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### Deliverable 4.6

### Report 2 Technical Meeting

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 Authors (Institutes) Uwe Bach (MPiFR)

## Dissemination Level

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

## INDEX

1	Introduction .....	3
2	Meetings summary .....	3
3	Participation.....	4
4	Summary & Impact.....	6
5	Publications .....	7
6	Acronyms .....	7

# 1 Introduction

EVN (European VLBI Network) is a network of radio telescopes (Europe, Asia and South Africa) that performs simultaneous observations in the cm-wavelength regime. GMVA (Global Millimeter VLBI Array) provides a complementary infrastructure that combines European and US telescopes, and ALMA to provide ultra-high resolution observations at mm-wavelengths. It is essential to maintain and improve these infrastructures in order to satisfy the requests for constantly increasing science goals and to sustain radio astronomy into the far future. The success of EVN is heavily based on standardization of equipment and procedures across the network. The Technical & Operations Group (TOG) of EVN is the platform for innovations and standardization within EVN and has been responsible for the maintenance of the technical and operational infrastructure of EVN for the last 30 years. Regular technical meetings provide a crucial work platform for the TOG. In early 2016 the GMVA Technical Group (GTG) was officially constituted to provide comparable services to the GMVA.

The TOG (Technical and Operations Group of the EVN) meeting takes place every 9 months in a different observatory of the EVN to allow a direct exchange of technical expertise and experience between the station personnel. Every 18 months the TOG meeting is held together with a meeting of the GMVA technical group (GTG). The meetings are attended by VLBI friends and technical staff of the stations and the correlators as well as by selected external experts. The general objective of the TOG and GTG meetings is to identify operational issues of the EVN and GMVA infrastructures and discuss strategies to mitigate those in the future. Permanent agenda items deal with improving the quality of calibration, maintenance of the data acquisition and recording equipment as well as of the used software components. In addition strategies for improving the future scientific capabilities of the infrastructures are being discussed and implementation plans are being established.

After the last report D4.2 there has been one in-person TOG meeting in 2019, but due to the COVID-19 pandemic the following meeting could not be held in-person. A two day TOG/GTG meeting with a workshop on VLBI backend developments was planned for May 2020, which had to be postpone because of the world wide travel restrictions. A virtual meeting was held on the same day, instead. Up to the end of this reporting period no in person meeting have been planned yet.

## 2 Meetings summary

Since the last deliverable D4.2, describing the TOG/GTG meeting until 5.10.2018, one in-person TOG meeting was held at Jodrell Bank Observatory, UK in June 2019, followed by two virtual TOG meetings and one virtual GTG meeting, all of which received partial funding from RadioNet.

Date	Location	TOG	GTG	Links	Report
26.06.2019	Jodrell Bank, UK	✓		<a href="#">meeting page</a>	<a href="#">report</a>
05.05.2020	Virtual meeting	✓	✓	<a href="#">meeting page</a>	<a href="#">report</a>
24.11.2020	Virtual meeting	✓		<a href="#">meeting page</a>	<a href="#">report</a>

All meetings have been prepared and managed by the coordinator(s) of this work package together with the Local Organizing Committees (LOC) of each meeting. The coordinator(s) issued the calls for all meetings, prepared the agendas, evaluated economic requests for partial funding, chaired the meetings, generated and reviewed the minutes and published the presentations, minutes and action items.

All meetings are documented in reports, which were supplied by the coordinator(s) to the RadioNet management shortly after the event. The reports (linked in the last table column) contain detailed information on the meeting agendas, the list of participants, minutes and action items.

### 3 Participation

A statistic of the number of participants, their gender and participating countries are listed in the table below:

Meeting Place (Date)	Male	Female	Total	Countries
Jodrell Bank (June 2019)	24	2	26	11 (Europe, Africa, America)
Virtual (May 2020)	40	4	44	15 (Europe, Africa, America, Asia)
Virtual (November 2020)	44	3	47	15 (Europe, Africa, America, Asia)

There is an extremely low percentage of women versus men among the attendants. This proportion is clearly different from the more balanced ratio typically seen in the Astronomy scientific environment.

Due to the global nature of VLBI infrastructures and techniques the proportion of countries versus attendants is very high. A core group of around 30 people regularly attends the TOG and GTG meetings. Depending on the meeting location additional participants take advantage of the proximity of the meeting venue. A lot more institutes took advantage of the virtual meeting and representatives from nearly all institutions participated in the meetings. Although global time differences still make it more difficult for the more distant countries.

The financial support provided by RadioNet for the meeting in Jodrell Bank allowed to invite experts that normally would not have attended the TOG meeting. Most noticeably the maintainer of the VLBI field system was invited to give a presentations on recent developments, which are fundamentally important in the VLBI field.





