# CDEV GENERIC SERVERS FOR RHIC COMMISSIONING AND OPERATIONS *

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*Abstract*

Several systems at RHIC are build using the CDEV Generic Server environment. These include the on-line modeling server (ACME), the system for managing ramps and real-time control knobs (Ramp Manager), the longitudinal profile monitoring and reconstruction system (Wall Current Monitor Manager), the beam position server (Orbit Manager), and several others. We describe these servers, their operational impact, and present results from the commissioning run.

## 1 INTRODUCTION

The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory consists of two intersecting storage rings. Using super-conducting magnets, RHIC will be able to collide ions from protons to gold. The existing AGS accelerator complex will be used as injector, supplying gold ions at 10.8 GeV/u and protons at 28.1 GeV. The beams are then accelerated in RHIC to 108 GeV/u and 249 GeV respectively. All ion beams except protons will cross the transition energy during acceleration. At storage energy, the beta functions in the interaction points are reduced from 10 meters to 1 meter. The machine was declared operational in August 1999 when gold beam was stored and accelerated in the Blue ring. Gold beam also was stored in the Yellow ring for 1000 turns. Commissioning will resume in December, with collisions planned soon thereafter.

The control system for RHIC is RPC based and described in [1, 2], while the control system for the AGS and Booster is of the 'mature' (i.e. older) type [3]. For this reason CDEV [4] was introduced to provide a common API to both systems. Several generic applications, like datalogging, are written by the Control Group using the CDEV API. In addition, accelerator physics applications are authored by people in the Rhic Accelerator Physics group (RAP). There the CDEV API is used to provide access to the control system and also to connect to the multiple 'middleware' servers which are described in this paper.

## 2 RHIC APPLICATION ENVIRONMENT

The Accelerator Physics applications used for RHIC commissioning are build using the 3-tier control system view. Middleware servers perform data collation from Front-End Computers (FEC's), and timing synchronization. Other servers provide a high level device view of the machine (i.e. by ring name), or provide an interface to the ramping, magnet, and modeling systems.

### 2.1 Magnet Control and Ramping

The super-conducting magnets are powered by multiple power-supplies in a main bus, multiple trim bus scheme shown in Figure 1. This was done to minimize the number of power feed-throughs into the cold regions but it complicates the programming of the Wave Form Generator drivers. Each WFG (Figure 2) needs to be programmed with a waveform which describes the change in magnet parameter like K, for quadrupoles, or angle, for dipole correctors. We define discrete points on this curve as 'stepstones', each describing a full set of magnet settings. These stepstones are presented as devices in the Ramp-Manager. Clients include the Ramp-Editor where tunes and chromaticities can be changed (Figure 3).

A 'ramp' device contains a set of stepstones and associated energies. Multiple ramp and stepstone devices are available simultaneously in the Ramp-Manager. Each of these devices supports the standard 'get', 'set', 'monitorOn', and 'monitorOff' verbs for several properties. In addition a ramp device supports an 'activate' message which will initiate the loading of the WFG's.

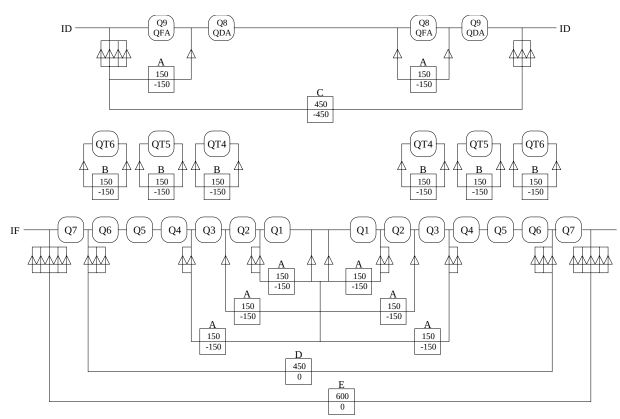


Figure 1: Wiring of Power Supplies and Magnets

### 2.2 Model Servers

Each stepstone device provides access to the associated optics through properties like 'LatticeFunctions', 'Orbit', or 'ClosedOrbitMatrix', amongst others. In addition, to support what-if scenarios, we provide the logical devices

