Current Status of an Implementation of a System Monitoring for Seamless Auxiliary Data at the Geodetic Observatory Wettzell

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Abstract The first test implementation of an auxiliary data archive is tested at the Geodetic Observatory Wetttzell. It is software which follows on the Wettzell SysMon, extending the database and data sensors with the functionalities of a professional monitoring environment, named Zabbix. Some extensions to the remote control server on the NASA Field System PC enable the inclusion of data from external antennas. The presentation demonstrates the implementation and discusses the current possibilities to encourage other antennas to join the auxiliary archive.

Keywords Seamless auxiliary data, system monitoring, Zabbix

1 Introduction

The Global Geodetic Observing System (GGOS) requires permanent monitoring systems (e.g., for the determination of the local ties at sub-millimeter accuracy) to achieve the positioning precision goals ([5]). Besides the main products, several additional parameters might be worth being monitored to improve the final geodetic solution. Therefore, the IVS Task Force for Seamless Auxiliary Data was founded during the Analysis Workshop in Shanghai 2014 to discuss and find solutions to improve the current situation (for the following see [4]). Possible implementations should be demonstrated. Further on, suggestions could be made about the type of data which are useful and how observatories can contribute to the real-time data stream. It would also have some positive effects on the accuracy of IVS data products if data were to be continuously available. Real-time auxiliary data can also contribute in a dynamic observing scenario where scheduling decisions are automatically made.

Therefore the main goals are:

- Continuous, auxiliary data (are of high interest),
- Additional data (might be interesting for research),
- Centralized data repository,
- Real-time overview of the observation network, and
- Preparations for dynamic observations.

The implementation of a seamless auxiliary database follows two phases (see Figure 1). The first is a proof-of-concept section lasting one year. The NASA Field System and the e-RemoteCtrl software ([3]) should be extended with a sending functionality during this development section so that currently available auxiliary data can be sent. Tests are ongoing at Wettzell including other data propagation mechanisms, such as the one from the mm-VLBI group [6]. To enable a centralized data repository, a server hardware with suitable RAID-sets of hard drives is under preparation at the Geodetic Observatory Wettzell, where the operating system and the software will be installed in the coming months. It is a set of hierarchical servers for the data acquisition and Web presentation.

Currently, the implementation is delayed because of the focus on tasks which are related to developments for the VLBI Global Observing System (VGOS). Some of the server hardware is prepared. Local extensions to the system monitoring at Wettzell are made. Expe-

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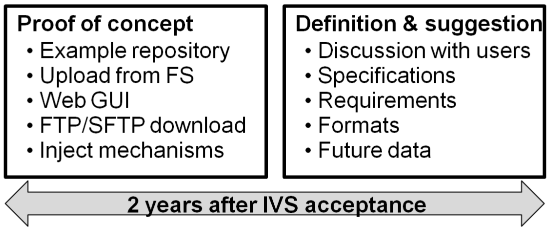

Fig. 1 The planned phases of the IVS Task Force on Seamless Auxiliary Data.

riments with different solutions to propagate data between the servers are already tested.

2 Local System Monitoring

The foundation of each global monitoring system is the local data nodes, which collect data and make them available. They collect data for science and analysis, data for system operations, and data for diagnostics. Because the data are essential for the operation of the antennas, the different observatories developed and use individual solutions. In a global context, the MoniCA system in Australia ([1]), the MIT Monitoring and Control Infrastructure for the new VGOS antennas in Haystack, Washington and Kokee Park, the mm-VLBI Radio Lab VLBI Monitor [6], and the Wettzell SysMon [2] are relevant. The following focuses on the Wettzell SysMon suite.

The main part of a sensor node in SysMon software is a data storage system using the Data Base Management Systems (DBMS) PostgreSQL. The database contains the short-term and current data sets. Monitoring data are kept in the PostgreSQL database for a few months to make a presentation of current data with suitable plots. It is extended with a file system server, to build up hybrid storage possibilities. The file system contains the historic and long-term data. The presentation layer on such a node is ZABBIX and a Web server [7]. ZABBIX is an open-source monitoring system which offers all capabilities of presenting and interacting with monitoring data.

