European ALMA Software Advisory Group

ALMA Memo #286

Choice of RTOS for ALMA - Another View

J.M. Stewart
UK Astronomy Technology Centre
V 1.1
20 December 1999

---

1. Introduction ____ *1*
2. Maturity ____ *2*
3. Support ____ *2*
4. Cost ____ *2*
5. Interfacing to Other Systems ____ *3*
6. Risks from Commercial Failures of Suppliers ____ *3*
7. Job Satisfaction ____ *4*
8. Recruitment Pool and Training Required ____ *4*
9. Other Systems ____ *4*
10. Conclusions ____ *5*
Appendix - Details of Gemini's Deal on VxWorks ____ *6*
History ____ *7*

1. Introduction

This is a response to Patrick Wallace's document *Choice of Real-Time Operating System for ALMA*, 8 December 1999.

The problem that we face here is the opposite of an interesting technical challenge. The technical requirements are not extreme and can be met in more than one way. VxWorks and RTLinux are the two possibilities being considered out of a larger number. Patrick demonstrates that RTLinux is technically able to do the job. VxWorks is also recognised as being technically capable, and so we must examine the other, more subjective, issues.

2. Maturity

This is a key issue. VxWorks is mature, though not obsolescent. It has a large customer base covering many application areas and is arguably the dominant RTOS in astronomy. It is actively being developed, both by Wind River with new versions and system components, and by third parties, with board support packages, drivers and associated products. Good support tools exist. VxWorks shows no signs of fading away.

RTLinux, on the other hand, is not yet mature and it is far from certain that it will ever attain this status. If it were called RTFreeware, say, I think we would be less interested - it is I feel riding on the Linux bandwagon. It comes in two flavours and it is not clear which if either will become the standard RTLinux. It is entirely possible that some other system will threaten traditional RTOS's, e.g. something based on Windows NT.

Conclusion: VxWorks has suitable maturity for ALMA - RTLinux does not yet.

3. Support

To be used in a large scale operation like ALMA, good support is important. This includes bug fixes, tracking new technology with new versions, obtaining help with specific problems and being able to communicate easily with other developers. Most users are happy with Wind River's support, although this is not perfect and there are some well known whinges to which Patrick refers.

Linux is also well supported, although in a very different way to VxWorks. Support for RTLinux seems much more uncertain. It depends on a very few small niche companies expanding a small user base. RTLinux seems risky from the support issue if external companies are to be relied upon.

One way of avoiding this risk is to allocate some effort within the ALMA project for the type of support that WindRiver provide for VxWorks. One FTE per year may be adequate.

Conclusion: VxWorks has appropriate mainstream support. To avoid unnecessary risk with RTLinux, the ALMA Project would have to allocate additional internal support effort, perhaps 1 FTE/year.

4. Cost

VxWorks has a justified reputation for being expensive. It is difficult for small groups to buy into the technology and this is, I feel, the main driving force behind RTLinux for ALMA. However compared to the capital cost of ALMA and the cost of the software effort its development will require, the cost of VxWorks is small. Organisations like ESO and Gemini have done deals with Wind River to allow collaborators to obtain licences at significant discounts.

Gemini's deal (see Appendix) allows collaborators to obtain a VxWorks development licence with Tornado Support Tools for $7500 plus $2750 year for indirect support after the first year, representing a saving of 45%. To put these figures in context, they represent on the order of 10% of the cost of a year's software effort in the first year, taking overheads into account, and 3% subsequently.

Whether collaborating institutions need to purchase VxWorks licences themselves is really just a management decision, since the ALMA Project could decide to fund such licences for collaborators.

Conclusion: VxWorks is expensive compared to RTLinux, but not significantly so in the context of the ALMA Project.

5. Interfacing to Other Systems

Other operating systems will be used in ALMA i.e. Unix, probably including Linux, and perhaps exclusively. The RTOS must be able to interface effectively with the other OSs.

VxWorks interfaces well with Unix and new technologies are adding enhanced capabilities, e.g. Java and CORBA. LabView has been discussed in some areas of ALMA, but it's not clear, at least to me, how easy it is to interface VxWorks with LabView.

