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EL/IX and eCos Open Source

Offering from Silicomp

EL/IX Overview: the Post PC revolution

The evolution of microelectronics is leading to what we are witnessing today, which has been referred to as the Post PC world or Post PC revolution. As powerful microprocessors and memory chips become available at low cost, it opens up opportunities for a whole new market of appliances.

The Post PC world is enabled by more microprocessors becoming more pervasive and doing more things than were possible in the computer client server world. In the Post PC world devices are being created, including microprocessors that have the same computing power as that of 1995 PC’s but whose functions are not to serve as a general-purpose computer. These devices have functions corresponding to a wide market such as consumer electronics, payment terminals, smart cards, automotive control, medical devices, process control, digital imaging, game consoles and beyond.

In the PC client server world, we have seen the development over several years of Open Source Software. In particular the GNU software development tools (GCC compiler, GDB debugger, …) have made it possible to develop open source software systems and applications including Linux, Apache, Mozilla, Perl, Gnome, KDE, etc., that have become successful worldwide.

Open Source means anybody can read, modify, or share the software source code as they wish, and contribute new code to an existing body of software. For integration of these contributions, the open source community works with a democratic process through which the code with the “best" design and quality wins, which also means that lower quality code loses. This Darwinist software evolution model has resulted in a fairly high rate of innovation for software with great functionality, high quality, and continuous support for existing applications

A characteristic of the Post PC world products is that software designers are faced with strong hardware constraints: scheduling, available power supply, resource sharing and cost requirements that are unique to an application. Unlike the PC world, which is based on a single platform for application development and deployment, the Post PC world is creating a wide variety of devices with specific capabilities.

It is a reason why the embedded systems market has seen multiple commercial software tools products each addressing a niche market. In this context, code that would be best for one platform is out of the question for another one.

The availability and the fast paced evolution of the open software tools developed for the PC world make them attractive for the Post PC appliances and devices. In fact, many embedded systems developers are already using the GNU tools for their development, and they are inclined to go further in this direction.

But **Linux is the not the right operating system for *every* job**. This is definitely a market where one size does not fit all. For deeply embedded applications where every kilobyte counts, the functionally rich and megabyte-sized Linux configurations are not appropriate for the job.

The Post PC world appliance developers want to enjoy the benefits of open source software but do not want to suffer from fragmentation of the solutions. It would be unfortunate to lose the benefits of Linux as a common platform for software development, but it would also be a shame if Linux failed to fully connect with the Post PC revolution. An approach is needed that solves the problem in a way that is both Linux-compatible and Linux-independent.

Driven by the requirements of the embedded systems market, the open source community, led by Red Hat, has developed the EL/IX specification. EL/IX is an Embedded Linux API based on the Linux interfaces and the international standards ISO-C and ISO 9945-1, which is suitable for other embedded operating systems as well.

The reader will find detailed information on EL/IX on the Red Hat web site at http://www.redhat.com/embedded/technologies/elix/

With EL/IX, it is possible to use desktop Linux systems for application development, and EL/IX to ensure that these applications can be recompiled and deployed across the complete spectrum of Post PC devices.

As formulated by Red Hat, the goal of EL/IX is, first and foremost, to standardize a well-defined subset of the APIs available in desktop Linux today in such a way that embedded system developers have a clear and consistent idea of what functionality they can expect for a given embedded target:

1. Support for developing embedded applications using the GNU development environment as both a host and development platform
2. A way to scale that functionality according to the requirements of their embedded target
3. The freedom to use any operating system kernel (Linux or otherwise) that implements the interfaces of EL/IX that their application requires
4. The ability to port easily to any hardware that runs any kernel that supports the subsets of EL/IX they require

Moreover, the first version of EL/IX adheres to these additional requirements:

5. Elements must already be implemented in standard Linux distributions (i.e., do not define what does not already exist)
6. Possible to demonstrate real real-time performance when running on a real real-time OS (prove it works beyond Linux)
7. Based on ISO 9945-1 (POSIX) and ISO-C international standards where possible (build on accepted standards)
8. Does not include superfluous code (keep it simple)
9. EL/IX is extensible
10. EL/IX is Open Source

EL/IX provides a normalizing force that makes it easier for software developers to generate applications for the Post PC world, expanding the market opportunity for software without increasing fragmentation.

