Resources to achieve 2 Gbps (AI: IRB-07)

P. de Vicente (TOG chair)

2 Gbps capabilities at EVN stations (10/4/2017)

Station	Recorded	Limitation	eVLBI	Limitation
Arecibo	512 Mbps	Backend	512 Mbps	Backend/Conn.
Badary	2 Gbps		512 Mbps	Backend/Conn.
Effelsberg	2 Gbps		2 Gbps	
HartRAO	2 Gbps		2 Gbps	
Irbene	2 Gbps		2 Gbps	
Jodrell	2 Gbps		2 Gbps	Proxy. Not tested
Kunming	2 Gbps		?	Backend/Conn
Medicina	2 Gbps		2 Gbps	
Metsähovi	2 Gbps		2 Gbps	More tests needed
Noto	2 Gbps		2 Gbps	
Onsala	2 Gbps		2 Gbps	
Robledo	2 Gbps		?	Connection
Sardinia	2 Gbps		?	Connection
Svetloe	2 Gbps		64 Mbps?	Never tested
T6 (Shanghai)	2 Gbps		1 Gbps	Backend
Tamna	1 Gbps	Backend	?	Backend
Torun	1 Gbps	Backend	1 Gbps	Backend
Ulsan	1 Gbps	Backend	?	Backend
Urumqi	2 Gbps	Not tested	1 Gbps?	Connection
Westerbork	1 Gbps	Backend	1 Gbps	Backend
Yebes	2 Gbps		2 Gbps	

Yonsei	1 Gbps	Backend	?	Backend
Zelenchukskaya	2 Gbps		512 Mbps	Backend/Conn.

2 Gbps rate for recorded experiments requires one of these backends:
- DBBC2 (4 CORES+4/3 IFS)
- CDAS
- DVP

and recorders:
- Mark5B+/Mark5C/Mark6/Flexbuff

Torun operates a DBBC2 with 2 COREs.
Westerbork operates a DBBC2 with 2 COREs but it has already acquired two more COREs + Fila10G. Not delivered yet.
KVN stations operate KDAS. It would be possible to use one polarization at 1 Gbps channelized and the other one at 2 Gbps unchannelized.

Notice that it is possible to do 2 Gbps with a DBBC2 (2 CORES) in PFB mode but the EVN does not use PFB for 2 Gbps, continuous calibration is not supported yet by the FS with this mode and the PFB mode requires a common LO at all stations.

DBBC2 Costs:
- Each additional CORE is: 5250 €
- Each IF: 2750 €
- One Fila10G: 6250 € + Transceiver (~ 400 €)

The minimum cost to upgrade to 2 Gbps using a DBBC2 is **10500** € by acquiring two COREs, but only using 2 IFs. Our recommendation for **Torun** is to acquire two COREs and one Fila10G. The total cost is 16750 € plus the cost of an XFP optical transceiver. The Fila10G will allow to do 2 Gbps eVLBI.

Having 4 COREs also benefits observations at 1 Gbps because the filter shape is much better in the 105E mode that supports 2 Gbps.

The cost to upgrade KVN stations is unknown. We will contact them.

eVLBI 2 Gbps rate requires:
- VDIF format: for the moment only two data acquisition equipment available at the EVN:
  - DBBC2 (4 CORES) + Fila10G

- - DVP from JPL
  - A proxy at each station to manage the data acquisition from the correlator
  - A high speed Internet connection > 2 Gbps

  - Stations missing 2 Gbps eVLBI capability and their backends:
    - Bd, Sv, Zc: CDAS R1002 (2 Gbps, VSI-H). No VDIF
    - Kt, Ky, Ku: KDAS (2 Gbps, VSI-H). No VDIF
    - T6, Sh, Ur: CDAS & DBBC2. VDIF
    - Km: CDAS, (VSI-H) No VDIF
    - Ro: DVP VDIF
    - Ar: VLBA. (512 Mbps)
  - Notes:
    - Some chinese stations already have CDAS2 (VDIF compatible)
    - Chinese stations are connected to Shanghai with links 1 Gbps
    - KVN stations should be able to yield 2 Gbps for eVLBI. The connectivity is available but the EVN has never tried 2 Gbps eVLBI with the KVN and the same problems present for recording at 2 GBps apply here.
    - There is a new backend for Kvazar: BRAS. It is VDIF compatible.

e-VLBI above 1 Gbps depends on the connectivity and the backends to be used. New backends are being developed at China and Russia, but we do not know if the modes will be fully compatible with the DDC modes provided by the DBBC2. The main driver for these developments is VGOS and it may happen that the new backends only yield either one full 500 MHz channel per polarization or PFB mode. It seems no DDC development is on the way neither for CDAS2 nor for BRAS.

The cost for upgrading the connection depends on the stations. The cost to implement backends CDAS2, BRAS and DVP, that can send directly VDIF data to the correlator is also unknown.

Disk space requirements

2 Gbps observations may require 200 TB per station per session, with the standard two-session supply being available, to avoid being the disk space the limiting factor for observations.

We have found that current Flexbuffs from On, Ef and Ys at the correlator do not cover a full two session, and would not even cover the single largest historical session (May/June'15: 105-122 TB for Ef,Wb,On,Mc) whole session. This is so for two reasons:
- By the time the disks were bought the best size/price ratio was for 4 TB disks.

- The implementation of a RAID like system decreased the size of the unit by 30%. This is not happening at the stations because they do not use RAID systems.

Flexbuffs at several stations already cover the 2 Gbps requirement per station. See the table below (from last TOG report as of May 2017).

Proposed solution:
- Based on EVN session 2017-1 we think stations may need one or two 32 TB disk packs to cover all experiments to be correlated at Bonn, even those at stations with Flexbuffs. See the TOG chair report discussion about experiments to be correlated at Bonn.

- In the mid term (within one or two years) we should try to upgrade disks at these 3 Flexbuffs (Ef, On, Ys) with 8 TB disks and we could recycle the 4 TB disks at those units to populate 32 TB disk packs. If three Flexbuffs are upgraded we would get 13 diskpacks 32 TB size to be injected into the EVN. The cost of the upgrade and the assignment of that cost should be decided by the CBD taking into account the investment currently done by stations. These three stations (Ef, On and Ys) already invested ~12 k€ per unit with a total size of 432 TB.

Investment from stations in years 2016 and 2017 according to the information provided to the TOG chair by the VLBI friends. *The information may not be complete*. Stations that have not invested in 2016-2017 are not in the table.

Station	Flexbuff investment 2016/2017	Disk pack investment 2016
Effelsberg	144 TB	
Onsala	144 TB	
Yebes	216+144 TB	
Hartebeesthoek	144+288 TB	
Medicina	160+240 TB	96 TB
Noto	160 TB	
Westerbork	288 TB	

Torun		96 TB
Jodrell Bank	144 TB	288 TB
Total	2072 TB	480 TB

Executive Summary

- Torun should upgrade their DBBC2 fro 2 Gbps and VDIF. Cost: ~ 17 k€.
- Stations with Flebxuffs 144 TB size should upgrade their units at JIVE with larger disks in one or two years time. Cost: ~ 7200 /station
- Stations to buy one 32 TB disk pack. Cost: ~ 960 €
- KVN stations should upgrade their recorders and backends for 2 Gbps. Cost: unknown
- It is important to get eVLBI 1 Gbps connections for these stations:
  - Kvazar antennas
  - Sardinia
  Cost: unknown