CO-SOURCING DEVELOPMENT OF ACCELERATOR CONTROLS

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Abstract

Frequently, accelerator facilities make use of products and services offered by the industry. This paper's focus is on such outsourcing of control system hardware and software. Firstly, an attempt is made to explain the facility's motivation for seeking outside help, which is typically due to lack of resources, technology or knowledge. Then, the risks of outsourcing are enumerated. To mitigate them, the industrial partner should have not only the adequate technical expertise, but also a reliable, yet agile management and quality assurance process that meets the facility's expectations, schedule, budget constraints, maintenance and support needs. Finally, *Cosylab*'s business model is presented, designed to provide lasting open-source solutions that help not only a single facility, but the entire community.

INTRODUCTION

In the last decade, outsourcing became a hot topic in the business world: the *outsourcer* hires inexpensive labour, typically overseas (the *outsourcee*), to perform time-and-material work. There are a plethora of risks in doing so – distributed, incoherent development teams, the inadvertent transfer of technology and domain knowledge to the outsourcee, and increased unemployment rate. It appears that the benefits – reduced development costs – outweigh the risks. But this is so in the commercial world; are research facilities any different?

In this article's *Outsourcing* section, the classical outsourcing model is explained, with its advantages and risks enumerated and briefly discussed. The section following it focuses on technological and organisational specifics of *Accelerator Controls*. The *Co-sourcing* section introduces a variation of the outsourcing model, which allows industrial partners to participate in development of controls to the benefit of the entire community, not just a single research facility.

As an example, company *Cosylab* and some of its co-sourcing endeavours are described. The lessons learned in the several years of co-sourcing experience are briefly summarized in the *Co-sourcing Guidelines* section.

It should be noted that some of the authors of this paper are affiliated with *Cosylab*. However, a sincere attempt was made to present the subject of co-sourcing in an un-biased manner, to be helpful to accelerator facilities and other industrial partners as well.

OUTSOURCING

When building a complex system such as controls of an accelerator, it is inevitable that many components will have to be acquired and then integrated into a whole. Some of these, such as CPU power or computer networks, are available commercially, and it is economically much more feasible to purchase them than to build them in-house.

During selection of commercial products with rich feature-sets (in particular software) the probability that the features won't be quite right is considerable. Also, complex products are more likely to be defective than simple ones. Such products that are available off-the-shelf are typically proprietary. Proprietary development model is a necessity to secure the commercial interests of the vendors, but might not deliver the best value to the buyers. Therefore, custom development must often take place.

Custom development can be done either in-house, or entrusted to an external organisation – the outsourcee (see Figure 1). The outsourcer hires an outsourcee on a time-and-material basis, who then delivers work against the outsourcer's product. Often, the outsourcer strives to retain the domain knowledge. The process is usually cost-efficient because of the low cost of outsourced work.

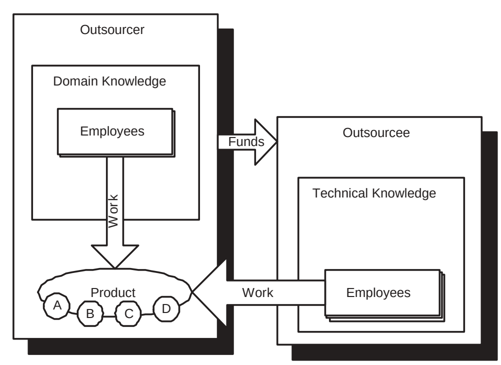

Figure 1: Classical outsourcing model.

Motivation for Outsourcing

The most commonly cited reasons why outsourcing is a desirable alternative to in-house development are:

- **Special tools.** The project might require special tools that would be too expensive to purchase for a project only to remain unused afterwards.
- **Production process.** The process required for the project to yield deliverables of high quality is not yet established in an organisation.
- **Additional resources.** An organisation might not have enough available personnel that could carry out a project, at least not in the desired time frame.

