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First proof of concept of remote attendance for future observation strategies between Wettzell (Germany) and Concepción (Chile)

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Current VLBI observations are controlled and attended locally at the radio telescopes on the basis of pre-scheduled session files. Operations have to deal with system specific station commands and individual setup procedures. Neither the scheduler nor the correlator nor the data-analyst gets real-time feedback about system parameters during a session. Changes in schedules after the start of a session by remote are impossible or at least quite difficult. For future scientific approaches, a more flexible mechanism would optimize the usage of resources at the sites. Therefore shared-observation control between world-wide telescopes, remote attendance/control as well as completely unattended-observations could be useful, in addition to the classic way to run VLBI observations. To reach these goals, the Geodetic Observatory Wettzell in cooperation with the Max-Planck-Institute for Radio Astronomy (Bonn) have developed a software extension to the existing NASA Field System for remote control. It uses the principle of a remotely accessible, autonomous process cell as server extension to the Field System on the basis of Remote Procedure Calls (RPC). Based on this technology the first completely remote attended and controlled geodetic VLBI session between Wettzell, Germany and Concepción, Chile was successfully performed over 24 hours. This first test was extremely valuable for gathering information about the differences between VLBI systems and measuring the performance of internet connections and automatic connection re-establishments. During the 24h-session, the network load, the number of sent/received packages and the transfer speed were monitored and captured. It was a first reliable test for the future wishes to control several telescopes with one graphical user interface on different data transfer rates over large distances in an efficient way. In addition, future developments for an authentication and user role management will be realized within the upcoming NEXPReS[†] project.

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1. VLBI observation strategies

At the Geodetic Observatory Wettzell, several possible observation strategies were investigated (fig. 1). The standard case is that an observer controls a VLBI observation locally on site at the telescope (local observation). With new remote control technologies it is no longer necessary for the operator to be on location. The operator can control the system remotely (remote observation). This technology can also be used to control more than one telescope by one operator. This allows shared observation between several sites. At Wettzell also completely unattended observations have been done especially for the weekend sessions for over 2 years now. For these the antenna runs completely autonomously and automatically without an operator (unattended observation). Especially, remote and shared observations offer many possibilities: Passive data access can be granted for live monitoring. There are possibilities for tele-working with full control access or specialists can assist local operators remotely. Very remote telescopes such as those in Antarctica can be controlled from large distances. Further, shared observations can reduce the manpower for shifts or help react to current research needs.