RTLinux interfaces even more easily with Unix, including of course Linux. Software can presumably be moved somewhat more easily between RTLinux and Unix than between VxWorks and Unix. LabView runs on Linux, though with poor device support and without some associated NI products, but not on VxWorks. RTLinux may therefore offer some advantages, if interfacing to LabView becomes an issue.

Conclusion: RTLinux may offer some advantages in interfacing to Unix and LabView.

6. Risks from Commercial Failures of Suppliers

Vendor independence is one of Linux's "selling" points and this presumably is also true for RTLinux. The implied scenario that this avoids is Wind River Systems going bust, leaving developers without support or access to source code. I think this risk is overstated. If Wind River Systems did go bust, all their assets would not go up in flames but would be acquired by another company, which would be potentially very profitable with such a large customer base.

RTLinux support comes from two niche companies much more likely to go bust than Wind River. Support would be affected and, although the RTOS source code would be available to ALMA, supporting it internally would be expensive.

Conclusion: RTLinux may benefit somewhat from vendor independence, but the risks resulting from bankruptcy of RTLinux or VxWorks companies are finely balanced.

7. Job Satisfaction

Although never mentioned, I feel this is the other driving force behind RTLinux. Academic collaborators tend to work for their institutions rather than commercial companies because of the greater job satisfaction and a greater or lesser degree of academic freedom. RTLinux offers advantages in this area: source code is available and developers can work in the internals, rather than being limited to a published API. However some job satisfaction also results from meeting requirements with minimum risk.

Conclusion: RTLinux offers developers potentially greater job satisfaction, though this cannot be considered an important criterion for an expensive project like ALMA.

8. Recruitment Pool and Training Required

Efficient development and support requires that software engineers can be recruited without the need for further lengthy training. Although Windows NT continues to dominate more areas, a large pool of Unix experts exists and will continue to exist. Linux is becoming popular in some areas, further increasing the pool of software engineers familiar with Unix in general and Linux in particular. Although Linux expertise is now common, this is not true of RTLinux.

VxWorks is widely used and there is a reasonable pool of potential recruits familiar with it. It has a fairly rapid learning curve for those with knowledge of Unix and realtime. Good courses exist although they are as expensive as other commercially supplied courses.

Conclusion: Recruitment and training should not be a significant problem for either VxWorks or RTLinux. RTLinux has the advantage that staff need to be recruited and trained in only one operating system.

9. Other Systems

Three studies were planned to investigate RTLinux. Two of these, IRAM and RAL, found that Linux (rather than RTLinux) met their requirements. A lot of effort can be wasted using an RTOS for what is only a soft-realtime application. For ALMA, there is no reason why Linux should not control hardware, where there are no demanding realtime requirement.

Another system widely used in industry for control and process automation is the LabView suite of software, usually running on Windows NT although there is limited Unix and Linux support. LabView is now being developed to provide some realtime capability and, although it is early days, it may eventually compete with traditional RTOSs and spell the demise of RTLinux.

Whether or not LabView is ever used in the operational system, it seems likely that it will be used by electronics engineers for testing purposes. RTLinux then offers the advantage over VxWorks that it is more likely that the hardware will support both the operational RTOS and LabView/NT.

Conclusion: LabView is likely to be used for test purposes and might become suitable for operational use. RTLinux offers greater portability since hardware that runs RTLInux will also run Windows NT and LabView with drivers. Linux can be used for control in non- hard realtime applications

10. Drivers

Effort will be saved if suitable drivers are available commercially, e.g. for motion control and CANbus. VxWorks has the advantage over RTLinux in this respect, although LabView/NT probably has the advantage over both. CANbus drivers exist for VxWorks and LabView/NT.

Linux could be used for non- hard realtime applications, but there could be a similar issue with drivers not being available.

Conclusion: vxWorks has more commercially available drivers than RTLinux, but LabView/NT probably has more than both RTLinux and VxWorks.

11. Conclusions

My overall view is that VxWorks meets the requirements, is well proven and is likely to be better supported over the lifetime of the ALMA Project. RTLinux is cheaper in terms of capital cost, though this is not a significant factor. However it is still an immature product and would impose unjustified risk on the ALMA Project, if its adoption did not include additional internal support effort. If and when RTLinux it matures, it may become a better alternative to VxWorks, but the same could be said of other products such as LabView/NT.

