VGOS correlation

Suggested decisions:

- Highlight VGOS correlation as a prioritized activity on the Subcommittee on geodesy's 3 yr work plan
- Establish a VGOS correlation centre working group within the subcommittee and invite relevant group members outside of the subcommittee (IAG/GGOS/IVS/universities/?)
- Request the VGOS working group to create a long term step wise plan for the establishment of VGOS correlation centres with the aim to correlate VGOS data from VGOS antennas in 24/7 operation. The plan must address both regional and global needs and be made in close cooperation with IAG/GGOS/IVS/
- Raise VGOS correlation as an agenda item in the UN-GGIM regional committee meetings

Present situation (from a European perspective)

Soon there will be a rather large number of European VGOS stations (e.g. 2 in Sweden, 2 in Norway, 2 in Germany, 1 in Finland, 4 in Spain/Portugal, …) which will require corresponding correlation capacity.

For Norway and Sweden, part of the prerequisite for building of the new VGOS antennas was that after two years of parallel operation the old legacy S/X VLBI antennas were to be taken out of operation. Operational costs is always a challenge, and to afford operation of the new VGOS antennas, the old and worn out antennas must be shut down, or dedicated to other use. In addition, the legacy antenna in Ny-Ålesund has several issues that can make it hard to keep it going for many years to come. To be able to stop operating the legacy S/X antennas without degrading the reference frame, requires strongly that VGOS comes into operation soon.

Presently, the only VLBI correlation centre that correlates VGOS data on a regular basis within the IVS VGOS Pilot Test Phase is

1. Haystack – 24 hrs observation sessions every 14 days – up to

The Haystack correlator has documented some of their VGOS work performed during the last years in a recent publication, see Niell et al. 2018 (Radio Science 2018, doi 10.1029/2018RS006617). There are also some VGOS activities in Europe (Bonn), Asia, in particular Japan and Australia, but these are in an experimental state yet.

Correlating VGOS 24/7 demands both high data transfer and computation capacity. The VGOS correlation centres need sufficient connection to the international fibre network backbone, probably > 100 Gbps or more, to be able to receive the huge amount of observed and recorded VGOS data. The Bonn correlator currently carries out operational S/X-band correlation for which a bandwidth of up to 2 GB/s is sufficient. Though the computing power of the Bonn MPI cluster is VGOS ready, the current bandwidth is not sufficient for VGOS activities and requires a financial investment of the community. Haystack works a lot with disk-shipping with the American VGOS stations, while most of the Europeans and Asian stations will be e-transfer stations. Haystack has a better fibre access than Bonn, but nevertheless there are still restrictions for e-transfer. The current experience with Haystack is that an e-transferring station gets the possibility of using up to about 1 Gbps on its own, and even then it takes quite a long time to transfer the 17 TB of data recorded during these VGOS tests.

The situation now is that some observing stations have the necessary line capacity for e-transfer, and that the correlator is the bottleneck. For a single 24-hour session, we can expect in the order of 30 to 60 TB of data per VGOS system. This means data rates in the order of 5 to 10 Gbps per system will stream into the correlator if all these data shall be transferred during one day. In Europe, there will be many VGOS systems, e.g. 2 in Sweden, 2 in Norway, 1 in Finland, 2 in Germany, 4 in Spain/Portugal, and maybe more at some point. Of course, VGOS will involve international stations outside Europe, too. Thus, it will be a challenge to handle the huge amount of data.

One potential approach to this is to have a number of regional VGOS-correlation centres that work together and use e.g. distributed correlation. Of course, these centres need sufficient connection to the international fibre network backbone, probably > 100 Gbps or more, to be able to receive the huge amount of observed and recorded VGOS data. The IVS has started to investigate distributed correlation, however so-far with the legacy S/X VLBI only. More experience needs to be gained to evaluate the approach and make it applicable for standard IVS operations and in the future for VGOS.

When consulting IVS on the matter of VGOS correlation, the answer was that “VGOS correlation is quite a big issue and in no way resolved within the IVS and its components. There is no plan yet of how to handle this. The hope is that everything settles by itself in a continuous process of ramping up.” In other words, measures must be taken if the matter of VGOS correlation shall speed up.

A VGOS correlation and fringe-fitting cookbook is in preparation by the Haystack group, and the plan is to discuss this with the IVS community at the Technical Operations Workshop 2019 at Haystack. According to Haystack, this cookbook will then be revised/updated and finally distributed to interested parties later in 2019. It is expected that this cookbook can be used as basis for VGOS correlation, at least in its initial stage. Further additions/modifications are of course anticipated.