The online recovery system of the ATLAS experiment at CERN oversees a massive parallel IT infrastructure of 17,000 CPU cores running in the order of 20 thousand applications with very high up-time and efficiency requirements.

A group of young students from the University of Marburg decided to take this challenging example as a use case to demonstrate the potential of Software AG’s Apama. Based on a set of monitoring data gathered at the CERN, they implemented, within three months, an application capable of analyzing the incoming information streams and emulating the basic reactions of the real recovery system in ATLAS. This project was the winner of Software AG’s University Relations Idea Contest and was awarded with €10,000.

The ATLAS experiment at CERN

Physicists at CERN have conducted one of the most challenging and exciting experiments in our century to explore the origin of our universe and all within. This not only helps better understanding the Big Bang but also gives answers to the most important questions of mankind. In 2012 a particle consistent with the Higgs boson aka the ‘God particle’ was discovered at CERN by the ATLAS and CMS collaborations. The ATLAS experiment at the Large Hadron Collider (LHC) produces data at a rate of one petabyte per second. If all the data would be recorded, this would fill about 1.5 million CD ROMs per second. Special-purpose hardware is used to filter out 99.75% of the data immediately, but handling the remaining data of about 1 TB/s is still very demanding and requires a large, distributed data selection and acquisition system.

A massive parallel IT infrastructure of 2,000 server machines with a total of 17,000 CPU cores is employed running about 20,000 application programs. The high volume of continuously arriving data renders the common store-and-analyze-later paradigm impractical. Instead, the applications process the incoming data on the fly and store only a small, scientifically relevant, fraction of the data.

Statistically, failures in such a distributed IT infrastructure are bound to happen and, therefore, it is crucial to detect and overcome these failures as fast as possible in order to take data with the highest possible efficiency while the accelerator makes particles collide.

It is of the utmost importance to make the IT infrastructure self-aware and self-healing with minimal need of human interaction. Therefore, reliable control software that monitors the IT system in real-time and reacts upon failures and anomalies is in place since the beginning of data taking in 2010. This system has evolved with time from a rule-based expert system to a complex event processing approach, in order to support the continuous analysis of increasingly complex temporal information patterns.
ATLAS as a showcase for Apama

The similarity of the ATLAS data acquisition error recovery system to the Apama real-time analytics tool of SOFTWARE AG has fired the idea of demonstrating the capabilities of the latter at hand of this real-life example.

The team of the database research group at University of Marburg has implemented, in cooperation with CERN and University Relations of Software AG, a monitoring and recovery application based on Apama that emulates the behavior of the existing ATLAS recovery system. Apama provides powerful and easily combinable mechanisms for rapidly correlating, aggregating, and detecting patterns across large volumes of fast-moving data. The team used these mechanisms for both, defining meaningful rules for detecting critical situations in the IT infrastructure and initiating appropriate counteractions. In addition, a tool for visual analytics is running on top to enable end-users getting insight into hidden patterns and important live statistics of the flowing data. All of the analysis does not require any data to be stored, but runs on the fly as monitoring data arrives. If desired, aggregated data can be stored for sake of comparison with its corresponding live data.

What is special about the project?

As the winner of Software AG’s University Relations Idea Contest, this project was kicked off three months prior to CeBIT 2014, where the results were to be presented in a showcase to top media representatives and industry leaders. The entire solution was implemented by a group of students from the University of Marburg. Though the students had already basic knowledge in real-time analytics, they had no experience with Apama before the start of the project. Due to the intuitive programming interface of Apama and its excellent support, the students easily have become familiar with this Software AG product and its powerful functionality.

Outcome

• A system that emulates the basic behaviour of the ATLAS error recovery system has been implemented successfully using Apama in a very short timescale.
• The Apama editor, which is based on Eclipse, simplifies a lot the coding work. Moreover, it allows testing the behavior of created rules, which makes the deployment safe.
• The application of Apama to a demanding real-life use case has allowed demonstrating its power and ease of use.