.178 46226 "net2file=close;"
sy=mk5command 198.116.24.178 46226
    "net2file=open:/rmt_dir/r4713_Ww_316-1830b.m5a,w"
etstart
preob
!2015.316.18:30:00
disk_pos
disk_record=on
disk_record
data_valid=on
midob
!2015.316.18:31:00
data_valid=off
disk_record=off
etstop
disk_pos
postob
```

Modify FS prc and snp after drudg

prc file:

```
define  etsetup         15309182511x
"Setup SEND jive5ab
sy=mk5command 156.62.231.188 2620 "runtime=thread02;net_protocol=udp:32000000:2000000;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;mtu=1450;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;net_port=46226;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;ipd=50;"
"Setup RECIEVE jive5ab
sy=mk5command 198.116.24.178  46226 "net_protocol=udp:32000000:2000000"
sy=mk5command 198.116.24.178  46226 "net_port=46226"
sy=mk5command 198.116.24.178  46226 "mtu=1450"
enddef

define  etstart         15309183313x
sy=mk5command 156.62.231.188 2620 "runtime=thread02;mem2net=disconnect;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;mem2net=connect:198.116.24.178;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;mem2net=on;"
sy=mk5command 198.116.24.178  46226 "evlbi?;"@!,20S
enddef

define  etstop          15309183423x
sy=mk5command 198.116.24.178  46226 "evlbi?;"
sy=mk5command 156.62.231.188 2620 "runtime=thread02;mem2net=stop;"
sy=mk5command 198.116.24.178  46226 "evlbi?;"@
enddef
```

Data Rates and Protocol