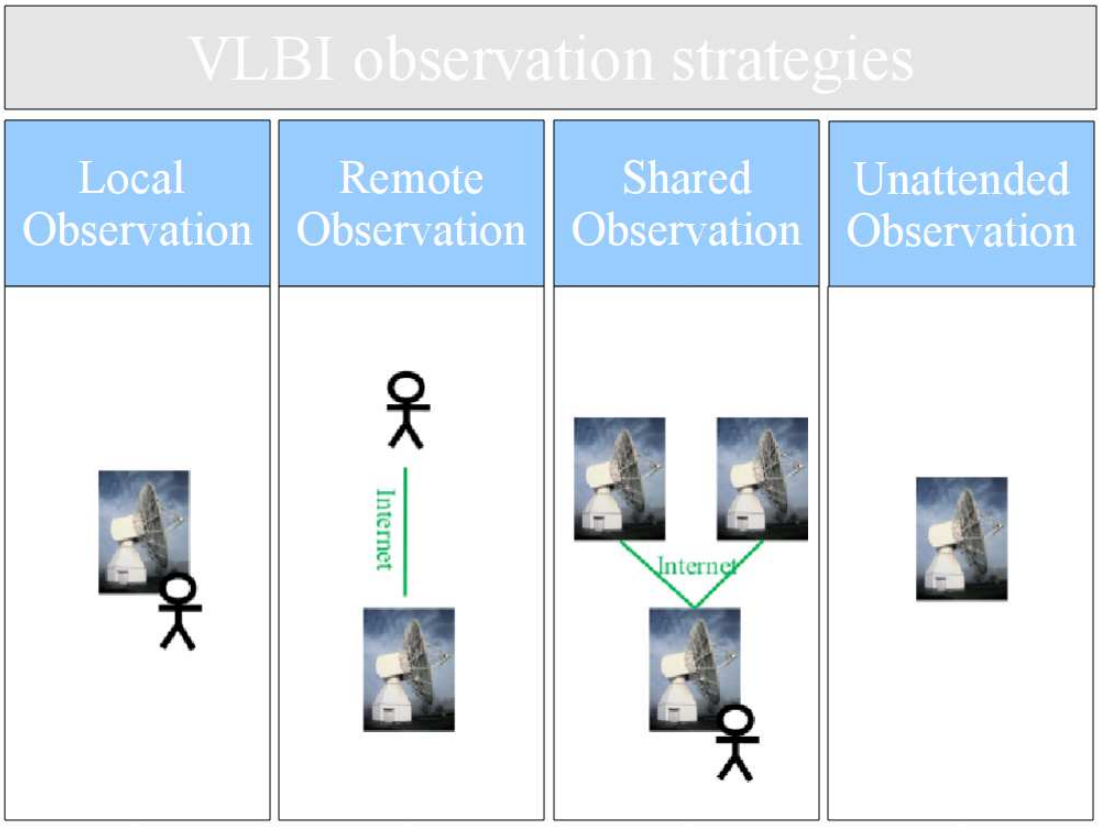


Figure 1: Possible observation strategies.

2. Shared observation test

Wettzell is developing a software extension for remote control to the existing NASA Field System (FS) in cooperation with the Max-Planck-Institute for Radio Astronomy (Bonn). The software, called e-control[1], uses remotely accessible, autonomous control cells as server extension[2] to the FS on the basis of Remote Procedure Calls[3] (RPC). Based on this technology, several remote control and attendance tests were successfully shown with telescopes in Germany, Chile and Antarctica (fig. 2). The latest test now demonstrated the idea of shared observations. Both telescopes at Wettzell, in Germany and Concepción, Chile were operated by one operator at Wettzell for a whole 24 hour IVS-session (R4438), where both telescopes participated. For security reasons, the whole communication was tunneled using Secure Shell (SSH) with automatic connection control. It (re-)establishes broken SSH tunnels without user interaction. During the session, local operators were available on both sides in case of malfunctions or for assistance. The integrated chat functionality and a webcam live view gave additional feedback.

