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# Differences Between S/X and VLBI2010 Operation

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**Abstract**

The intended VLBI2010 operation has some significant differences to the current S/X operation. The presentation focuses on the problem of extending the operation of a global VLBI network to continuous operation within the frame of the same given amount of human resources. Remote control operation is a suitable solution to minimize operational expenses. The implementation of remote control operation requires more site specific information. A concept of a distributed-centralized remote control of the operation and its implications is presented.

## 1. Present and Future Operation

The present IVS network operation is based on regular $24h$ observation sessions, which are conducted by different networks with five or more stations, and on daily $1h$ observation sessions with smaller networks up to three stations. The VLBI2010 idea proposes to replace the different sessions by a continuously observing (24/7) VLBI network, in which stations are permanently participating or are joining a couple of sessions per week. For the first case, the permanent observation, a new VLBI2010 radio telescope concept was developed, the so-called Twin-Telescope Wettzell. Having two identical radio telescopes at one site makes it possible to observe even if one of the telescopes stops for maintenance [1].

The increase of radio telescope usage time for geodetic VLBI requires not only increased availability of the radio telescope itself, but also of operators controlling the increased number of observing hours per station. Due to the fact that human labor cannot be increased at many IVS sites, a new strategy of network control instead of individual station control of VLBI operation needs to be implemented.

Considering the fact that VLBI observations will occur around the clock, it is possible to take advantage of the different daylight zones throughout the observation period for the network control operation (see Fig. 1). In this case, individual night shifts, which are difficult for the human body and therefore more expensive, may be saved at stations. The saved labor hour volume becomes available for a redistribution of network control shifts during the entire week. Therefore it will become in general possible to introduce continuous 24/7 operation into the future VLBI2010 observation scheme, without creating a big burden on the staff situation at each observatory.

The requirements for a network operation of a global VLBI network are:

- **reliable radio telescopes.** It is necessary that radio telescopes and the VLBI hardware may work unattended for 24 hours. This implies that a robust VLBI system is available at each of the VLBI2010 sites and that more sensors (video and acoustic), which will control the operation remotely, will be installed and become part of the operational system.

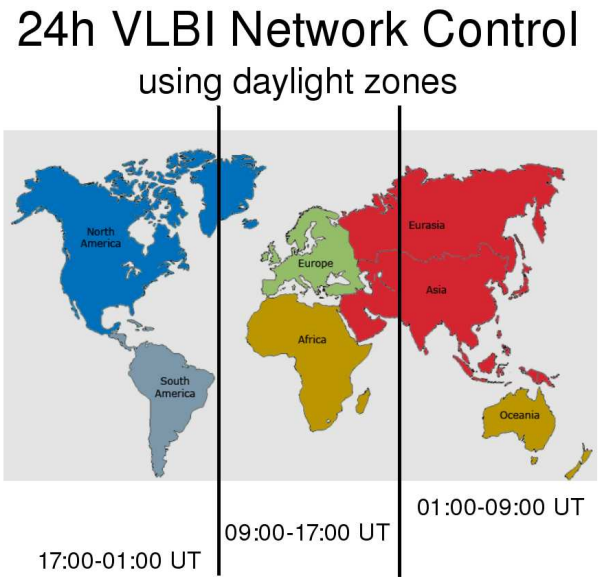


Figure 1. World map showing three daylight zones with proposed time slots for network control enabling continuous VLBI2010 observation.

- **reliable remote control software.** For remote control operation, safety issues and full Field System operation must be covered by the used software. This addresses standardization as much as possible for the radio telescope control as well for the station interface in general. Finally the remote control software must be robust against power failures and contain the information of an emergency hotline in case of a local failure which cannot be recovered remotely. A first attempt towards this goal is the e-control development at the Geodetic Observatory Wettzell, which allows radio telescopes to be controlled remotely [2]
- **reliable communication links between the control station and radio telescopes.** The Internet of today is fairly robust and could be the underlying technology to receive the necessary remote information about the status of the controlled instruments. Smart software developments must consider the minimization of the number of transmitted bytes from/to a remote controlled station. This is because the control of $n$ radio telescopes requires $n$-times the bandwidth to the network controller of intercontinental distances with sometimes small bandwidth available.

## 2. Comparison Between Station Control vs. Network Control of an 8-Station Network

The current operation is labor intensive. Tab. 1 compares the number of staff needed with individual station control (current) versus network control (future VLBI2010). A usual VLBI operation shift is set to 8h. In an 8-station network, covering the entire week with continuous VLBI operations requires 168 (=3x7x8) shifts of 8h each for individual station control. Realizing the same amount of observation with network control creates the need for 21 (=3x7) shifts for the network control itself. This control is done by one of the network stations and is handed over around the globe from daylight zone to daylight zone. In addition we request that once per

day each remote station is visited once during daylight to do local data carrier exchange work and local checking at each remotely operated station—adding 49 (=7x7) shifts. In total 70 shifts, instead of 168 shifts, need to be considered. These numbers can be translated to the number of staff needed at each site to do the VLBI operation. In the 24/7 continuous observation mode, six staff per station are needed with individual station control versus three staff per station with network control. (The number of staff considers five working days per week, a minimum of 12h pause between labor shifts, and vacations according to western European labor laws.)

The conclusion of this calculation is that only with network control can the ambitious goal of continuous 24/7 operation be reached with the available operator staff at many stations of the IVS network.

Table 1. Individual station control vs. network control of an 8-station network (24/7).

| **Number of** | **station control** | **network control** |
|---|---|---|
| operators per 8h shift | 8 | 1 |
| shifts per week | 168 | 70 |
| staff needed | 48 | 24 |
| staff needed/station | 6 | 3 |

## 3. Network Control

Once network control becomes available the question arises of where the network control should be located. There are two extreme positions, which are both valid:

- **decentralized network control by stations.** This requires perhaps some investments at radio telescope stations so that they can host the network control for regular daylight zone shifts in a globally shared manner. This way of operation will not lead to a cut in the existing staff at the sites, as the staff will be needed for both maintenance and operation. Past experience has shown that a minimum number of experienced staff is a necessity for providing a certain quality and quantity of data. The shared network operation with passing the network control through the daylight zones keeps the importance of each individual station and staff alive and strengthens the VLBI spirit. The shared and distributed network control is robust against failures of one controller as it can be passed easily to another station.
- **centralized network control by one center.** This control center could be located at one of the correlators or at the IVS Coordinating Center. If the network control is not shared among the participating network stations, it will become difficult to keep the importance of VLBI within the individual institutions alive.

Therefore it is concluded that the ownership of remote control shall be shared among the contributing network stations and perhaps further IVS components. From the perspective of most network stations, only the option of being sometimes in the position to control the entire network will enable the access to be remotely controlled. For the implementation of VLBI2010 operation in the future VLBI2010 network, the development of at least three network control centers, one in each daylight zone, will be the minimum to avoid costly night-shifts.

## References

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