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The Gemini Data Handling System: A Case History

Séverin Gaudet, Norman R. Hill, Jennifer Dunn, Shannon Jaeger, Steve Cockayne

National Research Council Canada, Herzberg Institute of Astrophysics, 5071 West Saanich Rd., Victoria B.C., Canada V8X 4M6

Abstract. The Gemini Data Handling System, developed by the Canadian Astronomy Data Centre for the Gemini 8m Telescopes Project, provides the data handling infrastructure for the Observatory Control System and the instrument control systems. An overview of the preliminary design was presented at ADASS '95. In August 1998, the DHS passed its acceptance tests and was released operationally to Gemini North in Hawai'i. This paper will present a case history of the project: how the requirements changed, how the design evolved to its final form, the approaches taken, the tools used, and the problems encountered.

1. Introduction

The Gemini Data Handling System (DHS), developed by the Canadian Astronomy Data Centre (CADC) for the Gemini telescopes, provides the data handling infrastructure for the Observatory Control System (OCS) and the instrument control systems. An overview of the preliminary design was presented at ADASS '95 (Gaudet 1996). This paper will not discuss the functionality, design, user interfaces, nor technologies of the DHS, as details on these topics are documented elsewhere (Cockayne et al. 1998a, 1998b; Dunn et al. 1999a, 1999b; Hill et al. 1999a, 1999b; Jaeger et al. 1999). Rather, we will present a case history of the project: how the requirements changed, how the design evolved to its final form, the approaches taken, the tools used, and the problems encountered.

2. Evolution of the Project

The Gemini software system is being produced mostly by allocated work packages to institutions in the partner countries to tap into existing skills, expertise, and experience (McGonegal 1996). An international committee worked on the high-level design of the whole control system which defined the functionality and boundaries of all work packages, including the DHS.

Early into the contract, it became obvious that the requirements for the DHS were not complete. But as the various design steps proceeded and the requirements were completed, the design evolved causing changes in both the DHS functionality and the DHS boundaries with other systems.

The design evolved from a sequenced single-threaded, single server program for each instrument into a data-driven, multiple threaded servers, each encapsulating some functionality. The DHS is also capable of accepting data from many sources simultaneously. The system also became highly configurable in terms of data structures, topology, and data dictionary to allow Gemini to adapt it to the emerging summit requirements. In addition, the system had to be distributed where subsets of the DHS would run both at the summit and at the base facility.

3. Approaches Taken

- **Object-oriented.** A team decision lead to the adoption of object-oriented methodology for both the design (Booch) and development (C++).
- **Multi-threaded distributed servers.** We used multi-threaded servers to encapsulate functionality and to localize interfaces to the rest of the Gemini software systems. For example, there is only one server handling the data put and get requests.
- **Persistent store.** The SYBASE RDBMS was used to store file status and location as well as history records.
- **Code re-use.** We have utilised many CADC data management libraries as well as *cfitsio* (NASA), the *IMP* messaging system and *SDS* data structures from AAO, ESO's *Skycat* display tool, and the Gemini Project's tcl/tk shell *OCSWish*.

4. The Environment

To allow the team to work as efficiently as possible, the proper working environment had to be created. This consisted of:

- **A well supported development environment.** The CADC already had a code management process that allowed four programmers to work simultaneously with a minimum of conflicts, allowed for configuration management, and had well defined installation and release procedures.
- **Good tools.** This included a good design tool (Rational Rose), a good set of base classes implemented early in the project (libdhs++, libGen, libdhsSta), a good debugging environment with thread support (Visual Workshop), and a good documentation tool (Framemaker).