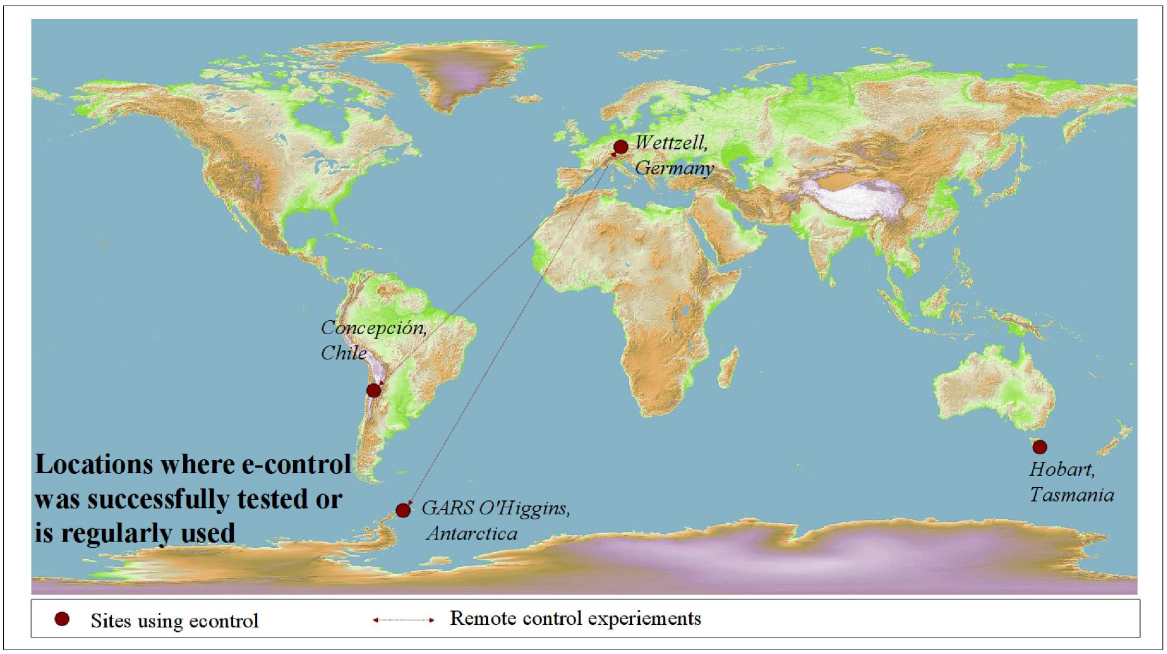
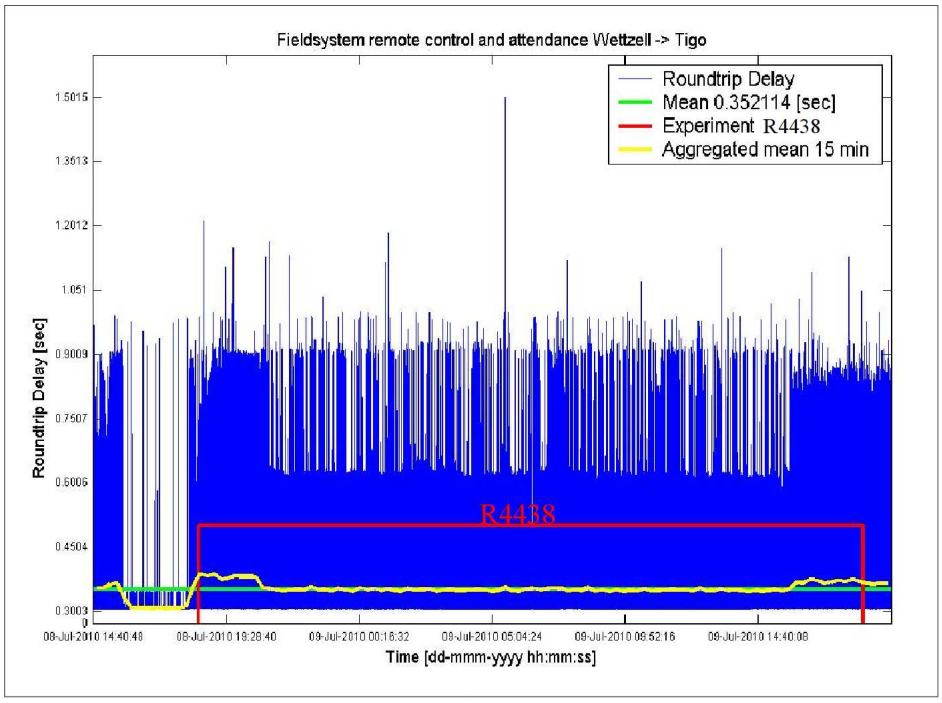


Figure 2: Locations where e-control was successfully tested or is regularly used.

3. The results

During the shared observation, the round-trip delays (time for sending a request and receiving the response) for commands were captured. For a better interpretation, an aggregated mean calculation for 15 minute intervals over the round-trip delays is used (fig. 3). The setup and preparation phase is clearly visible a few hours before where the chat communication and the antenna moving tests increased the communication load. After this, low traffic was detected where the control was on stand-by. During the start time and the end time of the experiment user interaction increased the traffic while over the rest only the normal logging information where exchanged. With this

test, very important insights were made: The use of SSH stabilization without a human interaction worked quite well. There are no gaps in the communication anymore, as seen in other experiments before the stabilization. Another point was that the telescopes use very proprietary setup and antenna procedures and commands. Even with the standardized FS it is quite difficult to know all of these specifics. This means that standardized pro-, mid- and post-session procedures must be designed on the basis of checklists and graphical logbook reports. It will help to get direct, standardized feedback from different systems. In sum, the shared observation test showed new possibilities and was very successful. Therefore these new strategies can offer technical realizations for vision as the Global Geodetic Observing System[4] (GGOS) or new Square Kilometer Arrays[5] (SKA), where a set of telescopes must be flexibly controlled by few operators. The next development steps are organized in the Novel EXplorations Pushing Robust e-VLBI Services (NEXPReS).



Roundtrip delay measurements for shared observation during VLBI experiment R4438

Figure 3: Roundtrip delay measurements for shared observation during VLBI experiment R4438.

Acknowledgments

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