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IDCDACS: IDC's Distributed Application Control System

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The Preparatory Commission for the CTBTO is an international organization based in Vienna, Austria. Its mission is to establish a global verification regime to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which bans all nuclear explosions. For this purpose time series data from a global network of seismic, hydro-acoustic and infrasound (SHI) sensors are transmitted to the International Data Centre (IDC) in Vienna in near-real-time, where it is processed to locate events that may be nuclear explosions.

We newly designed the distributed application control system that glues together the various components of the automatic waveform data processing system at the IDC (IDCDACS). Our highly-scalable solution preserves the existing architecture of the IDC processing system that proved successful over many years of operational use, but replaces proprietary components with open-source solutions and custom developed software. Existing code was refactored and extended to obtain a reusable software framework that is flexibly adaptable to different types of processing workflows.

Automatic data processing is organized in series of self-contained processing steps, each series being referred to as a processing pipeline. Pipelines process data by time intervals, i.e. the time-series data received from monitoring stations is organized in segments based on the time when the data was recorded. So-called data monitor applications queue the data for processing in each pipeline based on specific conditions, e.g. data availability, elapsed time or completion states of preceding processing pipelines.

IDCDACS consists of a configurable number of distributed monitoring and controlling processes, a message broker and a relational database. All processes communicate through message queues hosted on the message broker. Persistent state information is stored in the database. A configurable processing controller instantiates and monitors all data processing applications. Due to decoupling by message queues the system is highly versatile and failure tolerant.

The implementation utilizes the RabbitMQ open-source messaging platform that is based upon the Advanced Message Queuing Protocol (AMQP), an on-the-wire protocol (like HTML) and open industry standard. IDCDACS uses high availability capabilities provided by RabbitMQ and is equipped with failure recovery features to survive network and server outages. It is implemented in C and Python and is operated in a Linux environment at the IDC.

Although IDCDACS was specifically designed for the existing IDC processing system its architecture is generic and reusable for different automatic processing workflows, e.g. similar to those described in (Olivieri et al. 2012, Kværna et al. 2012). Major advantages are its independence of the specific data processing applications used and the possibility to reconfigure IDCDACS for different types of processing, data and trigger logic. A possible future development would be to use the IDCDACS framework for different scientific domains, e.g. for processing of Earth observation satellite data extending the one-dimensional time-series intervals to spatio-temporal data cubes.

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