What exactly is EL/IX?

EL/IX is a set of application-programming interface (API) based on a subset of the ISO 9945-1 (POSIX.1) and ISO C international standards, plus extensions from Linux/GNU and BSD Internet access interfaces that are applicable to embedded applications. The result is an API that is more concise than the simple union of these standards because unnecessary or duplicated functionality is eliminated.

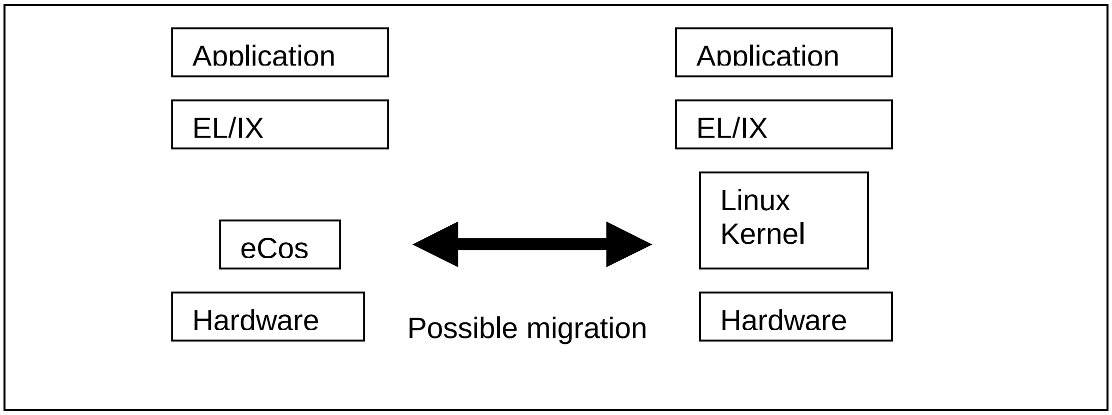
EL/IX provides an interface that ensures application portability for any EL/IX enabling operating systems, such as Linux or eCos. With EL/IX, developers have the tools and framework that ensure that applications maintain compatibility between different underlying implementations of the operating system.

There are four graduated levels defined for EL/IX, scaling from a minimal set of interfaces required for the smallest of embedded applications (EL/IX Level 1) to the full Linux API (EL/IX Level 4) for the high-end of the market.

EL/IX Level I provides functionality available in both Linux and in typical deeply embedded operating systems. Use of EL/IX improves time-to-market by enabling code re-use and by capitalizing on engineers' existing experience in Linux and C programming.

With the EL/IX Level I compatibility layer, embedded system developers can write portable code and re-deploy their embedded software in a variety of applications, from small, deeply embedded or real-time applications to large applications running full versions of Linux and every point in between these two extremes.

EL/IX provides a bi-directional path for both upgrading and reducing device functionality. One can migrate from eCos to Linux in high-end versions of a device, and from Linux to eCos in order to get real-time capability or to reduce the size and cost of making the device. The EL/IX environment provides developers with a high degree of flexibility and control over features, size, and performance of their runtime system.



The EL/IX API definition and the EL/IX open source project can be found at http://sources.redhat.com/elix

The ECOS Kernel

EL/IX is a set of application programming interfaces that can potentially run on multiple operating system kernels.

Two operating systems kernels support EL/IX today: Linux and eCos

Linux is a high-end operating system. Linux currently scales from a minimal size of around 500 kilobytes of kernel and requires 1.5MB of RAM, without taking into consideration application and service requirements. This means that a typical Embedded Linux application will require a high-end processor and about 4 MB of memory.

To meet the requirements of deeply embedded applications running on low cost configurations with low cost microprocessors, very small amounts of RAM and flash, and real-time support, another kernel was needed.

eCos, the **embedded Configurable operating system**, is such an open source real-time operating system that meets the requirements of the embedded space that Linux cannot satisfy.

eCos provides the basic runtime infrastructure necessary to support devices with memory footprints in the 10's to 100's of kilobytes, or with real-time requirements.

eCos supports EL/IX Level I, a Linux compatibility interface, for embedded applications in devices that are too small for even stripped down versions of Linux or that require real-time capabilities. eCos provides engineers with maximum control, flexibility and understanding over all aspects of their embedded solution. eCos is highly customizable and adaptable, and can be easily configured using the eCos graphical configuration tool to meet application-specific requirements.

eCos development is coordinated by Red Hat, the Linux market leader. Red Hat takes contributions from the Open Source community and integrates them into the eCos central source repository for worldwide access.

