ALMA Scheduling – It's Dynamic!

The ALMA Scheduling Subsystem has undergone substantial changes in the last couple of years. As well as a significant re-factoring, we have now implemented the dynamic scheduling framework and algorithm which will be used when the telescope begins full operations. This same framework and algorithm will be used in both the day-to-day running of the online observing software and as part of a simulation tool used by the time allocation committee. As well as an overview of the subsystem, we outline the changes made, the current factors taken into account by the algorithm and future work to be undertaken.

D. Clarke[1], J. Avarias[1]

[1] National Radio Astronomy Observatory

Introduction

At the heart of the ALMA Scheduling subsystem is its Dynamic Scheduling Algorithm, or DSA. The function of this is to choose what to observe next. This is used in two modes – online, where the observation selected is performed on the telescope itself, and offline, when we're simulating an observing semester to investigate its feasibility,

Selectors and Scorers

OpacitySelector Selects only SBs for which we can see anything at all at their representative frequency;

MoonAvoidanceSelector Selects SBs not too close to the moon;

SunAvoidanceSelector Selects SBs not too close to the sun;

HourAngleSelector Selects only SBs within 4 hours of the meridian;

SciScorer Considers the Scientific Priority assigned to the SB's Project;

HourAngleScorer Scores highly for SBs at or near the meridian;

TsysScorer Scores highly for SBs which will have a good Tsys compared to their theoretical best.

As an initial set this is obviously a little restricted. A richer set of factors is being developed, including: degree of completion of the SB and the ObservingProject, hourangle and U-V coverage, calibration status, and dependencies between SBs.

Hibernate and Spring

To access the project database we use the Hibernate object-relational mapping software to map database tables to java classes and *vice versa*. It also supports programmatically constructed *Criteria Queries*.

To allow flexibility in the definition of the scheduling factors, we use Spring. Each factor is either a *Selector* to choose viable SBs or a *Scorer* used to evaluate SBs, and is represented as a Spring bean.

Which selectors to use and how heavily to weight them are defined in a simple XML document called the *Scheduling Policy*.

Dynamic Scheduling Algorithm

1.Construct a Criteria Query from the beans specified in the current Scheduling Policy

2.Use this query to select which SBs can be observed at the current time

3.Invoke each Scorer bean specified in the current Scheduling Policy on each selected SB

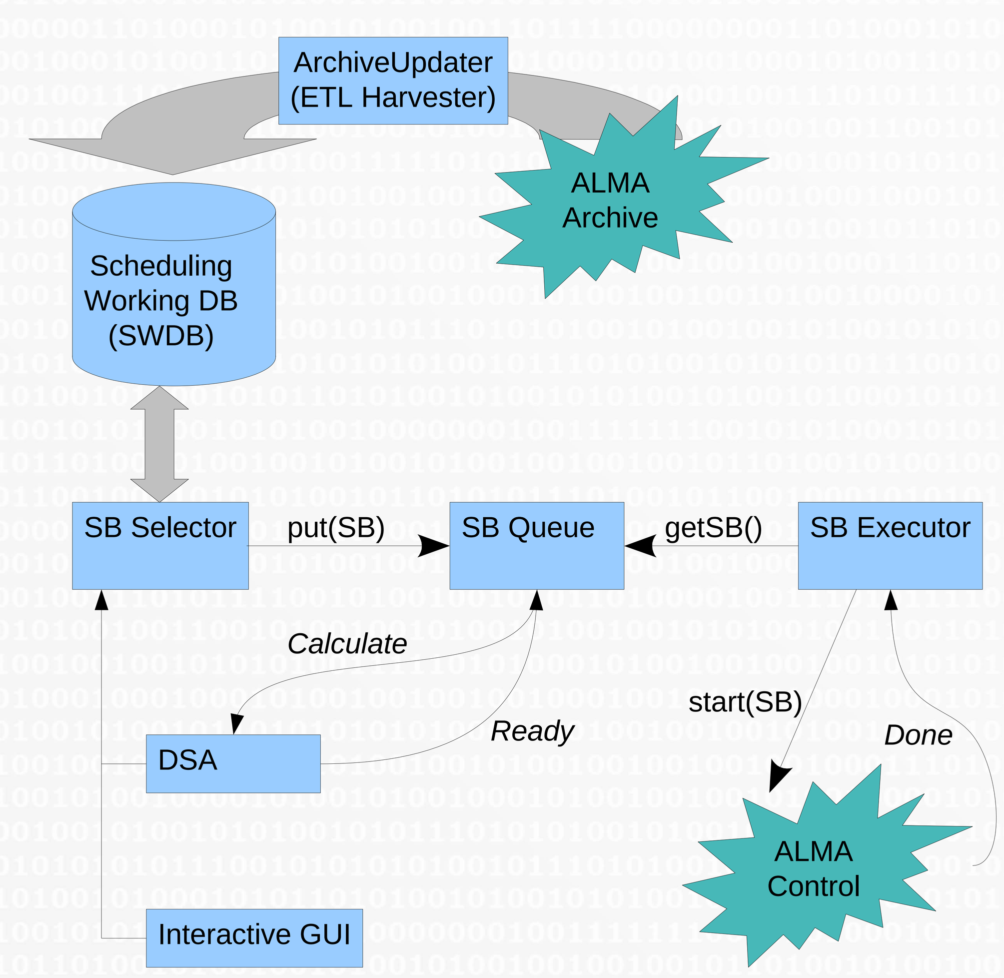
4.Using the weights in the Scheduling Policy, compute the overall score for each selected SB

5.Store the computed scores in the SWDB.