- **Knowledge.** The project involves knowledge that is beyond the scope of the organisation's core competence.
- **Scale of a project.** Mid-sized, several person-month projects are too small to employ additional staff, yet too large to be done in parallel with other activities.
- **Access to a wide assortment of expertise.** The outsourcee employs workers of various profiles, meaning that organisation would also have to employ more than one person to attain the same level of efficiency.

Risks Associated with Outsourcing

Projects that involve outsourcing have additional factors that might increase the risk of their failure:

- **Communication difficulties.** The outsourcer and outsourcee are typically geographically dispersed, incurring an overhead in communication.
- **Disapproval of in-house staff.** Having the work done externally might cause discontent of those who feel they could have done it by themselves.
- **Intellectual property rights and legal issues.** If ownership of project's deliverables is not agreed upon beforehand, either or both of the parties involved in outsourcing might be limited in their exploitation.

ACCELERATOR CONTROLS

Accelerator controls have many building blocks in common. For example, the types of devices (power supplies, vacuum pumps and gauges, RF cavities) and the process variables pertaining to them (current, vacuum pressure, RF frequency and amplitude) are fairly ubiquitous. Also, some common problems and their resolutions are reusable across research facilities.

The research community does not keep its domain knowledge proprietary to the extent found in the commercial world. This makes it possible to share concepts, ideas, program code and even hardware designs between research facilities. However, as there is no broker that would coordinate the dispersed effort of all facilities, the researchers might find only at conferences or in papers that a work like their own was being done simultaneously by someone else (see Figure 2).

CO-SOURCING

Co-sourcing is a viable outsourcing model for research facilities (Figure 3). The facilities do the work they do best, and leave the rest to a *co-sourcing partner*. The co-sourcing partner has sufficient knowledge, both domain and technical, to ensure that the product fits the needs and expectations of not only the facility, but also the entire community. If the resulting product is software, it might be made available under a free license. To an individual facility, the scheme is cost-efficient, as it contributes only a fraction of the funds required to cover the entire effort.

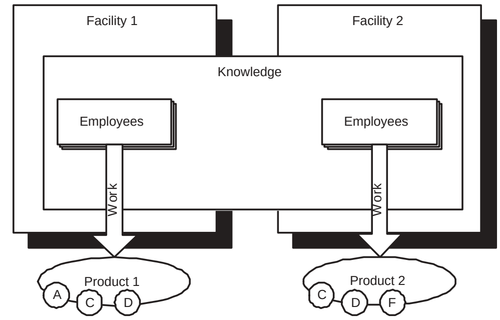

Figure 2: The approach of research facilities. Facilities share knowledge, however each maintains its own homemade product. Even though the products are typically freely available, the likelihood of their spontaneous convergence is small, as it would require a large amount of effort and consensus.

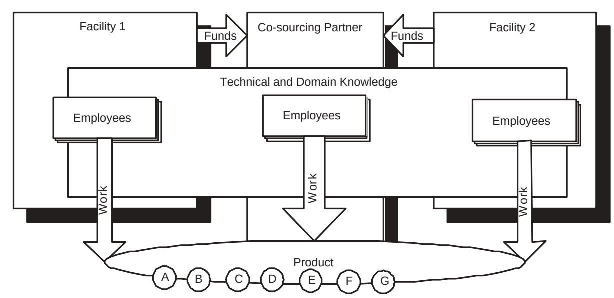

Figure 3: Co-sourcing.

EXAMPLE: COSYLAB

In the late 1990's, a team of researchers at the *Jožef Stefan Institute* developed a control system for the *Angströmquelle Karlsruhe* synchrotron light source (ANKA). In 2001, they founded *Cosylab*, a spin-off company of the Institute, which specialises in development, integration and support of control systems for large experimental physics facilities. *Cosylab* has extensive domain knowledge in the field of distributed control systems, as well as its specific applications for control of particle accelerators and telescopes.

Cosylab is cooperating on many projects with various research laboratories, among them (in no particular order): *Australian Light Source* (Australia), *Diamond synchrotron light source* (UK), *Deutsches Elektronen-Synchrotron – DESY* (Germany), *European Southern Observatory – ESO* (Germany), *Forschungszentrum Karlsruhe* (Germany), *Gesellschaft für Schwerionenforschung – GSI* (Germany), *Paul Scherrer Institute* (Switzerland), *Sincrotrone Trieste* (Italy), *Spallation Neutron Source* (USA) and *Riken* (Japan).

