IFWG Memo: Approach for costing MROI controls

John Young, Roger Boysen and David Buscher

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OBJECTIVE

To outline a bottom-up approach for costing all the hardware and software associated with in-house controls for MROI.

SUMMARY

We advocate a bottom-up approach to cost in-subsystem but in-house controls effort, and for more accurate costing of the top-level control system. This approach is intended to be complimentary to the earlier top-down treatment.

We confirm our support for the "large subsystems" model previously agreed for the control system. We suggest a modification whereby strict interfacing is adopted for subsystems that are the responsibility of in-consortium teams, with loose interfacing retained for those subsystems that are contracted out to commercial suppliers.

A summary of the proposed costing procedure is as follows. Steps 1–3 and 6 have mostly been done, but the results are not presented in detail here.

1. Identify hardware that needs to be controlled
2. Identify communication links
3. Group into "large subsystems" and decide which will be developed in-consortium
4. Compare with headings in overall costing
5. Cost hardware and software inside in-consortium subsystems
6. Cost the OCS
7. Update when baseline design is finalised

We must decide whether to assume the use of EPICS in costing the controls effort.

1. INTRODUCTION

Previous discussions have concluded that the favoured model for the MROI control system is the so-called "Large subsystems without strict interfacing" model. Dividing the observatory into large subsystems means creating boundaries between subsystems such that the only communication that takes place outside a subsystem is with a top-level control system (henceforth the Observatory Control System, or OCS). This communication should be low-bandwidth, all high-bandwidth links being confined within individual subsystems.

"Without strict interfacing" means that the protocol by which any subsystem communicates with the outside world is left up to the subsystem provider (the types of information that can be communicated must be defined by the OCS team however). Interfacing a subsystem to the OCS is the responsibility of the in-house team writing the OCS. This would be accomplished by adding an interface computer to perform translations between messages understood by the OCS and messages understood by the subsystem (Figure 1).

Attempts have previously been made to cost the staff effort and hardware associated with the OCS and interface computers. However, in order to cost *all* of the in-consortium controls effort we must consider who will provide the "large subsystems".

The authors are of the opinion that the project cannot afford to have commercial suppliers for most of the large subsystems required for the interferometer. In particular we suggest that only the unit telescopes (excluding the fast guider/source acquisition system and perhaps the wide-field pointing system — see Figure 2) be contracted out.

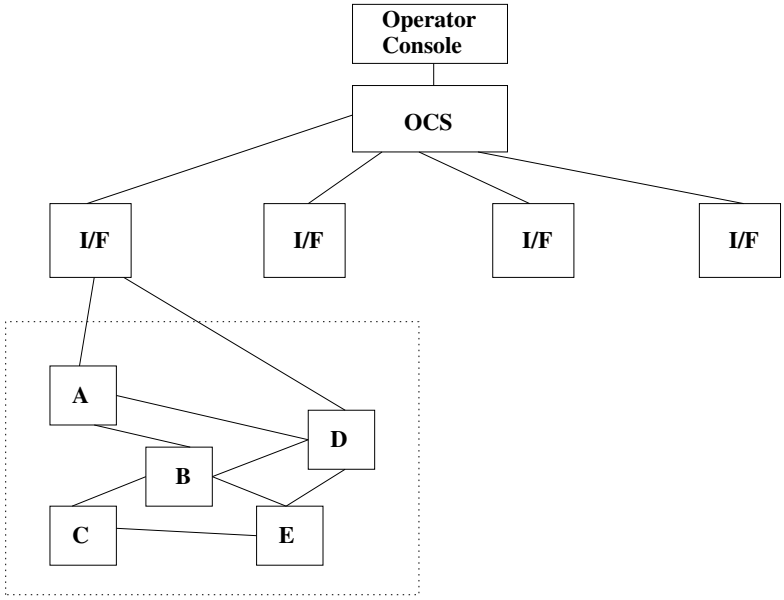

Figure 1. Illustration of large subsystems with loosely-defined interfaces. The boxes labelled "I/F" are computers whose function is to interface the top-level control system (OCS) with a particular subsystem.

The choice of "large subsystems" was made primarily to minimise in-house staffing, assuming external (in some sense) providers for the subsystems themselves. We believe the large subsystems model is still very useful in designing the control system, as it broadly separates low-level, high bandwidth control of hardware from the top-level sequencing needed for automated observing. It may also be helpful in separating the work done by different consortium members.

The choice of "loose interfacing" was driven by the desire to minimise the cost of commercially-provided large subsystems, to keep the task of interfacing subsystems to the OCS in the hands of the team writing the OCS, and to facilitate the creation of simulators for yet-to-be delivered subsystems. All of these arguments become much weaker for subsystems developed in-house rather than by a commercial supplier.

In the case of a large subsystem that is put together within the consortium, the *total effort* associated with producing the subsystem and interfacing it to the OCS is likely to be reduced if *strict interfacing* (i.e. specifying a communication protocol as well as what information can be communicated) is adopted. This approach also removes the need for a separate interface computer.