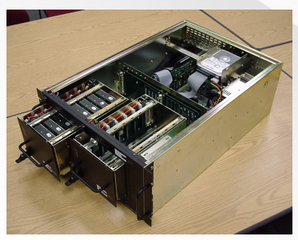
Data Rates and Protocol

- IVS R1: Either 256Mbps or 512Mbps
- IVS R4: 256Mbps

At those data rates we can use UDT and make sure all data is delivered !

Don't need to stream with UDP

Mk5 : **jive5ab -b -m3**
Data Store : **jive5ab -m3 -p xxxx**



Advanced Research & Education Network

net

in

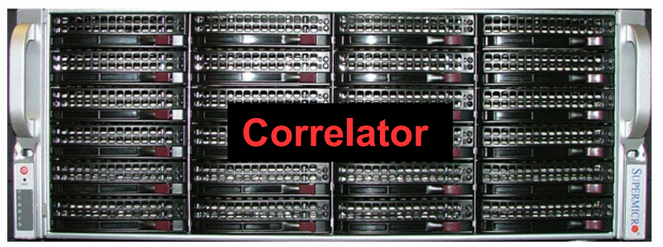
disk

net

file

Data Store

Correlator



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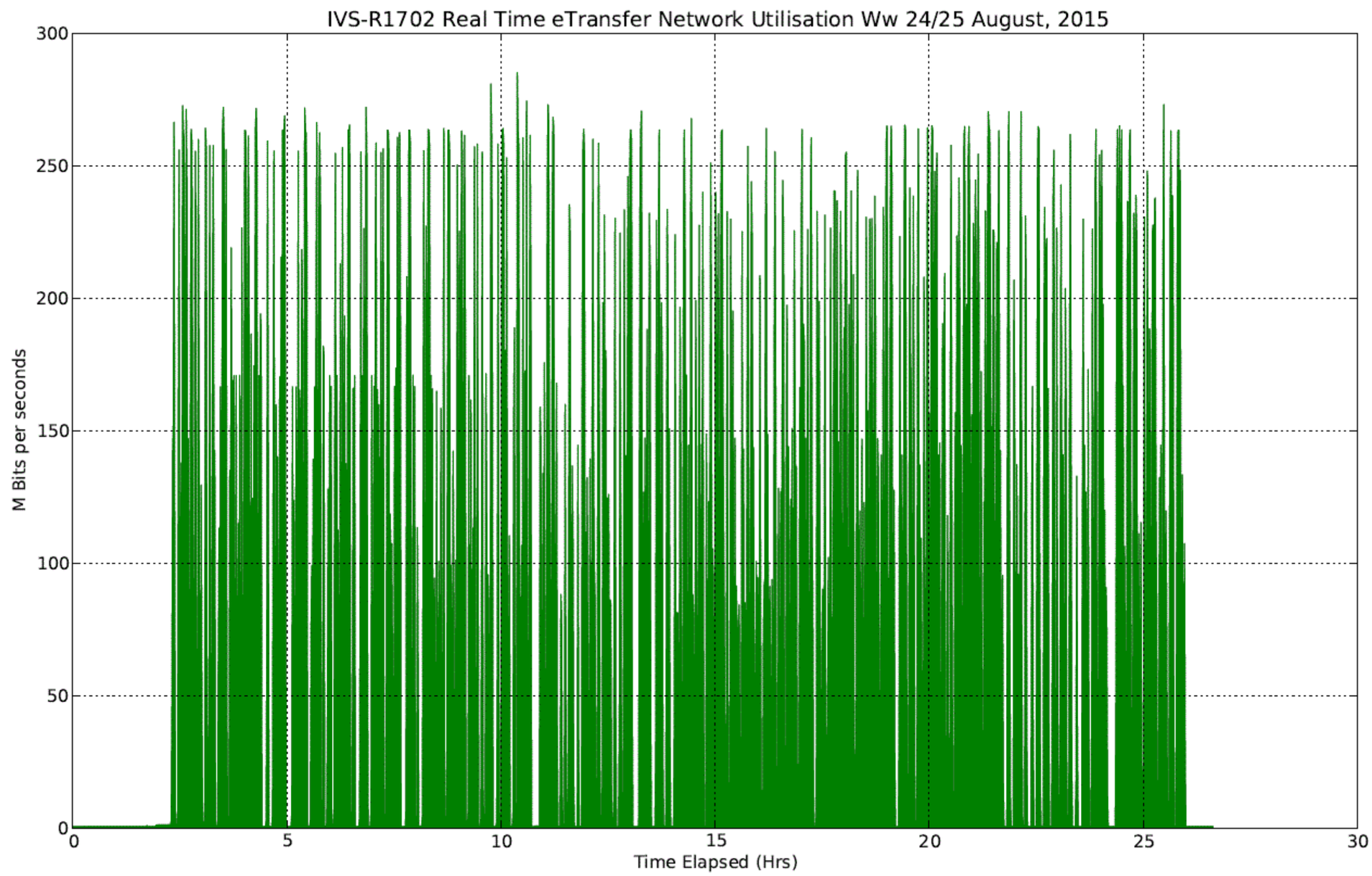