5. Problems Encountered

- **External contract vs. partnership.** Since we were in a contractual relationship with the Gemini Project, we could have managed the evolving design with change orders, etc. However, because of our partnership status, we had a stake in the final result. We had to be driven by "We have to produce something that works, not something that meets spec!". So it became a balancing act between needs versus resources.
- **External contract vs. internal work.** The CADC has been developing software for many years, mostly to support our core archiving activity. As in most groups, internal development does not follow a formal methodology but relies on back-of-the-envelope design and ad-hoc testing. Although

not easy, the group managed the transition to a new culture of a formal methodology.

- **Not all interfaces were well defined.** As the DHS design evolved, some functions originally in the DHS were moved to other work packages and some functions initially in other packages were moved to the DHS. This necessitated the development of new interfaces, some of which took a long time to finalise.
- **Separation of UNIX vs. real-time systems.** The DHS is mostly a UNIX system, but part of the core library is to be used by instruments running under the VxWorks real-time system. Porting the UNIX library was a Gemini Project responsibility which was continually delayed by lack of resources.
- **No instrument teams ready.** The DHS team, with the help of some Gemini scientists, had to make design decisions on data structures and data processing without being able to consult with instrument teams.
- **Developers not involved in high-level design.** The high-level design of the DHS was done before the CADC became involved with the project (see §2.). We had to accept a work package with fixed costs and fixed requirements, requirements which we could only interpret based on our assumptions - some of which proved wrong!

6. Strengths

- **Good team.** This is the essential ingredient for success. The DHS team shared a vision of the final product, adapted to the methodology and the environment and worked very hard and very well together to attain the goal.
- **Solid design.** The design presented at the Preliminary Design review proved to be a solid foundation upon which detailed design of all the subsystems of the DHS could proceed.
- **Formal project methodology.** Breaking the project down into manageable, measurable tasks allowed for the trace-ability of progress and costs. Microsoft Project was used to organize this information.
- **Interfaces.** The fact that most major interfaces were fixed early in the project helped minimize the assumptions on work package boundaries.
- **Meetings.** Travel was part of the project budget and that was a wise decision. There is nothing like face-to-face meetings with other groups to resolve misunderstandings common to distributed projects.

7. Conclusion

As mentioned above, the Phase 1 delivery of the DHS is up and running on Mauna Kea in preparation for first light. Phase 2 has been negotiated and the DHS final delivery is scheduled for January 1999. Not all requirements will have been met because of both the evolving requirements and the underestimation of the cost. The cost breakdown for the DHS project to date is shown in Fig. 1.

Overall, the experience has been positive for the CADC. The formal methodology and the new technologies have been good learning experiences and have

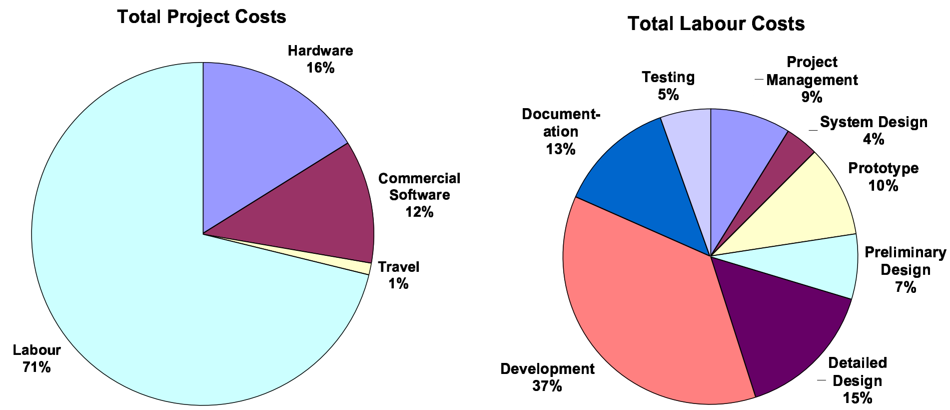

Figure 1. Total project and labour costs shown as percentages.

provided the team with intellectual challenges. This knowledge can now be applied of internal CADC projects. In addition, the CADC plans to re-use many parts of the DHS to augment the CADC archiving systems.

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