



Project IST-2001-38314, COLUMBUS

Design of Embedded Controllers for Safety Critical Systems

The COLUMBUS Experience: An experiment in joint transatlantic research

September 15, 2004

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3	University of l'Aquila	AQUI	Contractor
4	Institut National de Recherche en Informatique et en Automatique	INRIA	Contractor
5	University of California, Berkeley	UCB	Contractor
6	Vanderbilt University	VU	Contractor
7	PARADES, Rome	PARADES	Subcontractor

DOCUMENT HISTORY

Release	Date	Reason of change	Status	Distribution
0.1	20/5/2004	First draft	Draft	Partners
0.2	28/7/2004	Revised based on partner comments	Draft	Partners
1.0	10/8/2004	Revised based on partner comments	Draft	Partners, project officer
1.1	15/9/2004	Revised based on project officer comments	Final	Partners, project officer

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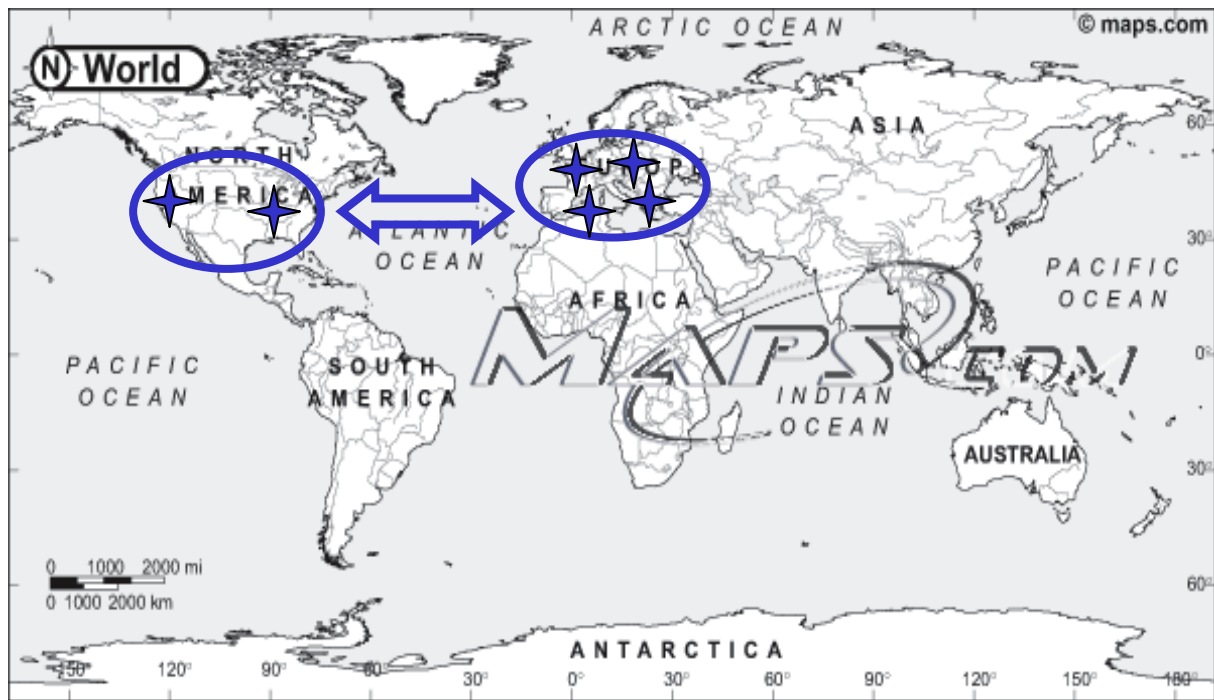
1. Introduction

The COLUMBUS project (IST-2001-38314) started on July 1, 2002, with duration of 24 months. The main goal of the project was to develop a framework for the design of controllers for safety critical embedded systems. Such systems arise, for example, in automotive systems, avionics and air traffic management.

In addition to the challenges facing the designer of any embedded system (heterogeneous modeling, real time constraints, etc.) safety critical embedded systems pose additional problems, because of the requirement to meet hard safety specifications. The COLUMBUS project set out to address fundamental issues that would pave the way for the development of a formal design methodology that would allow one to develop safety critical systems that are correct by design. The problems addressed in this context can be grouped in three classes:

1. Standardization: The development of a common language and environment in which tools and methodologies can be interchanged in a semantically transparent way.
2. Extending the current paradigm: The addition of features (e.g. stochastic uncertainty) to the current embedded system modeling paradigms, needed to capture safety critical applications.
3. Systematic design procedure: The development of a meet-in-the-middle methodology for the systematic design of safety critical embedded systems.

Problems in these areas are widely recognized as key for many technological developments and have therefore attracted the attention of the research communities both in the US and in Europe. Because of the difficulty of these problems, it was decided that the best way to address them would be to try to exploit sources of excellence on both sides of the Atlantic. The COLUMBUS project attempted to bring together the expertise of 2 teams in the US and 4 (later 5, due to a change of institution by the coordinator) teams in Europe in a joint transatlantic research effort.



As COLUMBUS approaches its completion, it is time to take stock of both the scientific and the administrative aspects of the project. In this short document the COLUMBUS team would like to share their experience on the transatlantic nature of the project. We list the main issues we encountered working in this environment and discuss ways that similar collaborations can be improved in the future.

