Design of a Control System to Use Twin Radio Telescopes Simultaneously in VLBI

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This document presents the design of a control system for the twin radio telescopes located in the Ny-Ålesund Geodetic Observatory. This system allows using the twin radio telescopes both simultaneously and individually. The goal of the design is to minimize the number of control devices used by the control system. To carry out this goal, the control system has been implemented by using the software programming infrastructure called ALMA Common Software (ACS) together with the software package for synchronization of Very Large Baseline Interferometry (VLBI) observations called Field System (FS).

Keywords: Control, System, Radio telescope, Ny-Ålesund, VLBI, ACS, FS.

1 Introduction

The Norwegian Mapping Authority (hereafer NMA) has started the erection of two geodetic antennas 13.2 m diameter at Ny-Ålesund. The antennas are basically identical to the 13.2 m one in Yebes. The Ny-Ålesund Geodetic Observatory requested the Yebes Observatory to develop a control system, based on the Yebes one, for the new twin radio telescopes. In contrast to observations carried out by the Yebes Observatory, where only one radio telescope is controlled, the Ny-Ålesund Geodetic Observatory may use both radio telescopes at the same time. This requires a method that allows managing twin radio telescopes simultaneously or individually.

The control system designed can manage both radio telescopes, whether they are tracking the same source or not. The control system was installed and tested on three computers delivered temporary by NMA to Yebes. Two of the computers run the FS and the third one the telescopes' control system. Other equipment was also sent to be tested and integrated in the control system: a MET4 weather station with Vaisala wind sensors and one Agilent counter to be used for the cable measurement and/or the GPS — maser comparison. A power meter was not sent since there is already one unit at Yebes that was used for testing the software and data acquisition.

The installation of the control system for Ny-Ålesund was done at the same time that we upgraded the control system at Yebes 13.2 m. This new system may provide a reliable path and a system for similar antennas designed and built by the same antenna vendor. The telescope control system runs under Debian/Linux and uses ACS infrastructure to host the control system and the FS that manages VLBI observations schedules.

2 ALMA Common Software (ACS)

The ACS provides a software infrastructure common to ALMA project partners. It consists of a documented collection of common patterns and of components, which implement those patterns. It was developed by the European Southern Observatory (ESO) as open source. It uses a distributed component model, with ACS components implemented as CORBA objects in any of the supported programming languages (C++, Java and Python).

Components are the result of programming the communication with the different parts of radio telescopes, like the antenna or back-end and front-end equipments. They can provide their services to other components or to a client, providing a flexible communication between radio telescope elements.

3 Field System (FS)

In VLBI observations it is essential that all radio telescopes involved do the same actions at the same time. The software package FS is a standard system for VLBI observations that allows radio telescopes to run an observation schedule. The FS developed and supported by NASA.

The FS can control and monitor different back-end acquisition and recording systems for VLBI observations.

In order to use the FS is necessary to customize it at the observing station where it will be used by adding some local station software. Most of the customization has to do with the antenna interface and with the front-ends (local oscillator frequency tuning and attenuation). In the end the FS manages back-ends, recorders and the antenna during VLBI observations.

4 Control system

As mentioned before, the control system requires three computers: one computer would run ACS and the other two, the FS.

ACS can initialize different instances of the same component. Each instance uses a database where variables like IP address(es) and the connection port(s) are stored. This feature reduces the source code of the control system and allows the control system to manage both radio telescopes using a single computer.

Since we wanted to use the ACS and the FS to control the twin radio telescopes during VLBI observations, the communication between these parts of the control system was developed. This communication is carried out through a TCP/IP connection. An ACS component is used as a server and the FS uses a client to connect to it. The FS client sends periodically a data block to the ACS component to update ACS information and to command the radio telescope. When commands sent have completed, the ACS component sends back a data block to the FS client with information that is used to update FS information.

The communication developed has two modes: single mode and twin mode. In single mode each FS computer manages one radio telescope opening one socket with one ACS instance. In twin mode a single FS opens two sockets, one for each ACS instance, to control both radio telescopes. Each ACS instance manages one radio telescope, so that when the twin mode is used both radio telescopes observe the same source. Fig. 1 shows a scheme of communication modes between the ACS and the FS

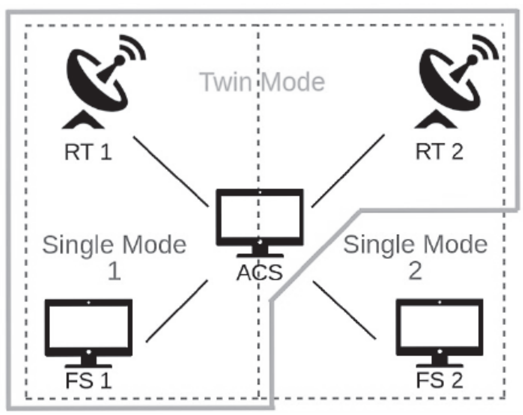

Fig. 1. Modes of communication between the ACS and the FS

5 Tests

The control system has been tested using two radio telescope simulators using different geodetic locations and in a real environment using both radio telescopes located at Yebes Observatory (40-m and 13.2-m). We scheduled a typical geodetic 24 hour observation and printed the position of the two radio telescopes (using the simulator). Below, in Fig. 2, we show horizontal positions printed for both radio telescopes.

```
#antcn#Antenna 1 and 2 onsource / Az1: 120.94, El1: 71.40 Az2: 117.40, El2: 74.66
#antcn#Antenna 1 and 2 onsource / Az1: 123.92, El1: 72.37 Az2: 120.64, El2: 75.72
#antcn#Antenna 1 and 2 onsource / Az1:  66.87, El1: 36.75 Az2:  66.01, El2: 37.42
#antcn#Antenna 1 and 2 onsource / Az1: 131.82, El1: 32.99 Az2: 133.08, El2: 36.55
#antcn#Antenna 1 and 2 onsource / Az1:  56.84, El1: 32.59 Az2:  56.35, El2: 32.63
#antcn#Antenna 1 and 2 onsource / Az1: -14.05, El1: 38.88 Az2: -13.17, El2: 35.46
```

Fig. 2. Antennas positions using the simulator

6 Conclusions

Using ACS as infrastructure and a single FS to manage the antennas and the VLBI back-end equipments, this setup reduces connections, space and cost by suppressing an intermediate computer from the antenna vendor setup.

As the control system is open source. It can provide a reliable path and a system for similar antennas.

References

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