Whenever applicable, the contractual agreement between *Cosylab* and the research facility adheres to the co-sourcing principles. Some examples are briefly described in the following subsections.

EPICS Development, Integration and Consulting

The *Experimental Physics and Industrial Control System* (EPICS) is a widely accepted control system infrastructure in experimental physics community. It has an active community of users that are supporting each other by exchanging advice and code (e.g., drivers).

Cosylab has successfully completed several projects that involved implementation of EPICS-based controls, for example a girder mover for the *Swiss Light Source* and a *Delta U55* beam-line control for the *Delta synchrotron*. Currently, *Cosylab* is building controls for the booster of the *Australian Light Source*. The knowledge and experience gained in projects like these is useful for widening the array of services the company can offer to research facilities, which already include consulting and training.

Through the co-sourcing approach, *Cosylab* is developing a pure Java implementation for the EPICS *Channel Access*. One of the future goals in this area is to unify the existing solutions to common problems (e.g., archiving services and viewers).

Visual Database Configuration Tool

Visual Database Configuration tool (Visual DCT, [3]) enables engineers to graphically compose EPICS records and links between them with a user-friendly *drag-and-drop* technique, a task that would otherwise have to be performed by lengthy and error-prone editing of text files.

The development of Visual DCT was performed by *Cosylab*, however feature requests and sponsorship of the development came from many research facilities, including the *Swiss Light Source* (*Paul Scherrer Institut*), *Advanced Photon Source* (*Argonne National Laboratory*), *Diamond Light Source*, *Thomas Jefferson National Accelerator Facility* and *Spallation Neutron Source*. Visual DCT is freely avalable under an open-source license.

Advanced Control System

European Southern Observatory (ESO) and *Cosylab* are jointly developing the *Advanced Control System* – ACS[1] – an infrastructure for development and deployment of distributed, object-oriented control software [2]. ACS is built using experience, technology and best-practice acquired by *Jožef Stefan Institute*'s researchers while developing the ANKA control system, and by ESO's experience with control software for the *Very Large Telescope*.

Development started in 2000, and today ACS is a mature, yet evolving, product. Even though primarily driven by ALMA requirements, it is reusable for other facilities as well, thanks to the *Lesser GNU Public License* (LGPL) under which it is freely obtainable. So far, ACS has been deployed at the *Hexapod Telescope* of the *Bochum University*, the *Atacama Pathfinder Experiment* (APEX) of the *Max Planck Institute* and at the ANKA synchrotron light source.

[1] In the context of the *Atacama Large Millimeter Array* radio telescope – ALMA – ACS acronym stands for *ALMA Common Software*.

The ANKA Control System

The team of researchers at *Jožef Stefan Institute* that founded *Cosylab* initially developed a turnkey control system for the *Angströmquelle Karlsruhe* (ANKA) synchrotron light source. Initial implementation, which started in 1996 and ended in 2000, was seamlessly upgraded by ACS in 2002, which by then improved in reliability and usability [4].

The example of the ANKA control system demonstrates that it is indeed feasible for a facility to let a co-sourcing partner exploit the product it had developed.

CO-SOURCING GUIDELINES

Co-sourcing relationships are particularly beneficial for all involved parties if they last for a longer period of time. Therefore, a research facility should choose the co-sourcing partner wisely, paying attention to its domain knowledge, technical expertise and quality management maturity. These capabilities of the co-sourcing partner can be best put to a test if the partnership starts with a small project.

Copyright and other legal issues should be resolved early, so that the partnership does not become a burden later on. In particular, research facility should ensure that its exploitation of the product can not be limited.

CONCLUSION

For development, integration and support of accelerator controls, outsourcing may sometimes be unavoidable. The examples in this paper strive to show that the benefits and efficiency of outsourcing can improve if a vendor-consumer relationship between the outsourcer and outsourcee is advanced to a co-sourcing partnership between a co-sourcing partner and the community of research facilities.

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