Embedded Linux – Redux 2009

Addendum to 2007 Total Cost of Development Paper

Jerry Krasner, Ph.D., MBA

May 2009

Embedded Market Forecasters

American Technology International, Inc.

About EMF: www.embeddedforecast.com 508-881-1850

EMF is the premier market intelligence and advisory firm in the embedded technology industry. Embedded technology refers to the ubiquitous class of products which use some type of processor as a controller. These products include guided missiles, radars, and avionics as well as robots, automobiles, telecom gear, and medical electronics.

Embedded Market Forecasters (EMF) is the market research division of American Technology International, Inc. EMF clients range from startups to Global 100 companies worldwide. Founded by Dr. Jerry Krasner, a recognized authority on electronics markets, product development and channel distribution, EMF is headquartered in Framingham, Mass.

About the author:

Jerry Krasner, Ph.D., MBA is Vice President of Embedded Market Forecasters and its parent company, American Technology International. A recognized authority with over 30 years of embedded industry experience, Dr. Krasner was formerly Chairman of Biomedical Engineering at Boston University, and Chairman of Electrical and Computer Engineering at Wentworth Institute of Technology and Bunker Hill Community College. In addition to his academic appointments, Dr. Krasner served as President of Biocybernetics, Inc. and CLINCO, Inc., Executive Vice President of Plasmedics, Inc. and Clinical Development Corporation, and Director of Medical Sciences for the Carnegie-Mellon Institute of Research. Earlier, he was Senior Engineer at the MIT Instrumentation Laboratory. Dr. Krasner earned BSEE and MSEE degrees from Washington University, a Ph.D. in Medical Physiology / Biophysics from Boston University and an MBA from Nichols College. He is a visiting professor at the Universidad de Las Palmas (Spain) where he is recognized for his work in neurosciences and computer technology.

Copyright 2009 by Embedded Market Forecasters, a division of American Technology International, Inc, 1257 Worcester Road #500, Framingham, MA 01701. All rights reserved. No part of this document covered by copyright hereon may be reproduced or copied without expressed permission. Every effort has been made to provide accurate data. To the best of the editor's knowledge, data is reliable and complete, but no warranty is made for this.

Introduction

In 2003 EMF produced a seminal report on the comparative development costs associated with Linux developers as compared with Microsoft Windows Embedded XP and with Windows CE. ("Total Cost of Development, a Comprehensive Cost Evaluation Framework for Evaluating Embedded Development Platforms" – available for free download at www.embeddedforecast.com).

In December 2007 EMF published a paper entitled "Embedded Linux, Total Cost of Development Analyzed: An Evaluation of the Costs Associated with Embedded Linux Development as Compared with Commercial RTOSes and Non-Commercial Linux".

The purpose of that report was to re-evaluate EMF's 2003 findings regarding embedded Linux developments in light of the many changes in the embedded marketplace and to update the record for 2007.

The basis of the 2007 analysis was the extensive survey data that EMF compiles year-over-year from embedded developers. The findings and analysis were based on factual data.

The 2007 paper's conclusions were:

- Using a supported commercial Linux OS is more cost effective to an in-house Linux development undertaking
- Also, the use of Linux for embedded designs is no longer restricted to a few applications. The use of Linux for embedded designs is no longer restricted to a few applications.
- Furthermore, the design outcome data demonstrate that developers can consider using a Linux OS without concern that their end product will be inferior to end products produced for a proprietary RTOS.

Now, EMF is taking a look at the results of the 2008 and 2009 EMF Surveys of Embedded Developers to determine how embedded Linux designs compare with commercial RTOS design outcomes and whether the changes observed in 2007 have continued.

Looking at the Data

An important aspect of market research is to determine trending and to observe if recent statistical data derived from year-over-year surveys validates the original interpretations.

This report covers the years 2007 through 2009.

In order to establish a common basis for comparison, Figure 1 presents the year-over-year total lines of code for the major commercial RTOSes (Integrity, VxWorks and LynxOS) and for embedded Linux products.