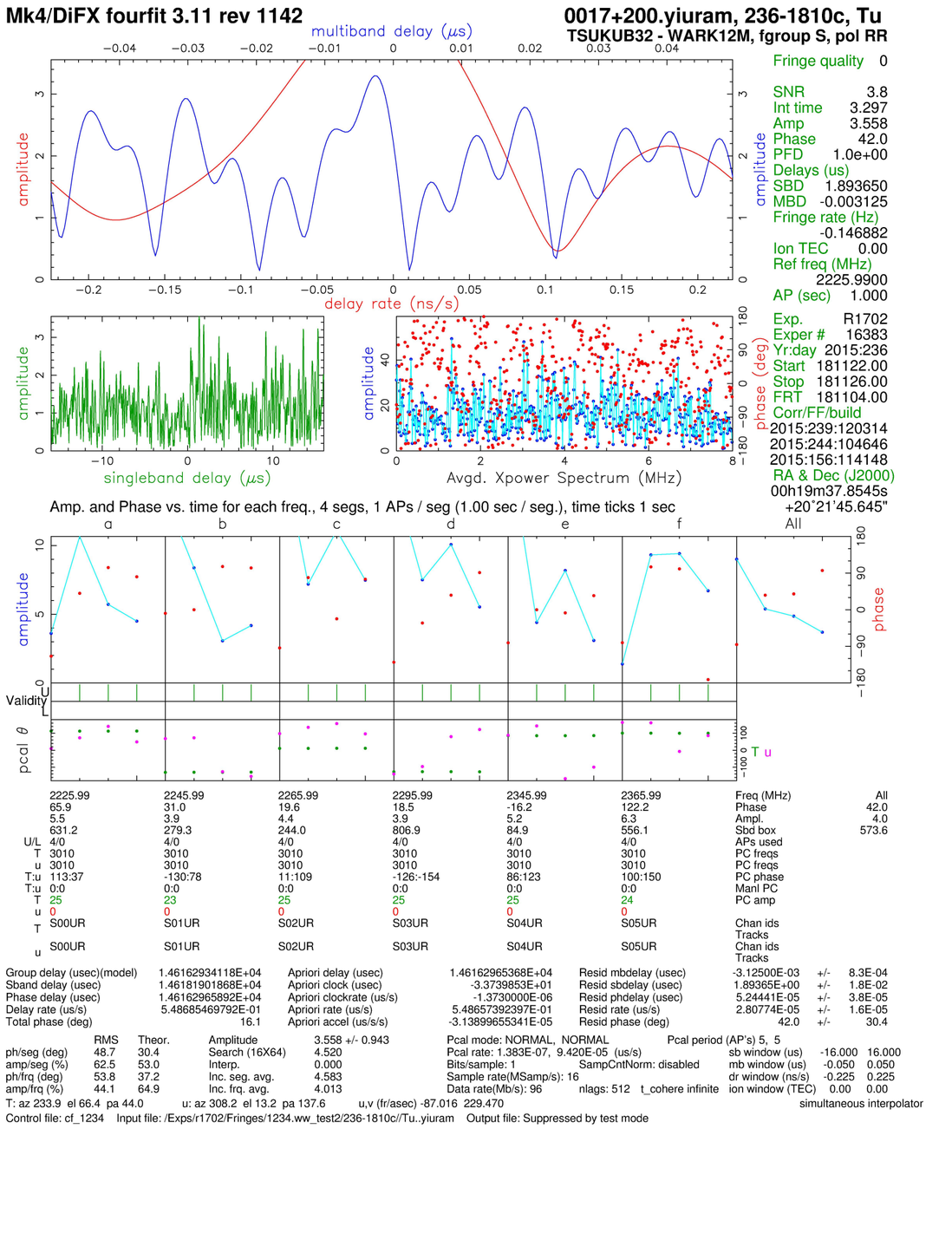
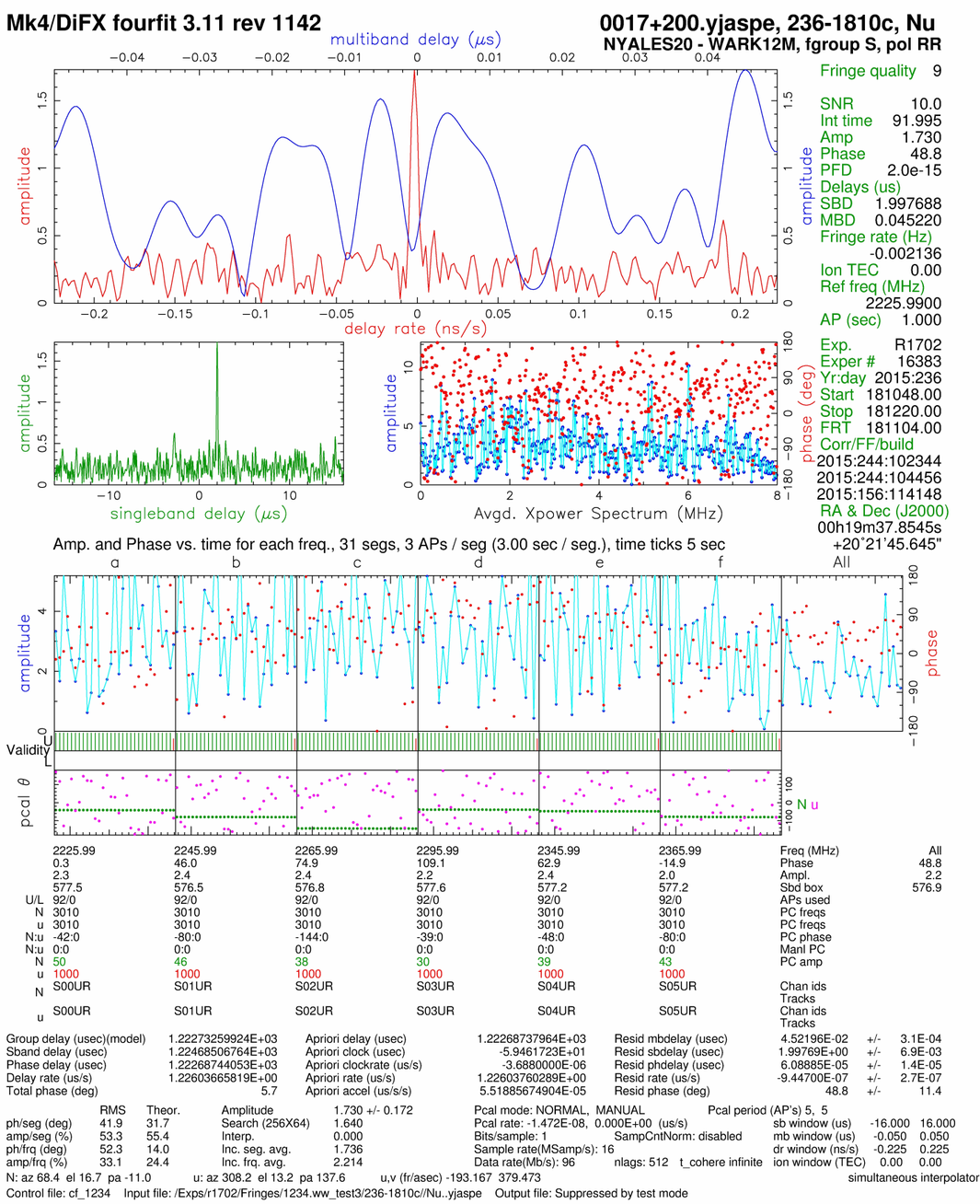

IVS-R1702 Real Time eTransfer Network Utilisation Ww 24/25 August, 2015
M Bits per seconds
300
250
200
150
100
50
0
0
5
10
15
20
25
30
Time Elapsed (Hrs)

R1702 2015.236



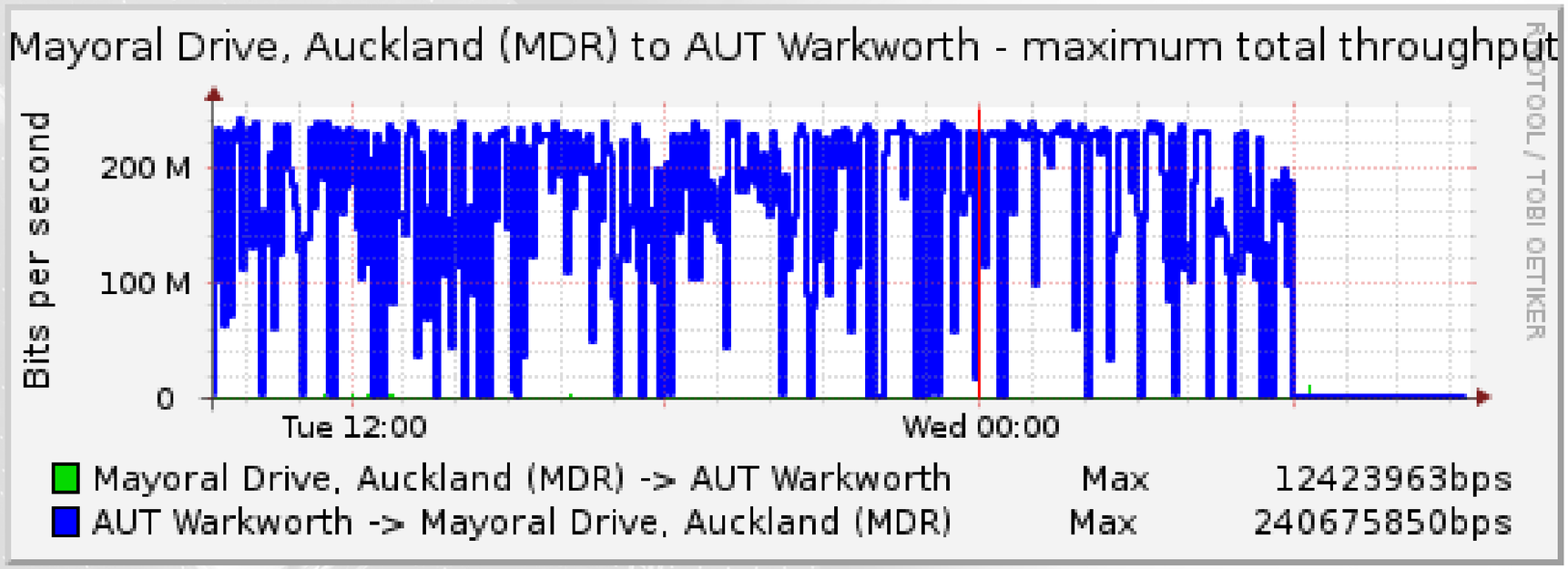


The Experiment

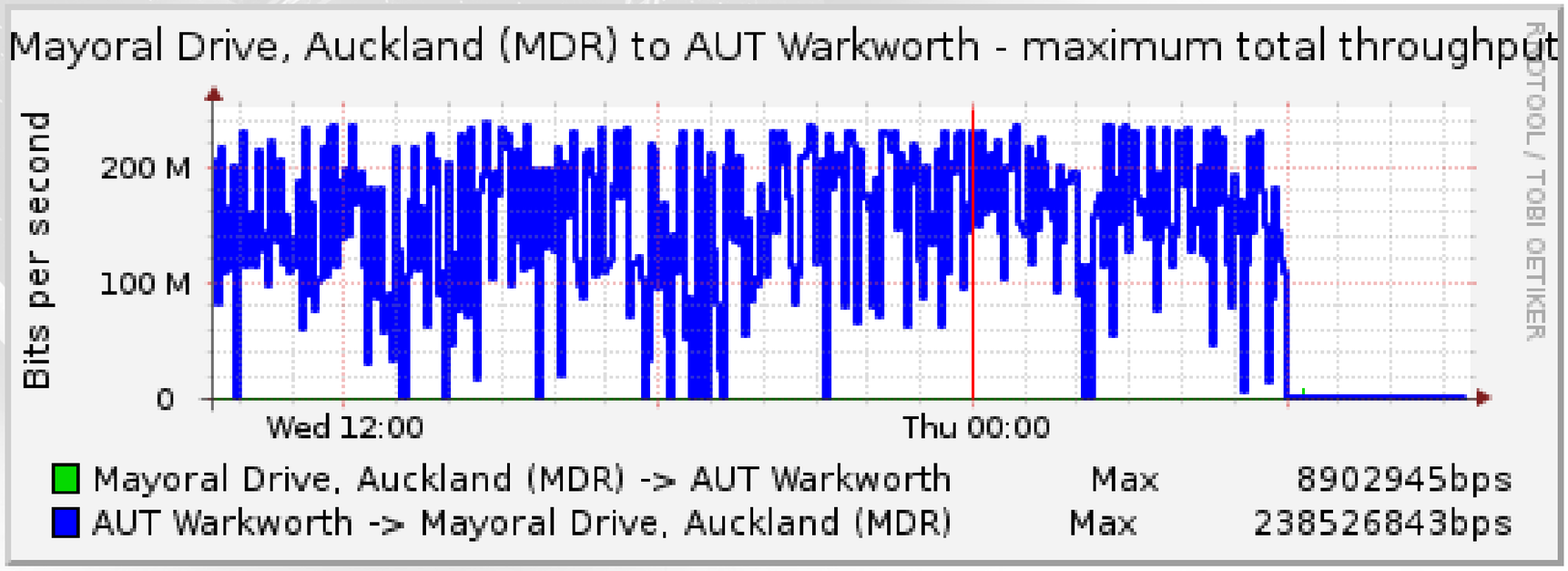
The 'fourfit' program was run on correlations with both data sets and found the same group delay of 120ps.