Detailed information about eCos can be found on the Red Hat embedded web site:

http://www.redhat.com/embedded/technologies/ecos/

Doing Business with Open Source Technology

Open Source technology means that the source code is available and there are no royalties associated with commercialization of the product.

However the source code is usually copyrighted and protected by a license.

There are several forms of open source licenses.

The original one, and still popular is the strict General Public License (GPL) from the Free Software Foundation. Sources released under this license have a constraint: any new software programs including GPL code must also be open source. In short, it is a transitive license. The entire bundle of software that makes up an application must be open source. It has the advantage that no one can block a market with a proprietary software component; no one can generate their own revenue from someone else's work. However it can be viewed as difficult to do business in this context.

There are also other forms of open source licenses that allow people to do business based on open source without having to release their own application as open source. Among these are, for example, the Mozilla license from Netscape, the Apache Software License from Apache, the NOKOS License from Nokia, and the eCos license from Red Hat.

The key point about these licenses is that extensions to the core technology must be released back to the open source community, but not the application code itself. It means that an organization developing an application over eCos, with such an open source license, must give back to the community the bug fixes it has found in the open source code, or extensions such as handling new peripherals or new functionality, but it has no obligation with respect to the application code.

The details of the eCos license are published at:
http://www.redhat.com/embedded/technologies/ecos/ecoslicense.html

The reader will find general information about open source licenses at
http://www.opensource.org/licenses/

Technical Information

A technical datasheet for eCos is available from Red Hat at

http://www.redhat.com/embedded/technologies/ecos/brochure.html

Silicomp can also provide this information on request.

A key piece of information is that eCos is available at the time of writing on the Atmel AT91 microprocessors.

Advantages of Open Source

Selecting open source technology as the basis for your products has multiple advantages

- Because the technology is freely available there are no royalties associated with distribution of the software
- The development environment consists mainly of the GNU tools. These tools are available freely for both the Linux development environment and Windows NT. The development environment tools are therefore widely available and mostly free

- The technology is rapidly evolving, as there are many people contributing to the core technology. New processors are supported very soon after their introduction on the market, and new peripherals are supported rapidly. In other words, the R&D capacity of the open source community is made available to you
- Users of open source technology are not captive to a commercial vendor, neither in terms of strategy nor of their pricing mechanism. There are many RTOS vendors on the market. Each of them has a limited R&D capability compared to the open source community and they release their products according to their own strategy and pricing, which might not be aligned with the expectation of their users
- Most universities and engineering schools are training their students with the GNU development tools. Hence there are many engineers entering the market trained to use the GNU tools for software development.

Silicomp Offering

The key issues when adopting open source technology are:

- Where do I get support? It is great to have the source code, but discovering the cause of a bug and correcting it requires specific skills and training in the core technology that may not be available among your staff. It is an advantage of a commercial RTOS that the company selling the product usually provides support for it. In the US, there are already companies providing support for open source technology, in particular Red Hat, the Linux leader. In Europe, there are still very few and Silicomp is one of the first companies to provide such support.
- How do I make sure that evolution of the core technology does not break my software? Today for example the current eCos release is version 1.3. There is no guarantee from the open source community that the future release 1.4 will still work well with your application. Although the open source community has a tradition of evolving in a compatible manner with past releases, there is no commitment to do so. The Silicomp offering provides you with a safe path to control evolution of the core technology and ensure that it does not break your applications.
- How can I have extensions made? If the existing core technology is lacking a feature that you absolutely need for your application, you may have to do it yourself, but your staff may not have the competences required to develop this extension. The Silicomp offering includes a commitment to implement the new features that you need in a timely and cost effective manner.

In summary, adopting the Silicomp EL/IX technology provides you with the combined advantages of both the open source world and commercial RTOS support.

Silicomp Operating Model

The Silicomp goal is to provide our clients with “custom support” tailored to their needs.