There is no reason not to use Linux, both for high level software and device control where there are no demanding realtime requirements, though the availability of drivers could be an issue. Currently VxWorks is a safer choice than RTLinux, but RTLinux could be used safely if additional effort is allocated for systems support and writing drivers.

Appendix - Details of Gemini's Deal on VxWorks

---------- Forwarded message ----------
Date: Mon, 18 Oct 1999 18:07:22 -0700 (MST)
From: Andy Foster <ajf@empusa.az.gemini.edu>
To: dsimons@gemini.edu, mmountain@gemini.edu,
     Jim Oschmann <joschmann@gemini.edu>
Cc: ddeweese@gemini.edu
Subject: Wind River Systems and Gemini

Over the past 3 months, I have been working with Harvey Wong of Wind River Systems to achieve a better deal for Gemini on the pricing of the VxWorks operating system. VxWorks is the real-time OS upon which all of our telescope and instrument systems are based. EPICS is essentially a toolkit which runs under VxWorks.

I am pleased to announce today, that the following agreement between Wind River and Gemini is in place (I quote from the agreement):

Intent
======

This quotation provides Gemini with discounted development licenses in consideration of the fact that their work is for academic research and that the additional sites (instrument groups etc) are in effect contractors or consultants performing work for Gemini.

Each University/research site or contractor requires a single seat of Tornado for the PPC750 and support/maintenance.

Gemini Pricing
==============

USA and Canada Sites

Tornado Host Tools	$1500
Annual support/maintenance of Host Tools	$ 500
VxWorks OEM License for PPC7XX	$3250
Annual support/maintenance of target OS	$2250
Total to add a USA or Canadian site	$7500

International Sites (UK, Australia, Argentina, Brazil, Chile)

Tornado Host Tools	$1950
Annual support/maintenance of Host Tools	$ 650
VxWorks OEM License for PPC7XX	$4225
Annual support/maintenance of target OS	$2925
Total to add an international site	$9750

International Sites (without local support) *

Tornado Host Tools	$1500
Annual support/maintenance of Host Tools	$ 500
VxWorks OEM License for PPC7XX	$3250
Annual support/maintenance of target OS	$2250
Total to add an international site	$7500

* This option allows licensing of international sites without local support. In this model, all support issues would be channeled through Gemini, Hilo. Also, maintenance updates would be shipped to Gemini, Hilo.

```
License Restrictions
====================

Gemini and its contractors or University affiliates may make use of the Tornado
tools and VxWorks OEM licenses at their respective sites for Gemini Projects only
and for the PowerPC 7XX processor family.

Upon completion of a Gemini project, a site will remove all copies of the Wind
River Systems software from its premises. The licenses may be returned to either
Gemini, Hawaii or Gemini, Chile but may not be transferred to any other sites.

Purchase orders from Gemini shall include the following information about
each new site:
        - site address
        - technical contact, phone, fax, e-mail
        - shipping address
        - billing address

End of quote...


To give you some idea of the saving here, without these terms, Gemini have been
paying:

VxWorks OEM License/Tornado tools for PPC7XX    $15000
Annual support/maintenance of target OS         $ 2750
-------------------------------------------------------
Total                                           $17750

So, this agreement represents a saving of 58% for each USA/Canada site
and 45% for each international site.


Our first order, under these terms, for the University of Florida (MIRI)
and the Australian National University (NIFS) will save Gemini $18250.

Cheers,

Andy

================================================================================
Andy Foster
Lead Programmer, Real-Time Systems
Gemini 8-m Telescopes Project           Tel:     1 (808) 974 2556 (direct)
Gemini-North Base Facility              Fax:     1 (808) 935 9235
670 North A'ohoku Place
University Park                 E-mail:    afoster@gemini.edu or ajf@noao.edu
Hilo                            Home Page: http://controls.gemini.edu/ajf
Hawaii 96720
USA
```

History

V1.0	14 Dec. 1999	original
V1.1	20 Dec. 1999	*Other Systems* - ability to run LabView/NT on same hardware as RTLinux. *Drivers* - section added *Support* - RTLinux could be supported with additional internal effort *Conclusions* - modified