Figure 1: Participants of the meeting at Jodrell Bank (TOG)

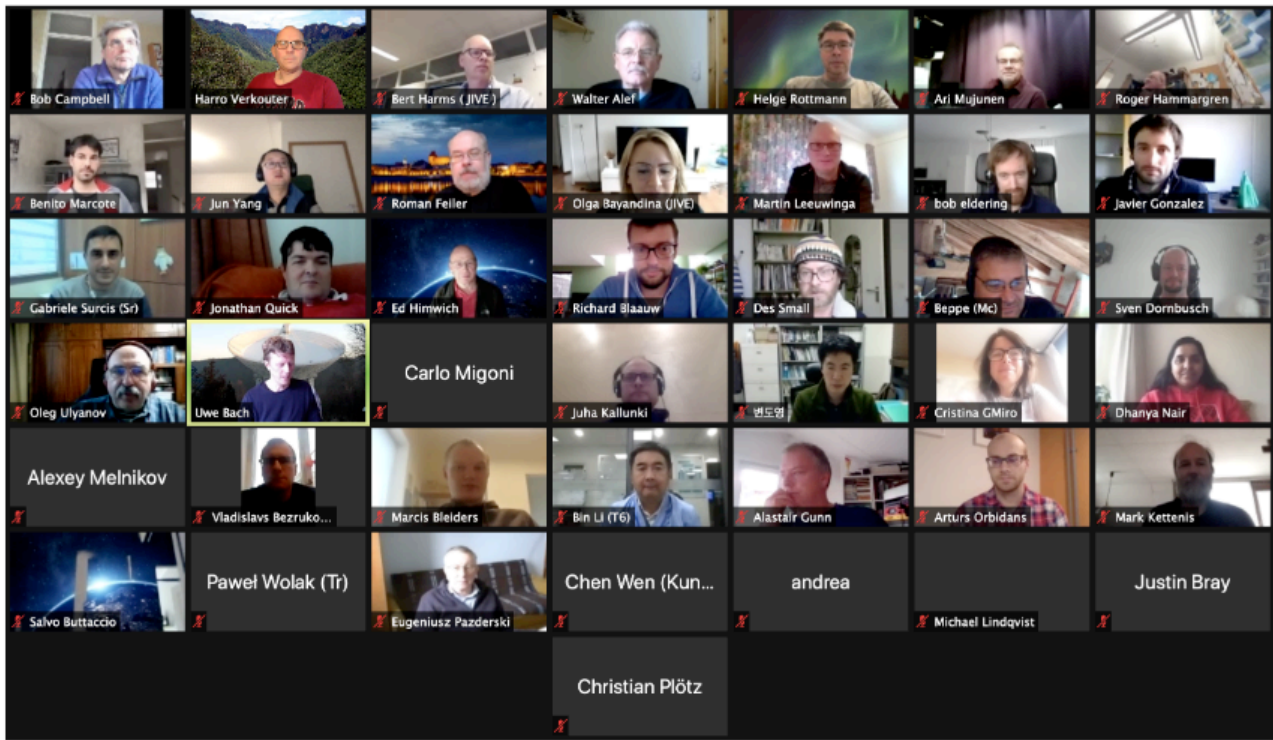


Figure 2: Participants of the virtual meeting in November 2020

## 4 Summary & Impact

The general objective of the TOG and GTG meetings is to identify operational issues of the EVN and GMVA infrastructures and discuss strategies to mitigate those in the future. Permanent agenda items deal with continuously improving the quality of calibration, maintenance of the data acquisition and recording equipment as well as of the used software components. In addition strategies for improving the scientific capabilities of the infrastructures are always an important and recurrently addressed topic.

Some of the main improvements recently achieved are highlighted in the following section

### 4.1 Increasing the standard recording rate in the EVN to 4Gbps

The achievements that allowed us to successfully increase the recording rate to 2 Gbps will also allow us to increase it even further to 4 Gbps. An increase to 4 Gbps would allow to further increase the sensitivity of the EVN by a factor of 1.4, but also requires more bandwidth from the receiving system and more storage capacity. The TOG has started to encourage stations to increase the storage capacity and investigates how to align receiver bandwidth most efficiently. A number of test and first science observations have been performed and 4 Gbps is offered to the EVN users since October 2020.

### 4.2 Towards 32 Gbps

The next generation of VLBI backends allows to increase the recorded bandwidth to 4 GHz per polarization and the TOG is working on a strategy to most efficiently make use of the possibility and investigate which receivers should be upgraded and which could be bought commonly in the EVN to achieve the best compatibility.

### 4.3 e-VLBI (EVN)

A subset of EVN observations is realized as so-called e-VLBI observations. In this special mode data are not recorded but transmitted in real time and the backends at the stations are remotely controlled by the correlator center. The standard recording rate for e-VLBI is 2 Gbps, which has now been achieved by most EVN stations and the remaining stations can participate in a mixed mode. Stations are encouraged to increase their eVLBI connection bandwidth to 10 Gbps to allow also higher bit rate recordings in e-VLBI mode in the very near future.

### 4.4 Improved calibration for higher frequencies (EVN and GMVA)

Another important aspect of the TOG and GTG meetings is the feedback between the correlator and the stations and the evaluation of the quality of the amplitude calibration at all observing frequencies. Like in the EVN, also for the GMVA regular calibration blocks have been inserted in the observing session to perform calibration measurements close in time to the science observations. The EVN has built a working group to establish a common calibration scheme for frequencies of 22 GHz and higher, where the current accuracy is still not as good as at lower frequencies.

## 5 Publications

No publications have been released. All information: presentations, agenda and minutes are publicly available on the RadioNet wiki pages.

## 6 Acronyms

VLBI – Very Long Baseline Interferometry

EVN – European VLBI Network

GMVA – Global Millimeter VLBI Array

TOG – Technical and Operations Group

GTG – GMVA Technical Group

SHAO – Shanghai Astronomical Observatory, Chinese Academy of Sciences

XAO – XinJiang Astronomical Observatory, Chinese Academy of Sciences

NTSC – National Time Service Center, Chinese Academy of Sciences

IAA – Institute of Applied Astronomy, Russian Academy of Sciences

SARAO – South African Radio Astronomy Observatory

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