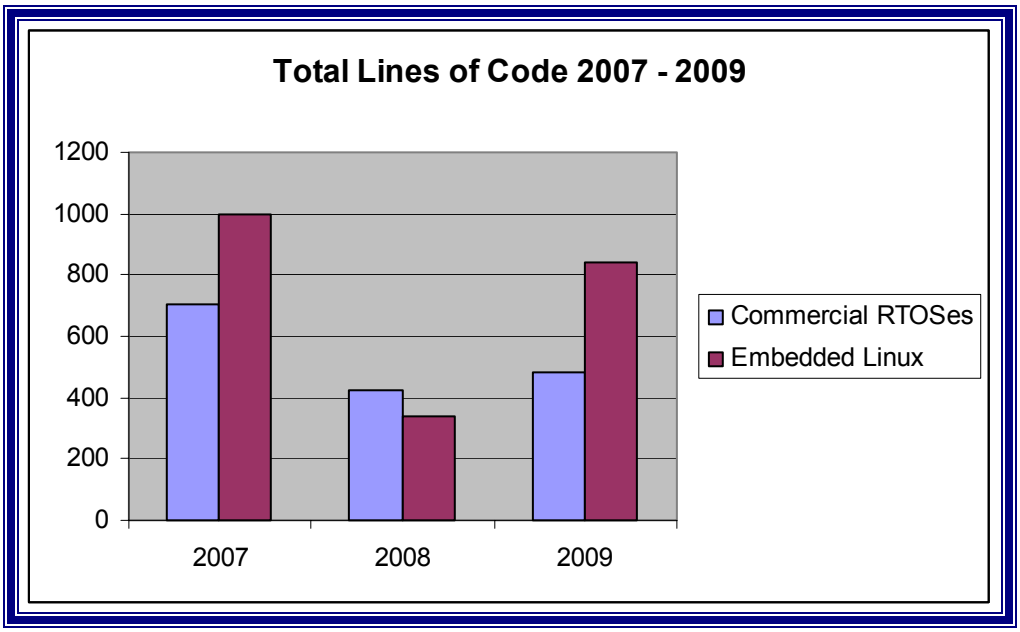

Figure 1

For two of the reported 3 years, embedded Linux designs tended to contain more lines of code. Given the nature of Linux designs and the availability of reused code, COTS and open source software, this is not surprising.

The time it takes from design start to product shipment is an important factor that can be included in a formal ROI. In the 2003 EMF paper, Linux designs took a longer period of time when compared to a commercial RTOS.

Table 1 illustrates and compares "Time to Market" for commercial RTOSes and embedded Linux designs over the 3 year period 2007 – 2009.

	Commercial RTOSes	Embedded Linux
2007	15.5 months	14.4 months
2008	16.1 months	14.3 months
2009	15 months	13.1 months

Table 1

Table 1 validates that commercial RTOSes continue to average 15-16 months to market, while embedded Linux developments average 14 months. Having very similar results three years running creates a high level of confidence in the data.

On-schedule design completions are an important aspect of a company's ROI as well as being an indicator of development management practices.

Table 2 presents year-over-year data for the percent of designs completed behind schedule. Again we see a remarkable consistency between 2007 and 2009 data.

	Commercial RTOSes	Embedded Linux
2007	46.0%	38.6%
2008	46.0%	38.6%
2009	40.5%	35.8%

Table 2: Percent of Designs completed Behind Schedule

Lastly, we can look at the percent of final designs that are reported by developers to be within 20% of their pre-design expectation. EMF considers final designs that are within 30% of pre-design expectations to be a good design outcome. Designs that are within 20% of pre-design expectation are considered to be an excellent outcome.

Figure 2 presents the comparison between design outcomes for Performance, Systems Functionality, and Features & Schedule, based on the results of the 2009 EMF survey of embedded developers.

