

13th International Real-Time Ada Workshop (IRTAW-13)

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Abstract

The 13th International Real-Time Ada Workshop was held in Vermont, USA. The main focus was on analysing the impact of the new Ada 2005 standard on the development of real-time systems, and the future of the language in this important domain. The workshop was very successful in identifying new developments and exploring new application areas. The delegates also had an enjoyable time thanks to the efficient work of the local organizer Ben Brosgol.

Keywords: Real-time systems, Ada 2005.

1 Introduction

The 13th International Real-Time Ada Workshop was held between the 17th and the 19th of April, 2007, at the impressive Woodstock Inn, in Woodstock, Vermont, USA (figure 1). Woodstock is a mountain resort with a beautiful view of forests and snow-covered hills that was the first ski station with mechanical tows to be operated in the USA (1934). The town has several covered bridges (figure 2), which are one of the distinctive features of Vermont. In spite of the advanced time of the year, we enjoyed plenty of snow, even a little too much for the trip from Boston to Woodstock on the first day, under the last winter storm of this year.

The local organization by Ben Brosgol was excellent, and there was plenty of time for discussions and informal conversation.



Figure 1 View of Woodstock Inn

The Program Committee accepted eleven papers as a basis for discussion, which are being published as part of the

official Proceedings of the Workshop [1]. There were eighteen participants, coming from Europe (Spain, UK, Italy, and France) and North America (USA and Canada). As in previous IRTAW meetings, all the attendants took active part in the technical discussions which were at the core of the workshop. The main points of the discussions and the overall conclusions are summarized in the rest of this report.

2 Technical program

The technical program was organized into five technical sessions and a conclusion session. Each session had a chair person and a rapporteur, who was in charge of writing a report of the session including the agreements reached. The sessions were organized into slots of 3½ hours, with a long lunch break according to the IRTAW tradition.

The contents of the technical sessions are summarized in the next sections.

2.1 Language issues

The first session focused on open issues related to the real-time aspects of the Ada 2005 standard. Three main points for discussion were identified:

- EDF semantics;
- Requeuing via interfaces;
- distributed extensions to Ravenscar

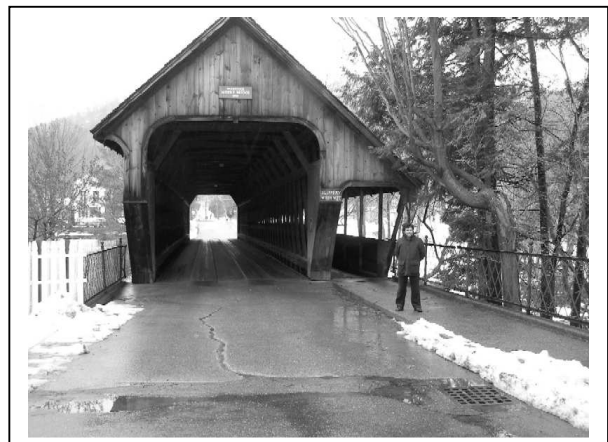


Figure 2 Covered bridge

Correcting the EDF definition in the Ada 2005 LRM

The first part of the session dealt with a problem related to the definition of priority inheritance in the Ada 2005 language reference manual (ALRM) [2], which was

intended to be the same as Ted Baker's Stack Resource Protocol (SRP) [3]. Alan Burns proposed a rewording of the current definition that eliminates the problem [4]. The workshop agreed that an Ada Issue (AI) should be addressed to the Ada Rapporteur Group (ARG).

Requeuing via interfaces

The second part of the discussion was centred on the possibility of allowing requeuing on procedures defined in synchronized or protected interfaces, and possibly, but not necessarily, implemented as protected entries. This possibility raises some semantics problems [5], which have to be solved in some way which is consistent with the current definition of requeue to an entry. The participants agreed that this is a useful feature, even in a restricted form (e.g. according to a static scheme). Consequently, a proposal to include requeue to synchronized or protected procedures will be put forward for discussion at the ARG.

Distributed extensions to the Ravenscar profile

The next discussion addressed a proposal to complement the Ravenscar profile (ALRM D13.1) with a restricted form of the Distributed Systems Annex (ALRM E) [6]. Some restrictions were proposed on DSA in order to keep with the Ravenscar profile motivation for predictable behaviour and simplicity of implementation. The workshop agreed that here is a need to build high-integrity distributed systems in Ada, and that more work is required on this topic.

2.2 Programming patterns and libraries

The second session addressed some proposals of architectural frameworks and coding patterns for Ada 2005:

Component framework for real-time utilities

The first part of the session was focused on a proposal by Andy Wellings to agree on a component framework for real-time utilities, much in the line of RT-Java [7].

Programming patterns for servers

The second topic for discussion was introduced by Alan Burns, who proposed a set of patterns for programming servers in Ada 2005 [8].

Code patterns for model-driven development.

The last proposal was introduced by Tullio Vardanega [9], who presented a framework for developing high-integrity systems in Ada 2005 using a design paradigm based on a four-view model-driven architecture.

After a general discussion on these proposals, the workshop agreed that there interest in defining a common framework for component-oriented implementation of real-time systems. It was recognized that more effort is needed before a recommendation for standardization can be made, and a proposal to continue the work on this topic through

series of meetings in the framework of the ARTIST network¹ was made by Alan Burns.

2.3 Implementation experience with Ada 2005

The next session was devoted to discussing early implementation experiences with new real-time features, and reviewing the support provided by the new real-time mechanisms. Some time was also devoted to discussing some of the features which were proposed in previous workshops but have not been included in the new standard.

