Astronomical Data Analysis Software and Systems IX
ASP Conference Series, Vol. 216, 2000
N. Manset, C. Veillet, and D. Crabtree, eds.

The New MAJORDOME: Efficient Scheduling of Autonomous Telescopes

M. Boër, M. Bringer, J. Berassain

Centre d'Etude Spatiale des Rayonnements (CESR/CNRS), 9, ave. du Colonel Roche, BP 4346, 31028 Toulouse Cedex 4, France

G. Fontan, C. Merce

Laboratoire d'Architecture et d'Analyse des Systèmes (LAAS/CNRS), 7, ave. du Colonel Roche, 31077 Toulouse Cedex 4, France

Abstract. In the context of the autonomous TAROT observatory we have developed an automatic scheduling software. It has the ability to select automatically the requests to be observed in the best conditions. We present here the last developments we are currently implementing, including long, mid and short term scheduling, the ability to take into account degraded conditions, etc.

1. Introduction

With the advent of automatic telescopes and the use in service mode of large facilities, the problem of efficient night scheduling is becoming more important. In the usual configuration, the observer is allocated a given amount of nights. A mixed approach has been introduced for the ESO NTT and VLT telescopes, with the use of the concept of *observation blocks* (Chavan et al. 1997). These blocks are handled by three schedulers, in charge respectively of the long, mid- and short terms. Bresina (1998) defines individual groups of observations sent to the telescope via a centralized system, the *Principal Astronomer*, with pre-affected priorities and time constrains. The system chooses the best sequence which optimizes an objective function.

The first version of our MAJORDOME software (Bringer et al. 2000a) was written for the use of the Télescope à Action Rapide pour les Objets Transitoires (TAROT - Rapid Action Telescope for Transient Objects; Boër et al. 1999), a fully automatic instrument in operation at the Calern Observatory (France). The primary goal of this instrument is the rapid detection and follow-up of Cosmic Gamma-Ray burst sources (hereafter GRBs) at visible wavelengths. For that purpose TAROT is able to slew to any location over the sky in less than 3 seconds (usually 1-2s), upon reception of a position sent by the GRB Coordinate Network (GCN)), few seconds after the GRB event has been detected. Since GRB observations uses only 10% of the telescope time, we use TAROT for various scientific objectives, usually connected with celestial variability. In order to accommodate all the above mentioned objectives, and to observe as efficiently as possible, we developed a suite of original algorithms and softwares, the MAJORDOME, in charge of the telescope schedule, which takes over the

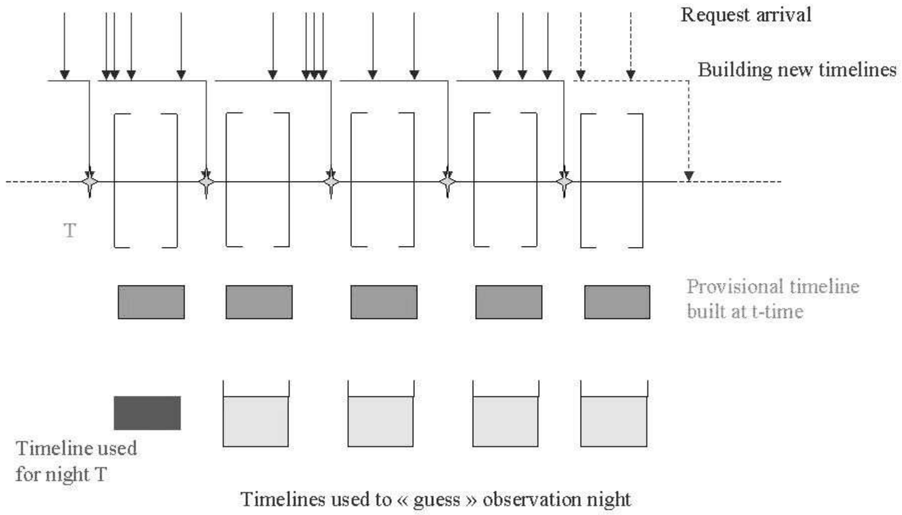

Figure 1. Request arrival, and schedule construction.

CONTROL software in the absence of any safety alarms (for a general view of the TAROT pipeline, see Bringer et al. 2000b).

2. The MAJORDOME Paradigm

Below we list some terms and concepts used for the scheduling by the MAJORDOME:

- A *request* is a set of observations requested by a distant user.
- A *group* is a set of contiguous images scheduled together. Hence a *group* is the validation and programming unit for the MAJORDOME.
- Any user may send a *request* at any time, the lifetime being 1 year.
- The user may give a constrain (period, date,...), but usually does not know when the request will be scheduled.
- All the scheduled requests (apart other constrains) should be observed in the best possible conditions. The priority evolves with time.