Online

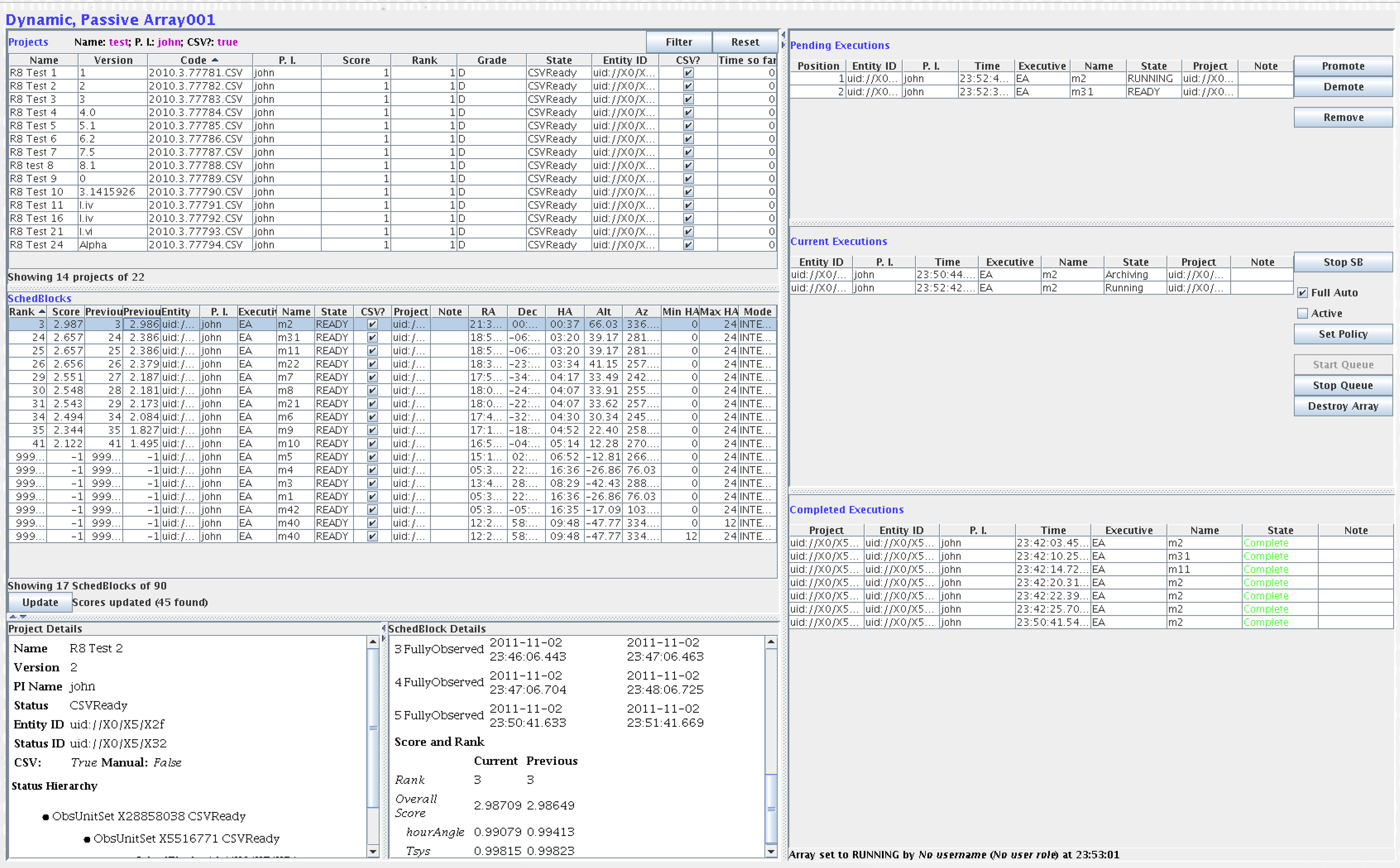
```
repeat
   set up array
   repeat
      choose SB using DSA
      simulate observation
   until configuration change
until the cows come home
```

Online Structure



Offline

```
repeat
   set up telescope configuration
   repeat
      choose SB using DSA
      simulate observation
   until configuration change
until simulated date > semester end
```



The Scheduling GUI

Acknowledgments

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, North America and East Asia in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and in East Asia by the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Academia Sinica (AS) in Taiwan. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI) and on behalf of East Asia by the National Astronomical Observatory of Japan(NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.

Atacama Large Millimeter/submillimeter Array