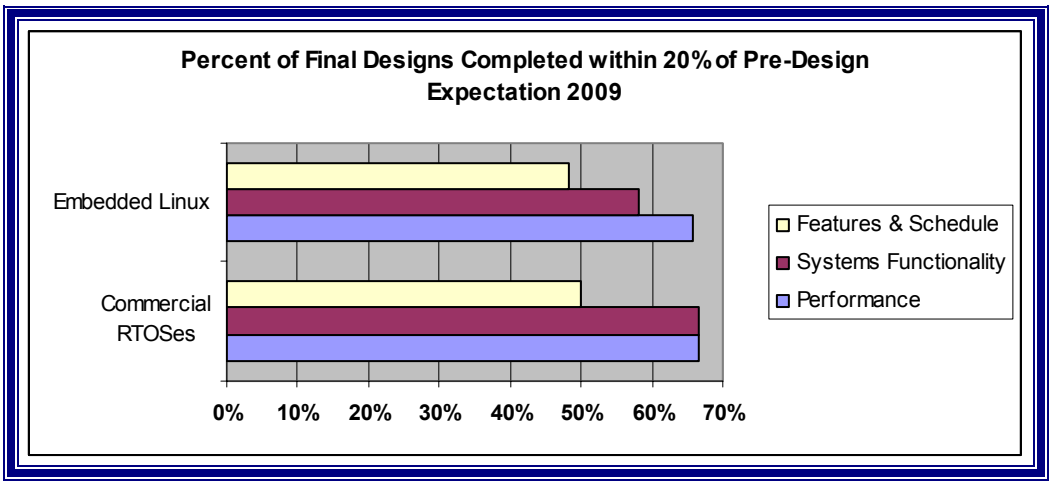

Figure 2

Figure 2 shows that commercial RTOSes hold a small lead over embedded Linux designs in Systems Functionality. Some of this difference can be attributed to the fact that the embedded Linux design data includes non-commercial Linux design

outcomes that have poorer outcomes than commercial Linux versions. EMF data shows that every commercial Linux product outperforms non-commercial versions of Linux.

Comparing Commercial and Non-Commercial Versions of Linux

It should go without saying that there are different versions of Linux. There is a popular (mis)conception that free Linux is truly free. This view has endured for at least the past 9 years and belies the fact that there is no free lunch – even for Linux.

A detailed ROI of this comparison is beyond the intended scope of this addendum, however the data remains clear, year-over-year, that commercial Linux products continue to outperform free download versions of Linux that use non-commercial tools.

Figure 3 compares final design outcomes as compared with pre-design expectations for Performance, Systems Functionality, and Features & Schedule.

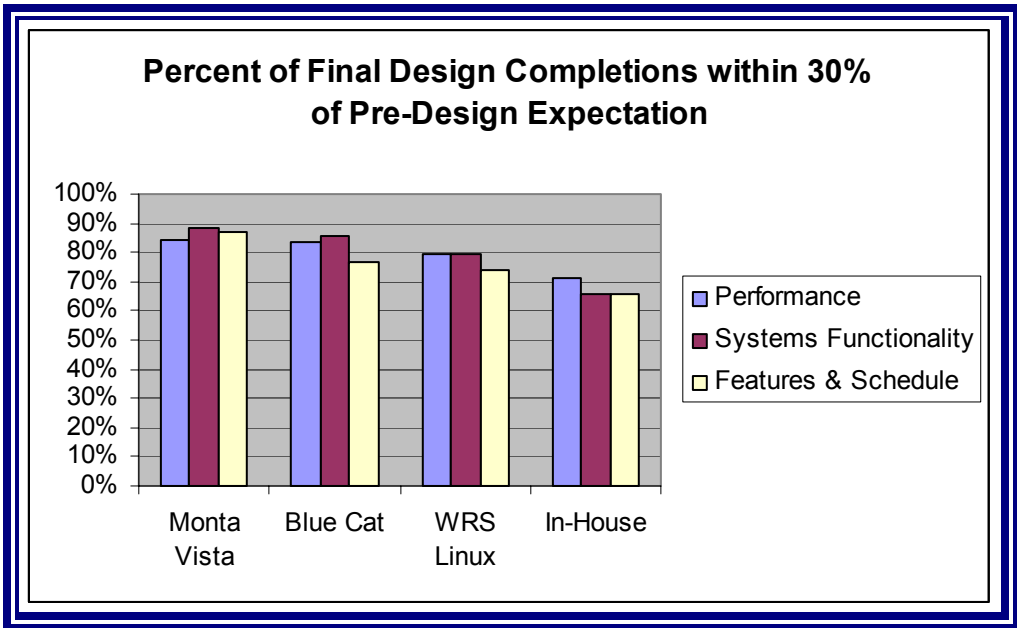

Figure 3

It is clear from Figure 3 that each of the commercial versions of Linux outperforms non-commercial Linux developments. This is a very important point – all commercial Linux versions outperform non-commercial Linux developments. This outcome repeats the data from the original paper.

Summary

EMF data from 2008 and 2009 surveys of embedded developers show that the results and interpretations presented in the 2007 EMF report are not only validated, but that Linux has emerged as an OS of choice for many embedded applications.

Advances made by Green Hills, Wind River and LynuxWorks on their mission critical and safety critical operating systems, has, interestingly, enabled Linux designs to be used in such stringent applications.

Linux designs can be used in a mission-critical environment that requires MILS, EAL certification or POSIX conformance, when used in protected memory (as a guest OS) under a certified RTOS.