Each monitoring count is configured with a configuration file. Using the program “sysmon_senderc -R test.conf” (where “test.conf” contains the sensor details, see Figure 2), a count can be registered at the system. The configuration file contains all relevant information about a sensor, for example a sensor identification number, a sensor name, the used unit, information about type and the manufacturer of the sensor, and data about the limits to set warnings and alerts. The registration prepares the database tables and the file system directories and even produces a template file for Zabbix, which simplifies the implementation of a ZABBIX Web page having graphs, triggers, and data injectors.

```
<MCISensorControlPoint>
        ControlPointID                 = Test
        ControlPointType               = test
        ControlPointPort               = 52666
    <MCISensorProprietarySettings>
    ...
    </MCISensorProprietarySettings>
    <MCIZabbixConnection>
    ...
    </MCIZabbixConnection>
    <MCIDBConnection>
    ...
    </MCIDBConnection>
    <MCIBackupSettings>
    ...
    </MCIBackupSettings>
    <MCISensor>
            SensorID                   = Test1
            SensorName                 = Test1Sensor
            SensorUnit                 = Deg C
            SensorManufacturer         = HBM
            SensorModel                = AED9001A
            SensorPosition             = Midway in azimuth axis
            SensorUpdateInterval       = 180s
            SensorResolution           = 0.05
            SensorDataAvailabilityTime =  1d
            SensorMinLimit             = -20
            SensorMaxLimit             =  50
            SensorMinWarningLimit      =  5
            SensorMaxWarningLimit      = 35
            SensorMinAlertLimit        =  0
            SensorMaxAlertLimit        = 40
            SensorFlagProvider         = yes
            SensorFlagConsumer         = no
            SensorFlagCommandable      = no
            SensorFlagManageable       = no
            SensorDataArchiveDirectory = /archive/MCI
            SensorPropArchiveDirectory =
    </MCISensor>
    <MCISensor>
    ...
    </MCISensor>
    ...
</MCISensorControlPoint>
```

Fig. 2 A configuration skeleton for SysMon.

“sysmon_sender” is also used to transparently inject single sensor values and counts to the database, the file system, and the presentation layer. There are two ways: data which should be injected can be defined as arguments to the program (“sysmon_senderc -s test.conf TestID1 200.0 1”, where “TestID1” is the sensor identification, “200.0” is the value, and “1” is an additional trigger for alert levels) or can be written as a table in a file (“sysmon_senderc -f test.conf datafile.txt”, where “datafile.txt” contains a table of sensor inputs structured in the same way as used as program arguments), which is then completely imported. The version using a file makes a complete update of several sensor values possible.

After the import of the template file to ZABBIX, it can directly be used to present data via a Web server on a Web browser (see Figure 3). ZABBIX provides several interactions, so that one can zoom into the data series to check specific events. Several types of charts can be adapted to an individual style of data presentation.

Fig. 3 A possible Web page showing the monitoring data which are collected from the cryo-system of the dewar.

The development of the local SysMon was one of the highly prioritized tasks at the Wettzell observatory, as it makes automated and autonomous observations possible while keeping the overview of the different telescope systems. Therefore, some projects extended the capabilities of SysMon. Even if SysMon is specifically used at Wettzell, it is interoperable to all the other systems, as data injectors can simply take data from other systems, such as MoniCA or MCI, to send them to SysMon with a simple call of the “sysmon_senderc” software.

3 Combination with FS Control

The main part of the control of VLBI telescopes is the NASA Field System, which processes schedules, controls hardware, and collects all necessary system data to log them to a session log file. This system is extended with a local station code to implement the access to the station-specific data from different sensors of the SysMon nodes, so that all data are accessible for the operator in the Field System. Additionally, an e-RemoteCtrl server offers remote access to all functionalities using a role-based authentication system. Related e-RemoteCtrl clients can be used all over the observatory network and also over the world-wide networks to access control remotely.

New observation strategies, such as the use of unattended night shifts, require a higher-level of safety. This additional requirement is provided by the SysMon nodes. Each node operates in parallel to the Field System and has all necessary data about the system to make decisions about the safety and the current system status. Because some of the standard monitoring data only arrive at the Field System, for example the meteorological data or the antenna parameters, the Field System must propagate these data to the SysMon node. Therefore, the SysMon nodes of a telescope and the controlling Field System interact closely. Critical situations are then directly visible for the operator in the Field System and in the ZABBIX Web pages (see Figure 4).