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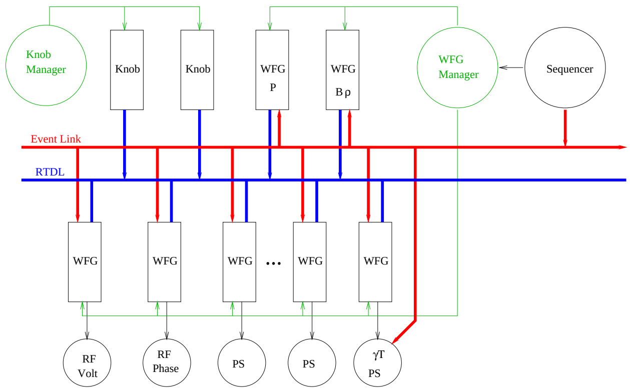


Figure 2: Control Model of Magnets and Power-Supplies

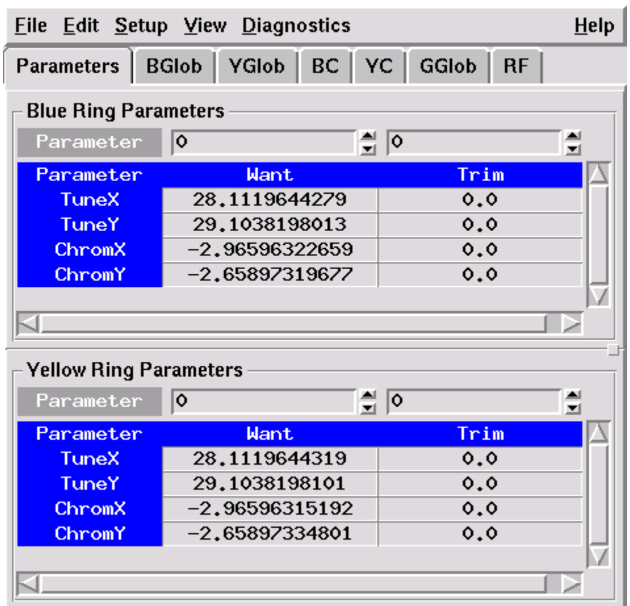


Figure 3: StepStone Parameter Editing Window

'Blue', and 'Yellow' for the two rings representing periodic optics, and 'BlueInj', 'YellowInj' devices representing the injection lines and the one-turn optics.

The Accelerator Computational Model Engine (ACME) environment (Figure 4) is described in [8], and multiple servers are available in the same CDEV server domain.

## 2.3 *Orbit Display and Correction*

The orbit system is monitoring approximately 700 Beam Position Monitor (BPM) devices times 10 properties per device, on several tens of FEC's. On receiving call-backs the data is synchronized across the machine and a callback is generated for each plane property ('xtbt', 'ytbt', 'xavg', and 'yavg') of the Blue and Yellow ring devices. The data associated with the call-back has the position for 128 up to 1024 turns for each BPM in the ring, the status for each turn, and the associated timestamp in seconds and revolution count when the triggering event was issued. The integration with the Ramp-Manager is shown in Figure 5,