3. The New MAJORDOME

Following these principles we designed the MAJORDOME, the software which is already in use by TAROT. The time line is computed every day for the next night, using all the visible requests from the database. As soon as a group

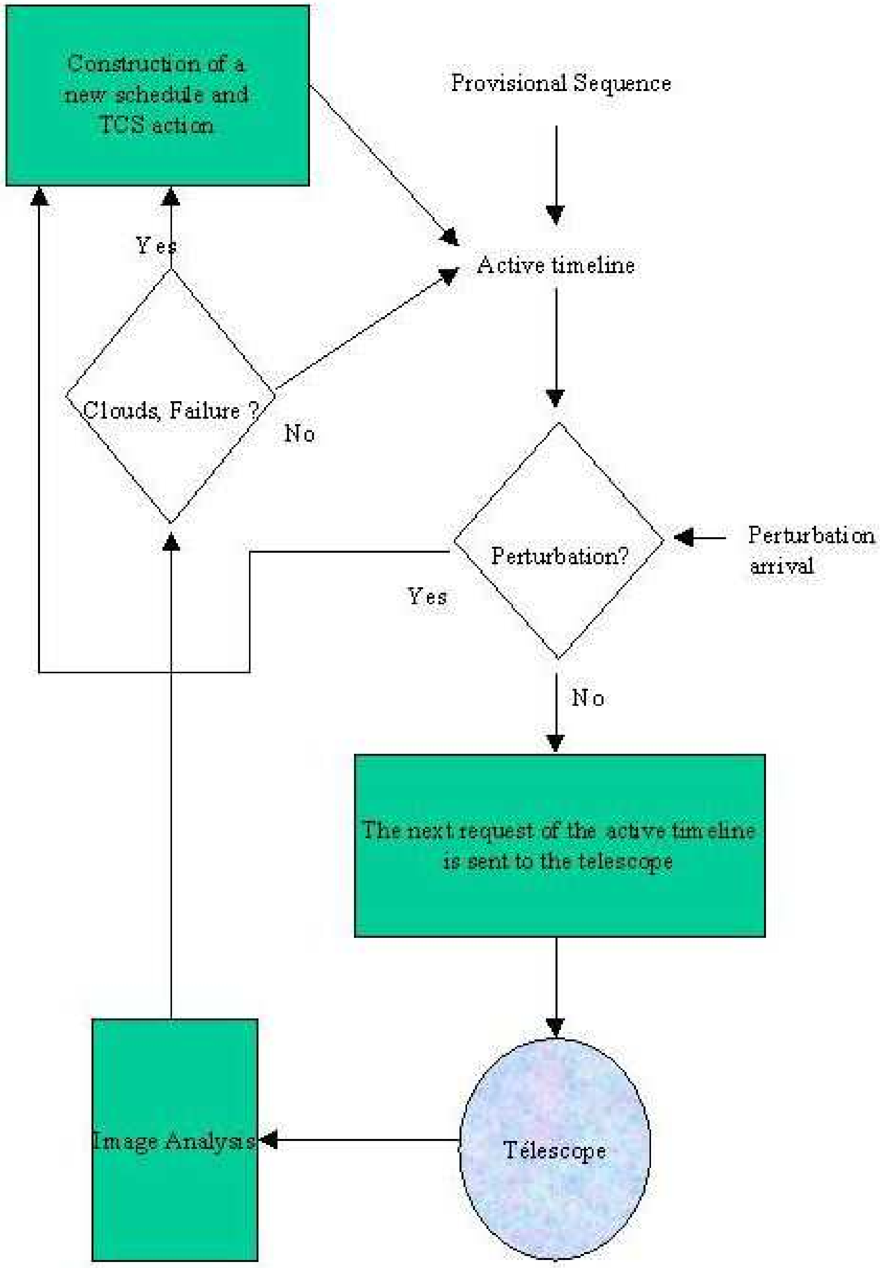

Figure 2. Functional diagram of the night operations and impact on the schedule.

has been validated, the corresponding request is removed from the database, if not periodic. This software schedules observations with an efficiency above 90%. However, we encountered some difficulties handling periodic or constrained requests with a large time interval, and it is unable to give to the telescope users and operators the visibility over the schedule. We though also that a larger programming horizon would result in more efficient optimization. The following guidelines are used:

- The user may send a request at any time, and after it has been checked, it is pre-affected a night,
- If for any reason the group is not observed during its transit period, its priority is growing,
- Periodic and constrained observation with a large (days, months) interval are allowed,
- A mid-term time line of one week is computed: this allows for efficient programming, but a longer horizon has fewer chances of realization,
- In a GRB alert occurs, a new time line is built up, including GRB follow-up observations. This approach can be extended to any TOO observations.

Figure 1 displays how the time line is built as a sliding, daily computed, series of mid-term time lines. The requests may arrive at any time. At a given time, the new nightly schedules are computed for a week. If an unexpected event happens (TOO, interruption...), a new schedule is computed for the remaining of the night. The normal process resumes the day after, including the un-observed scheduled requests. Figure 2 displays a functional diagram showing the reactivity of the system to unexpected events..

4. Discussion and Conclusions

We added also a “filter”, able to decide in which class will be an observation, and to reject eventually incorrect requests, or to react in case a given class (e.g. periodic or constraint) is overloaded. The MAJORDOME will also allow certain requests to be processed before the astronomical twilight or dawn (e.g. to search for comets or space debris), or in bad conditions (like partial cloud coverage, non-photometric night...). We are currently implementing the algorithms needed for this more complicated approach.

Acknowledgments. The TAROT experiment has been built with the support of the Centre National de la Recherche Scientifique, Institut National des Sciences de l'Univers (CNRS / INSU).

References

Boër M., et al. 1999, A&AS, 138, 579

Bresina J. 1998, Ph.D. thesis, Rutgers University, available at http://ic-www.arc.nasa.gov/ic/projects/xfr/sampling/thesis/

Bringer, M., Boër, M., Peignot, C., Fontan, G., & Merce, C. 2000a, in preparation

Bringer, M., Boër, M., & Morand, F. 2000b, this volume, 445

Chavan et al. 1997, SPIE proceedings, 3349, 97