Implementation experiences

Two implementations of the new Ada 2005 real-time mechanisms were described first. Mario Aldea presented the work on implementing Ada 2005 services in MaRTE OS and GNAT [10]. The implementation is almost complete, except for the new task dispatching policies and the priority band scheduling mechanism. A GNAT version for MaRTE OS including the new features will shortly be distributed by Ada Core.

Juan Zamorano described an implementation of the new real-time services in the Open Ravenscar Kernel (ORK) on a LEON 2 computer board [11]. This implementation is integrated with the GNAT for LEON compiler, and is also complete except for the scheduling mechanisms.

The workshop was not aware of any other implementations of the new Ada 2005 real-time services.

Discussion

Most of the discussion was on the accuracy of the CPU clock and timer mechanisms. Some sources of inaccuracy were identified, e.g. related to interrupt processing time being charged to application tasks.

Significant overheads due to execution-time monitoring mechanisms were also found in some cases, especially in architectures with poor hardware timer support such as LEON 2.

The discussion continued with an account on the implementation of application-defined scheduling. This feature was not included in Ada 2005, but Michael González-Harbour presented an implementation that can be added to GNAT as an extension. The workshop agreed that this is an interesting feature to have.

Finally, there was a discussion on the possibility of adding execution-time timers to the Ravenscar profiles, as proposed by Juan Antonio de la Puente. Some potential problems were identified, which require further work on this topic to be done before a consensus can be reached.

2.4 Beyond Ada 2005

The fourth session was aimed at discussing future directions in computing and their potential impact on Ada. Two main topics were addressed: stream-based parallelism and synchronous multiprocessing.

¹ www.artist-embedded.org

Stream-based parallelism

Neil Audsley presented a view of massive parallel computer architectures based on the concept of *system on a chip* [12]. An example of an Ada programmable system, using a tasking profile almost identical to Ravenscar, was described. The main problem for the use of Ada with such a system is the lack of a mechanism for simultaneously releasing groups of tasks for reading protected data, which is not possible with the current protected object model, especially under the Ravenscar restrictions. The workshop agreed that further work is needed on such an issue.

Synchronous multiprocessing

Andy Wellings started a discussion on how Ada can be used with the kind of synchronous multiprocessing (SMP) systems that are expected to be commonplace in the near future, including multicore architectures [13]. The current support for such architectures is very basic, and a number of potential issues were identified, especially related to the allocation of tasks to processors. The definition of task groups in Ada 2005 may be useful for defining affinities of task groups to processors, in addition to task affinity. A vivid discussion was held on these and other related subjects, and the workshop agreed that this indeed a very important area in which work should be continued and proposals should be put forward for subsequent workshops.

2.5 Ada and other standards

The last discussion session dealt with the relationship between the Ada standard and the POSIX and RT Java standards.

POSIX Ada binding

Stephen Michell introduced the discussion on the POSIX Ada binding, which has not been updated since 1998 [14]. Subsequent revisions of both the POSIX and Ada standards have led to minor inconsistencies and functionality mismatches. Stephen proposed to develop a new approach to interfacing Ada with operating systems through a set of library packages.

The workshop expressed some doubts about the suitability of putting a high amount of effort into this task. However, the participants agreed that a minimum update that would remove the current errors or inconsistencies would be useful.

Real-time Java

Ben Brosgol made a presentation of the current status of Real-Time Java and the efforts for developing a high-integrity version of RT Java. The discussion which followed highlighted a number of interesting RT Java features which may be useful in Ada, e.g. priority inheritance, garbage collection, or different kinds of physical memory. The workshop concluded that the Ada community should continue investigating such issues.

3 Conclusions

The meeting was considered successful by the participants. A number of issues have been solved, and many points of

interest for developing real-time systems in Ada have been identified and discussed. A final session was held that summarized the main conclusions of the workshop:

- An AI will be submitted to the ARG in order to correct the current definition of the EDF dispatching policy.
- A proposal will be made to the ARG to allow requeue to synchronized interface procedures. The details of the proposal need further investigation, especially with regard to the implementation cost.
- A meeting will be held in order to consolidate the proposals for a real-time component framework in Ada.
- The accuracy and cost of execution-time monitoring mechanisms needs further investigation.
- Further investigation on using executing-time monitoring mechanisms with the Ravenscar profile is encouraged,
- Research should continue on developing an extension of the Ravenscar profile for distributed systems.
- There is a need for enhanced support of multiprocessor systems and stream-based parallel systems in Ada. Research in this area is encouraged.
- A minimum update of the POSIX Ada bindings is to be made, in order to remove errors and inconsistencies.
- Work should continue on watching the progress in RT Java in order to identify potential enhancements to Ada.

Next Workshop

The participants agreed on planning a new IRTAW meeting for September 2008. Tullio Vardanega volunteered to organize it in Italy, and Neil Audsley volunteered to serve as Program Chair.

Social program

A reception and dinner was held at the Simon Pearce restaurant, in the neighbouring town of Quechee. The restaurant is located in an impressive old mill building, which currently also hosts a glass factory. The dinner was excellent and as usual provided a great occasion for strengthening the links among the participants and talking in an informal atmosphere which greatly contributed to the lively technical session discussions.

Acknowledgments

Ben Brosgol did an outstanding job with the local organization. Juan Antonio de la Puente was Program Chair, and Ben Brosgol, Alan Burns, Michael Gonzalez Harbour, Stephen Michell, Javier Miranda, Luis Miguel Pinho, Jorge Real, José Ruiz, Tullio Vardanega, and Andy Wellings also served in the Program Committee.

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