The Evolution of The Simulation Environment in ALMA

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Abstract

The Atacama Large Millimeter/submillimeter Array (ALMA) has entered into operation phase since 2014. This transition changed the priorities within the observatory, in which, most of the available time will be dedicated to science observations at the expense of technical time that software testing used to have available in abundance. The scarcity of the technical time surfaces one of the weakest points in the existent infrastructure available for software testing: the simulation environment of the ALMA software. The existent simulation focuses on the functionality aspect but not on the real operation scenarios with all the antennas. Therefore, scalability and performance problems introduced by new features or hidden in the current accepted software cannot be verified until the actual problem explodes during operation. Therefore, it was planned to design and implement a new simulation environment, which must be comparable, or at least, representative of the production environment. In this paper we will review experiences gained and lessons learnt during the design and implementation of the new simulated environment.

Overview

The priorities have been changing in the observatory since entering operations. This transition has lead to a reduction in the technical time both for software testing and engineering tools such as maintenance and hardware installation in benefit of having more time for science operations, and this tendency will increase in the following year. The previous reasons have lead to one of the weakest areas in the existent infrastructure for software testing: the simulation environment of the ALMA software.

ALMA simulation capabilities were mainly developed to validate Central and Correlator subsystems, complying with virtual interfaces to interface with the software components being developed. Later, additional simulation layers and capabilities were added, but focused on the functionality aspect instead of the real operation scenarios, leading to growing performance on scalability and performance problems introduced by new features or hidden in the critical accepted software. The lack of a representative testing environment will seriously impact the efficiency of the ALMA software release review process.

It was planned to design and implement a new simulation environment, which must be comparable, or at least representative of the production environment. Duplicating the production environment was not an option given the size/shape of the associated costs. As a consequence, adjustments to the current test environment architecture had to be introduced, taking special care in having a comparable simulation environment with regards to the production environment in terms of CPU load, network bandwidth throughput, memory usage, software configurations, etc.

The selected platform to provide computing power is based on the technology of Cisco Unified Computing System (UCS). The new simulation platform will provide the required amount of time for testing purposes and, at the same time, it will allow us to maximize the efficiency of the reduced technical time available in the production environment. This time will be dedicated only for the final validation of a new release and to test a small set of features that interest directly with hardware.

Testing Time

\textbf{Testing Time}

\begin{itemize}
  \item \textbf{Testing}
  \begin{itemize}
    \item Standard Test Environment: STE is a set of computers, which controls the entire telescope using a distributed framework called ACS (ALMA Common Software).
    \item The testing environment model was later consolidated and used for production, yet the name remained for historical reasons.
    \item Production STE:
      \begin{itemize}
        \item AOS: 66 antennas, BL Correlator, ACA Correlator, Central LO
        \item Verification STE
          \begin{itemize}
            \item TFBNG: 2 antennas, BL Correlator (2 antenna input), temporal Central LO
            \item TFGN: 2 antennas, BL Correlator (2 antenna input), temporal Central LO
            \item TFNG: 1 antenna
            \item TFVG: 1 antenna
          \end{itemize}
      \end{itemize}
    \item NEW Simulated STE
      \begin{itemize}
        \item ACEE: 66 antennas, BL Correlator, ACA Correlator, Central LO
        \item CDPM: 2 antennas, BL Correlator, Central LO
      \end{itemize}
    \item Connection to production hardware is available.
  \end{itemize}
\end{itemize}

Simulation

Use Cases

Since the resource use ratio in the previous environment, a new environment has been designed for the efficiency of the hardware platform, the improvement of the execution times (in hours), the scalability and reliability tests. The validation platform has also been used to test the performance of key components of the ALMA software.

- Correlator STE in the TESOS database: Using the TESOS database has allowed to introduce improvements that reduced the initialization time and characterization of the observations.
- End-to-end test: Transfer test allows to test the end-to-end and interface problems early in the testing process.
- Use cases: For a large number of users and capacity of the simulation environment, the use cases are used to carry out validation of the scalability and performance. STE is also used to test the robustness against failures, in order to verify the system's ability to handle certain failures.

- The simulation environment has also been used to test new deployment strategies before going into production.

Future Work

Future work is based on the simulation behavior of the hardware devices, such as antennas pointing, correlators models, etc. We expect to incorporate concepts such as model in the loop or hardware in the loop, which gives us the advantage to use the same software than production, therefore helping to achieve a better coverage with our testing process.

It is also considered to use the idle time of this simulation environment to run automatic testing. Our goal is to support continuous software integration, as part of the ALMA software delivery process [7], and this environment will be perfected to execute nightly builds.

Conclusion

A new simulation environment was designed and implemented to 15 billion tiny bits allowed requirements, enabling a representative environment of the production environment. After its consideration, the amount of technical time required on the production environment for software testing has been reduced considerably.

The testing environment has the same network configuration as well as the validation and testing platforms are identical in nature to the main one in production, allowing for the same simulation software and tests to be used in both places.

Both environments have been designed to provide an excellent environment to improve computing power, which helps, taking advantage that the observation process is real-time. The new simulation environment is expected to be used in the next years and provides an environment for production simulation in which the software is required in order to take the real-world software release time into production.

It was important to design the simulation environment to be fully compatible with our current network design. Initially, Cisco UCS Data center environment provides high reliability and capacity. By design, however, our focus is to replace the hardware environment with the software environment. This is expected to be done in this area, it is planned to upgrade in production environments using the same technology in the near future.

REFERENCES