More Recent Tests

R1712



R1713



Compare “evlbi?” between WACO & Bonn

R4712: Wark12m - > WACO

```
2015-11-06 17:09:51.52: Reply: !evlbi? 0 : total : 2031963 : loss : 57 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-06 17:14:37.33: Reply: !evlbi? 0 : total : 2051877 : loss : 23 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-06 17:18:33.32: Reply: !evlbi? 0 : total : 2091643 : loss : 17 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-06 17:20:34.36: Reply: !evlbi? 0 : total : 1172900 : loss : 20 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-06 17:26:43.40: Reply: !evlbi? 0 : total : 5187169 : loss : 91 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-06 17:30:08.35: Reply: !evlbi? 0 : total : 1723880 : loss : 0 ( 0.00%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
```

- Packet Loss minimal to WACO, udp and udt
- Can jumbo frames to WACO

R1713: Wark12m - > Bonn

```
2015-11-10 16:44:00.61: Reply: !evlbi? 0 : total : 846256 : loss : 5744 ( 0.67%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-10 16:46:40.76: Reply: !evlbi? 0 : total : 841422 : loss : 11998 ( 1.41%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-10 16:51:51.59: Reply: !evlbi? 0 : total : 3176970 : loss : 8090 ( 0.25%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-10 16:53:26.62: Reply: !evlbi? 0 : total : 851886 : loss : 1534 ( 0.18%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-10 16:55:29.54: Reply: !evlbi? 0 : total : 739486 : loss : 1754 ( 0.24%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
2015-11-10 16:58:28.50: Reply: !evlbi? 0 : total : 1504359 : loss : 7941 ( 0.53%) : out-of-order : 0 ( 0.00%) : extent : 0seqnr/pkt ;
```

- Packet Loss even with udt to Bonn ?
- Packet Loss 3-5% with udp to Bonn
- Can't jumbo frames to Bonn highest mtu=1490

Issues & Feature's

DiFX

Jumps 2 mins if bad frames, we might then only get a few sec's and a fringe quality of 0

Well an IVS scan can be < 2 mins, anywhere from 1 – 7 mins

Directory2filelist:

```
/data3/r1/warkworth/r1713/r1713_ww_314-1510.m5a 57336.632234 57336.634583
Warning: found corrupt data frames in file /data3/r1/warkworth/r1713/r1713_ww_314-1516.m5a
/data3/r1/warkworth/r1713/r1713_ww_314-1516.m5a 57336.636389 57336.638314
/data3/r1/warkworth/r1713/r1713_ww_314-1521.m5a 57336.639803 57336.640881
/data3/r1/warkworth/r1713/r1713_ww_314-1528a.m5a 57336.644502 57336.644928
/data3/r1/warkworth/r1713/r1713_ww_314-1530.m5a 57336.646458 57336.646875
/data3/r1/warkworth/r1713/r1713_ww_314-1533.m5a 57336.648113 57336.648542
```