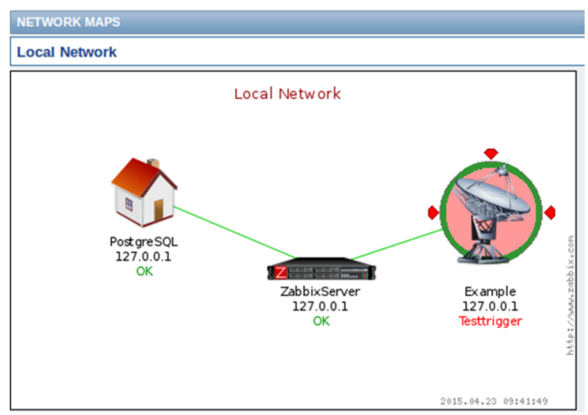

Fig. 4 The notification of a critical situation in the telescope control forced by a trigger signal to test the propagation.

Additionally, the status and auxiliary data are then propagated to a central monitoring node from where they are sent to the IVS repository for auxiliary seamless data.

4 Propagation to a Central IVS Repository

A proof-of-concept implementation of a centralized IVS repository for auxiliary seamless data is currently under development at the Wettzell observatory (see Figure 5). It will collect data from a limited number of observatories using a centralized SysMon node with a suitable RAID-set of hard drives and different data access points. The simplest way to receive data is an upload with Secure Copy (SCP) or Secure File Transfer Protocol (SFTP) to an incoming directory. The update times are defined by the participating stations. The uploaded file just contains meteorological data in a first step.

But in the near future, the server should enable the receiving of incoming data sets in different formats on different access points (such as the JSON-based format of the Radio Lab VLBI Monitor [6] or the currently used format for dynamic observations of the AuScope network in Australia, see presentations of J. Lovell). It will have a suitable ZABBIX frontend to access current values. Historic data files are archived in separate download areas.

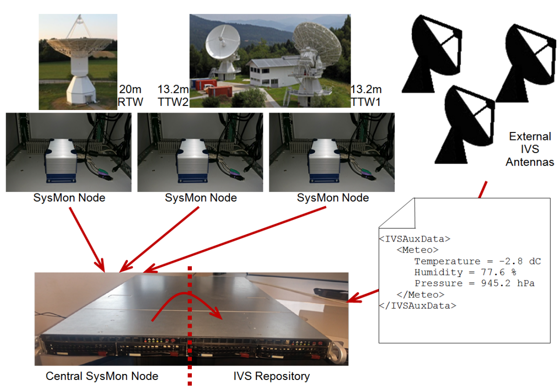

Fig. 5 The data from participating antennas are propagated to a centralized IVS repository for auxiliary seamless data.

5 Special Features

Having such centralized archives and reporting systems, a central failure and error management for the complete network of antennas is possible. Some first example developments at the Wettzell observatory implement notification services with text messages to mobile phones and output of dynamic audio messages to regular phones.

A mini-PC with Voyage-Linux is used to run the open-source software “Asterisk”, which can be used to automatically make phone calls (see Figure 6). If a trigger is activated by a critical limit of a value, the SysMon system sends text messages with the error codes to the mini-PC which converts it to audio files and makes phone calls to the responsible operator. He can then use e-RemoteCtrl and Virtual Network Computing (VNC) to access the system remotely. In most cases, this remote access can fix the problem to continue the regular operation. This technique can be used to run night shifts unattended.

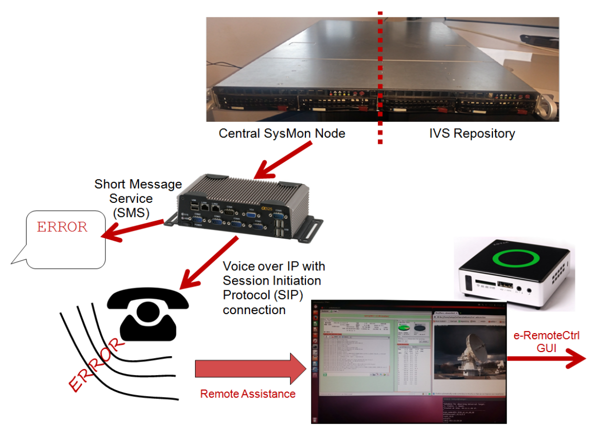

Fig. 6 Failure management and notification service tested at Wettzell to make unattended observations and remote assistance possible.

6 Conclusion and Outlook

The implementation of a centralized IVS repository for auxiliary seamless data is an ongoing task. Even if the project is delayed, several sub-tasks were developed with the focus on tools and equipment which are essential for future observation modes at the Wettzell observatory. The complete design is interoperable with other systems, so that parallel existing system monitoring software can inject data as well. After final tests, it will be accessible also for external partners and for the IVS components.

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