Loose interfacing is still recommended for those subsystems (probably only the unit telescope and its associated drive system) that will be contracted out.

2. PROPOSED COSTING PROCEDURE

We now describe a procedure for costing the in-consortium hardware and software for controls.

2.1. Identify hardware that needs to be controlled

Where the design of the interferometer has not been finalised, we must make some assumptions. It may be sensible to aim for a conservative costing by choosing the options that are most complicated from a controls point of view.

For the assumed design, we must count all of the actuators, sensors, amplifiers etc. that are directly connected to computers, as well as the computers and their I/O cards.

2.2. Identify communication links

We must identify the communication links needed between these computers to close servo loops etc., and also estimate their bandwidth requirements. Further communication links will be needed with the OCS, but the control system should be designed so that these are low-bandwidth.

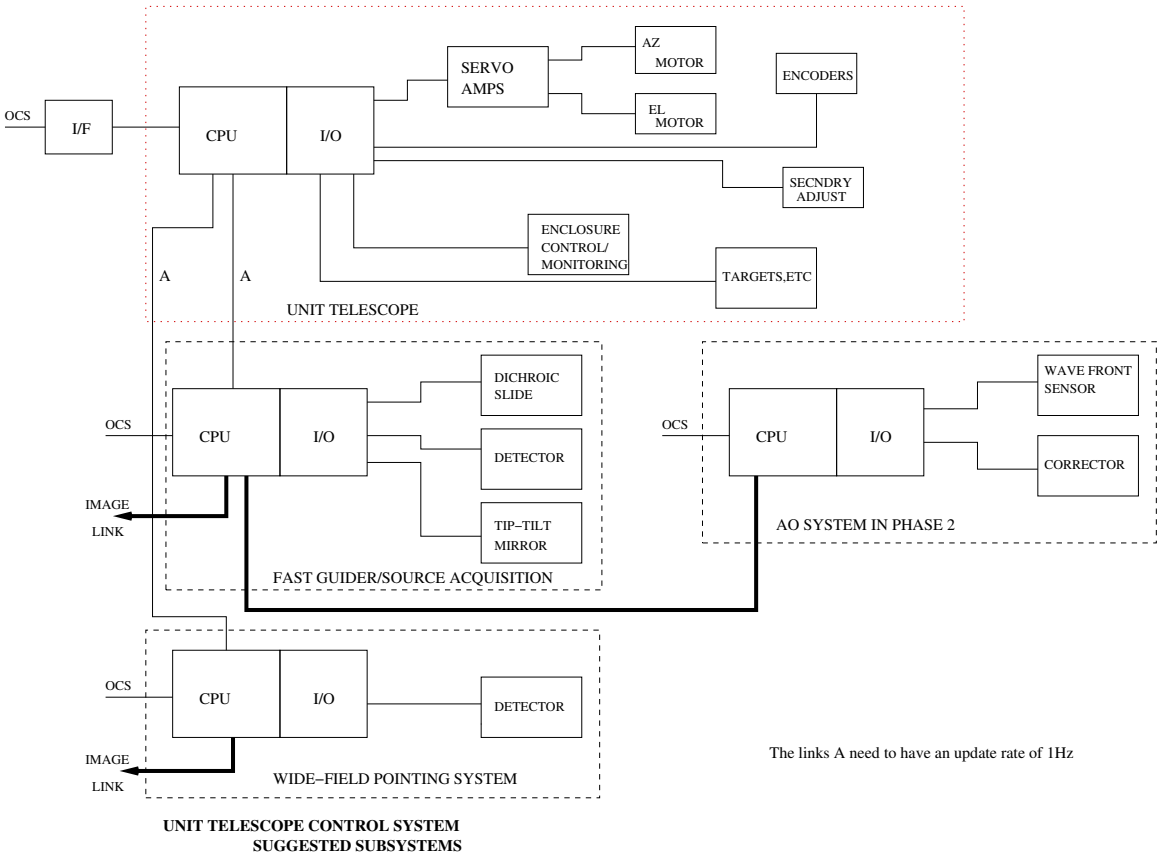

Figure 2. Suggested grouping into subsystems (part 1). High-bandwidth links that cross subsystem boundaries are drawn as thick lines. Subsystems to be contracted out have dotted boundaries.

2.3. Group into "large subsystems"

We must group the hardware and its control computers into subsystems, generally according to the bandwidth criterion outlined above (but perhaps allowing high-bandwidth *non-servo* links for e.g. video display and archiving to cross subsystem boundaries). However, we should break the bandwidth rule where it would be unrealistic for a commercial supplier or single consortium institute to be responsible for a subsystem in its entirety.

A suggested grouping is given in Figures 2 and 3. The reader should note that the design assumptions are fairly arbitrary at this stage. We have assumed that only the "unit telescope" subsystem will be commercially supplied, hence an interface computer is only included between the OCS and this subsystem.

The interferometer working group should agree which of the large subsystems are assumed to be produced in-consortium, and which are to be the responsibility of a commercial supplier. The baseline costing should incorporate *quotations* for subsystems in the second category, and bottom-up costs for those in the first.