No problems reported during decoding - other than that the first frame is found at an offset of 0x8a0 (=2208 bytes).

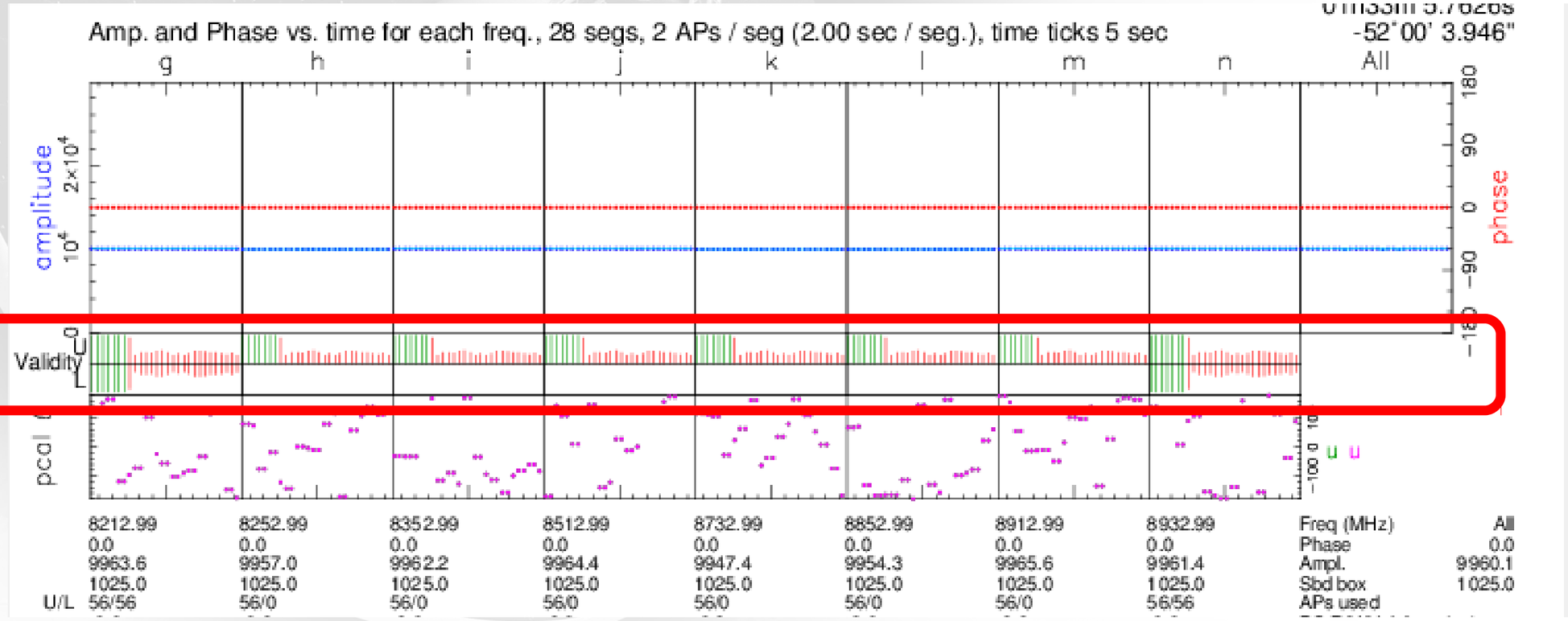
m5spec – auto correlates fine

Issues & Feature's

R1712

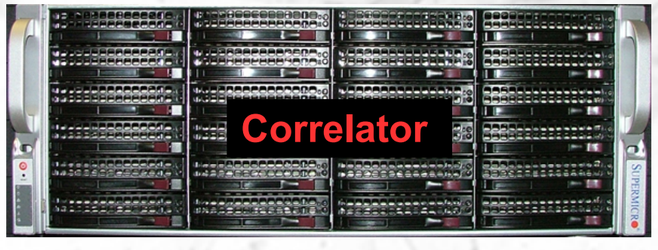
30 – 70% data loss and corrupted data

This is a 512 Mbps data rate session



Thank You

Advanced
Research
&
Education
Network



Analyst

The International VLBI Service (IVS) conducts bi-weekly global geodetic VLBI observations (simultaneous S and X band) to measure the earth orientation parameters (EOPs). The recorded data of the Monday rapid sessions (R1) are uploaded to Bonn (*) for correlation after the observations have finished. The aim is timely distribution of post-correlation analysis results, e.g. the group delay.

In an attempt to shorten the time-to-product, first steps were undertaken to make a real-time copy of the 12m Warkworth (New Zealand) dish's data (see image), as it is being recorded on its Mark5 VLBI data recorder. The copy is transferred in real-time over high-speed international research and education networks (REANNZ of New Zealand and GEANT in Europe) onto servers in Bonn (Germany). This recording mode is in direct contrast to e-VLBI, where, if something goes awry with the real-time transfer, science data is immediately lost. In this mode the recorded science data can always be re-transferred at a later time.

To support this mode a program to modify an R1's observing schedule was written. It inserts commands to set-up and tear-down the real-time transfer at both ends (e.g. opening a file with the correct scan name in Bonn, configuring the network, starting to transmit when the recording starts etc). Once modified the schedule runs autonomously.

On August 24th/25th R1709 was observed in this mode at 256 Mbps data rate (see network throughput plot). The recorded data was transferred separately after the observation, to be able to compare the real-time data with the recorded data. The 'fourfit' program was run on correlations with both data sets and found the same group delay of 120ps, see the attached plots.

This special observing mode, where a copy of the data a Mark5 recorder can be siphoned off and transferred in parallel, is made possible by software created at JIVE. The 'jive5ab' software, produced under the succesful EXPReS and NEXPReS projects(**), exploits functionality offered by the MIT Haystack Mark5 VLBI recorder hardware. Having its roots in e-VLBI it implements several network protocols for real-time data transfer. In this case the UDT protocol was used: a reliable protocol over UDP/IPv4.