2. Main features of the collaboration

From the beginning of the project it was clear that, due to contractual terms and the basis of the EU-US science and technology agreement, it would be impossible to use EU R&D funds to directly support the research effort of the US partners. Fortunately, the US partners were able to secure independent grants on topics closely related to COLUMBUS from funding agencies in the US (most notably NSF). These funds were used to cover the cost of their research contribution to COLUMBUS, part of the commitment they made by signing the EU contract. In addition, the COLUMBUS consortium was able to cover some of the travel expenses for distinguished researchers from the U.S. teams to attend the progress meetings and reviews and to visit the EU teams for collaboration. COLUMBUS also gave the opportunity to EU researchers to visit the US and hold the second project review meeting in Philadelphia in March 2004.

Despite the fact that there was no direct R&D funding transfer across the Atlantic, COLUMBUS still proved an effective vehicle for fostering transatlantic collaboration. Through the progress meetings, reviews and the joint work necessary for the preparation of deliverables, the project provided the opportunity for regular contact between the teams on both sides of the Atlantic. In some cases, simply the existence of the project provided people with the opportunity and motivation to look for possible collaborations overseas.

COLUMBUS provided the means for existing collaborations to flourish further and new collaborations to develop. The feeling among the members of team is that COLUMBUS was a world class research effort. Team members were able to make substantial contributions that would not have been possible without the opportunity and support for transatlantic collaboration provided by the project. In particular, fundamental advances have been made on the topic of composition of heterogeneous systems by combining the expertise and former results by the INRIA team and Paul

Caspi on synchronous languages and de-synchronization with the formal framework for comparing models of computation developed at Berkeley. Without COLUMBUS this significant accomplishment would not have been possible.

The significance of the results achieved by the team encouraged us to plan for a continuation of the collaboration. All the partners voiced strong interest in participating to other research activities that could even enlarge the group with a few selected teams in Europe and the US so as to increase the sphere of competence without violating the principle of a small focused team with members who could work well together at all levels.

3. What helped

A key factor that contributed to the success of the COLUMBUS transatlantic experiment was that fact that the project was small, which, coupled with the flexible management style of the project officer, meant that the administrative overhead was fairly low (in comparison with the average EU project). This made it easier, among other things, to keep US partners involved and interested.

The small size of the project also contributed to stronger links being formed between the participants, since it made it easier for everyone to attend and follow the meetings and establish personal contact with one another. Another factor that contributed in this direction was the fact that some links already existed among certain participants. For example, the coordinator was a member of the U.C. Berkeley team for a number of years, the subcontractor PARADES was founded by a U.C. Berkeley faculty member and AQUI and INRIA have a long standing collaboration with U.C. Berkeley. The fact that at least some of the core team members already knew each other and could work together provided some solid ground to get the collaboration going at the initial stages of the project and paved the way for further collaborations between other team members to develop.

Perhaps the most important factor that ensured the COLUMBUS team was able to work together despite the lack of direct R&D funding to the US partners was the fact that the collaboration was of interest beyond its financial aspects. The COLUMBUS project was centred on topics which were at the heart of the research interests of the teams involved. Before COLUMBUS other efforts were made to establish transatlantic links in IST related areas. Most met with limited success. Part of the reason for this may be that the emphasis of many of these efforts was not research per se, but networking, the development of common standards, or a common research agenda. COLUMBUS on the other hand was mostly research based dealing with problems people were keen to work on.

Finally, it would be an omission not to mention the contribution of the project officer towards the success of the project. The project officer was very supportive of the effort, took into account the special needs of a consortium, and put in a lot of effort to clarify and resolve the administrative complications that arose because of the transatlantic nature of the project.

4. What would have helped even more

Direct R&D funding of the US partners would have made the collaboration easier. The US partners had to rely on other sources of funding to support their research effort on COLUMBUS. Luckily, at around the same time, both US partners were able to secure funding on closely related projects from agencies in the US. To facilitate transatlantic collaborations in the future it would be good not to leave this aspect up to luck. One idea would be to establish direct contacts between funding agencies in Europe and the US and highlight common topics in their research agendas that could serve as starting points for joint transatlantic projects.

More flexible rules would also facilitate further the collaborations. One example is the rules regarding travel. The requirement to ask for permission for EU partners to travel to the US added an unnecessary level of administrative overhead, because it required careful planning and justification for all transatlantic travel, limiting the potential for spontaneous collaborations. Another degree of freedom that would have helped is the ability to establish new collaborations, unforeseen at the beginning of the project. For example, Paul Caspi collaborated with the INRIA and PARADES teams on certain aspects of their COLUMBUS work. However, because he is not a member of any of the COLUMBUS teams, the collaboration was kept informal. This worked reasonably well, primarily because Paul Caspi is in Europe. With the present rules such an informal link would have been very difficult to maintain with someone in the US, due, for example, to the restrictions imposed on travel discussed above. It would be good to provide a contractual or administrative mechanism for enabling such collaborations, without the time consuming formal procedure required to add new partners to the project.

5. Summary

As we approach the end of the project it becomes increasingly apparent that the collaborations established through the COLUMBUS project were both very productive and enjoyable. Even though different administrative arrangements in certain areas would have facilitated the day to day running of the project and perhaps increased productivity even further, still the project was enjoyed by all partners, was able to accomplish its goals, made an important contribution to the embedded systems community and led to the production of substantial results and documentation, which will very likely appear in the form of books in the near future. The consortium would like to thank the Commission for giving them this opportunity to work together, strengthen existing collaborations and establish new research links across the Atlantic.