2.4. Compare with headings in overall costing

The large subsystems defined in the previous step will not necessarily correspond to the headings which we will use to cost the baseline design. The main aim of the process described in this memo is to ensure that controls are properly costed under these headings. We must ensure there is no double-counting or omission of hardware or effort.

2.5. Cost hardware and software inside in-consortium subsystems

We will have estimated how much hardware is contained within each subsystem, and this should allow us to estimate costs by scaling values for previous projects. In particular the COAST team has first-hand experience of this sort of low-level control system.

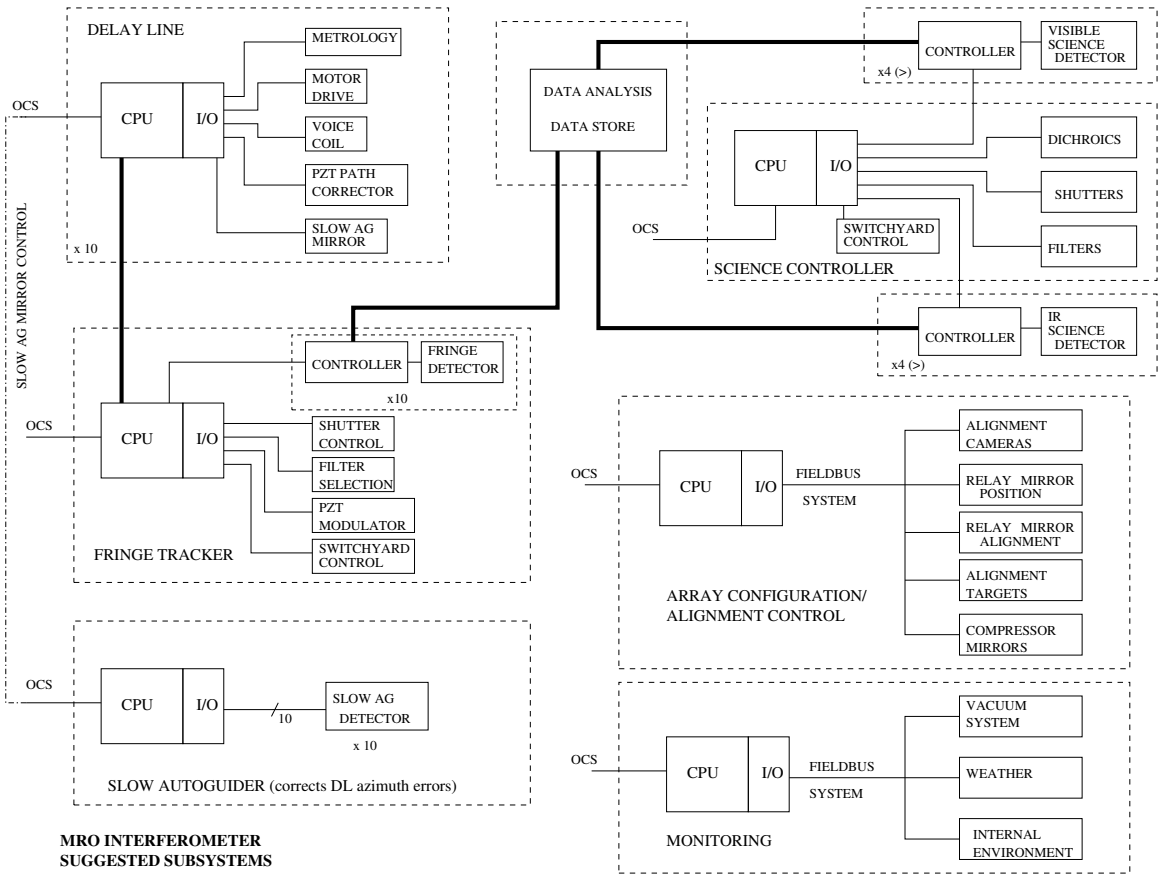

Figure 3. Suggested grouping into subsystems (part 2). High-bandwidth links that cross subsystem boundaries are drawn as thick lines.

We have to decide whether to assume the use of EPICS. If we do use EPICS, it would be preferable to adopt it for all in-consortium subsystems. Some of the pros and cons of using EPICS for MROI are as follows.

Advantages:

- Easier to interface to controlled hardware, making use of existing drivers
- Most of OCS software infrastructure already written
- Less forethought needed about what information must be accessible from where
- More reliable costing possible?

Disadvantages:

- Must use supported hardware and operating systems — these may be more expensive
- Learning curve
- High-bandwidth links must be implemented outside EPICS

2.6. Cost the OCS

We have attempted this already, using a top-down approach (see Anders' memo). The bottom-up approach allows us to estimate the number of computers connected to the OCS, which may help in costing the programming effort. Note that the hardware costs will be reduced from previous estimates, as the number of interface computers is smaller than before.

2.7. Update when baseline design is finalised

When the baseline design for the interferometer is agreed, we must ensure the controls costs are consistent with it.