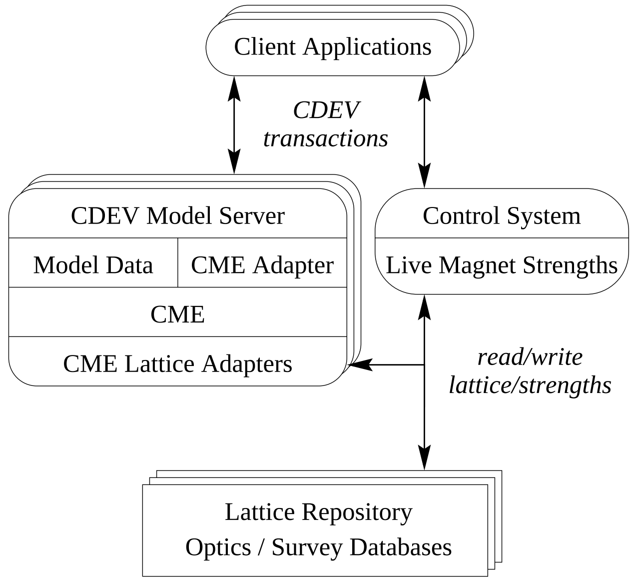


Figure 4: Model Server Program Processes

where the Orbit-Correction application is shown retrieving data from both the Ramp-Manager and the Orbit-Manager.

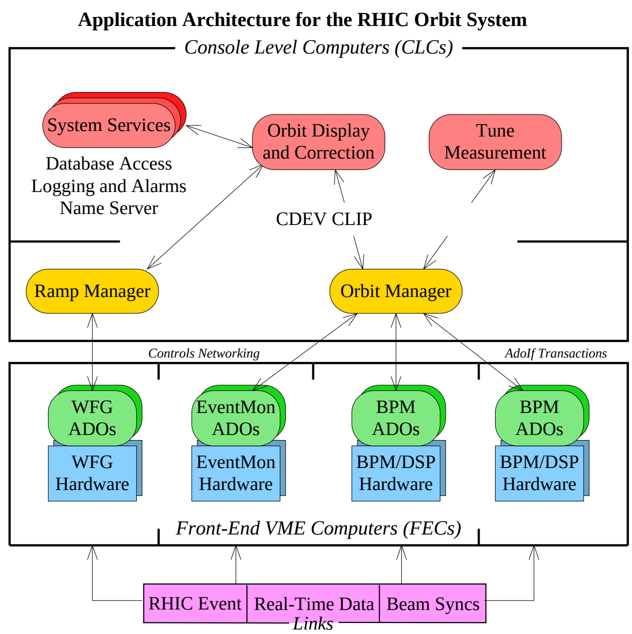


Figure 5: Orbit Display and Correction Program Processes

## 2.4 *Wall Current Monitor Manager*

This manager asynchronously collects data from several Wall Current Monitor (WCM) parameters and collates them into one cdevData which is delivered to interested clients. Each set of profiles typically consists of 1000 points times 100 turns. The manager also keeps a 15 minute buffer of profiles for quick historic diagnostics. The clients to this manager include an application which shows a waterfall-like display of the profiles, and an application which uses a commercial widget to show an interactive 3D display of the profiles vs. turn. Both applications can update a live signal at 1Hz. It is planned that the tomographic reconstruction work done at CERN [11] will be integrated through a server and accessed by new properties of the same device names.

### *2.5 Sequencing*

This application orchestrates the actions in the whole machine. A minimal scenario involves injecting beam in the Blue ring, followed by a polarity change in the switching magnet, injecting beam in the Yellow ring, and the initialization and triggering of the synchronized ramping. Currently this application is implemented in Tcl/Tk with a binary extension to access CDEV. The sequence proceeds asynchronously where for micro-second resolution, delay-generators are preprogrammed and triggered by events on one of the RHIC event links. Events on these links are monitored, on a slower time scale, by the sequencer and subsequently acted upon.

### *2.6 Gateway Servers*

Control system signals need to be available outside the local control network for use by interested 3'rd parties. These include users in the experimental halls and diagnostics users in their offices. For these purposes a CDEV Gateway is installed which allows CDEV applications outside the firewall read access to a selected group of signals.

## 3 CONCLUSIONS

CDEV middleware servers have been deployed to great advantage in the AGS/RHIC environment during the commissioning phase of RHIC. New logical devices add functionality and flexibility to client applications, while hiding a lot of the complexities otherwise exposed to the end-user. The CDEV Generic Server framework provides a robust and straightforward integration of Accelerator Physics services with control system access, using the same CDEV API.

## 4 REFERENCES


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