Custom support includes several steps, some of which are optional, described below

Step 1: BSP development

The first step in custom support is the Board Support Package (BSP). Silicomp will provide you with the exact BSP that you need. In other words, you provide Silicomp with the hardware board that is the core of your application and Silicomp will deliver to you the complete software BSP for that board. This BSP will be configured to run your application with all the software support that you need, and no superfluous code.

Developing a custom BSP typically takes between 2 weeks and 3-4 months after Silicomp has received a complete working board, depending upon the complexity of the hardware configuration, the pre-existence of an EL/IX port for the target micro-processor and the ease of access by development tools.

Of course Silicomp will return to you the complete source code of the BSP, and it will later be contributed to the open source community.

Step 2: BSP support

The next step after BSP development is to support the evolution of the BSP over time.

There are two paths in this support: hardware evolution and software evolution.

Hardware Evolution

For Silicomp's customers, the market mostly dictates hardware evolution. Under market pressure, you may have to evolve the platform to a new microprocessor, or new peripherals. Each time you make a change into the hardware, Silicomp will evolve the BSP to track your hardware evolution

Software Evolution

As mentioned earlier, the open source community is rapidly evolving, adding higher performance and new features. At your request, Silicomp will evolve the BSP to match the latest evolution from the open source community, to maintain your BSP, and the tool chain that produced the BSP, up-to-date with the latest technology.

Software Support and Regression Tests

At your request, Silicomp can deliver the BSP together with a regression test suite that will allow you to verify that modifications or extensions do not break the existing code. The scope of this test suite is mutually agreed with Silicomp at the beginning of the project.

Step 3: Application Support

Silicomp may provide you with complete support in two ways:

- We can take responsibility for guaranteeing non-disruption of your application with hardware or software evolution. At your request, we will then run regression tests on your application to ensure that a new software release of the BSP does not introduce a regression in your application. Of course, you will need to provide Silicomp with your application code if you want this level of support.

- At your request, we can actually take over complete maintenance of your application. Silicomp has significant references in such third-party application maintenance for very large applications. Then you are free to evolve your product, as Silicomp will take care of its maintenance, so that you can devote your own resources to the new products coming out of your organization.

Silicomp Support Levels

Silicomp provides different level of support to accompany your product evolution.

Bronze Support

This is the minimum level of support. It will fit your needs if your application does not need to evolve quickly. It includes the following:

- Silicomp will fix the bugs that you report, subject to the condition that you have produced a small test case reproducing the problem. Silicomp will include the bug fixes in scheduled releases. There will be at least one and at most three such releases within a year.
- Silicomp will upgrade the BSP to match a new hardware feature at most once a year.
- Silicomp will not provide systematic upgrade of the tool chain with the BSP upgrades
- Silicomp will provide no telephone or email assistance to your staff, only bug fixes

Silver Support

This level provides a medium level of support. It fits the need of customers who plan for significant evolution of their product

- Silicomp will fix the bugs that you report, subject to the condition that you have produced a test case or an application reproducing the problem. Silicomp will issue a patch with the bug fixes within 60 days of your report
- Silicomp will monitor for you the evolution of the open source community and produce automatic upgrades of your BSP, tracking the open source upgrades within 90 days and it will upgrade the tool chain as well if necessary.
- Silicomp will provide email assistance to your staff, but no telephone support.
- Silicomp will provide BSP upgrades, subsequent to hardware upgrades, at most twice a year

Gold Support

This level of support fits the needs of Silicomp customers who want to have a quick turnaround on defect repair, integration of the new features available, and plan for hardware evolution that follows the pace of the market (Moore law). It includes the following items

- Silicomp will investigate bugs that you report even though you are unable to reproduce the problem in a systematic way. Silicomp will devote a full time resource to investigate the cause of the anomaly. Silicomp will issue a patch with the bug fixes as soon as they are corrected.
- Silicomp will monitor for you the evolution of the open source community and produce upgrades of your BSP, tracking the open source upgrades within 45 days.
- Silicomp will monitor the evolution of the software tool chain that is used to produce the BSP and will provide systematic upgrades to the tool chain synchronized with the BSP upgrades.
- Silicomp will provide email and telephone assistance to your staff
- Silicomp will provide BSP upgrades subsequent to any hardware upgrade.

Platinum Support

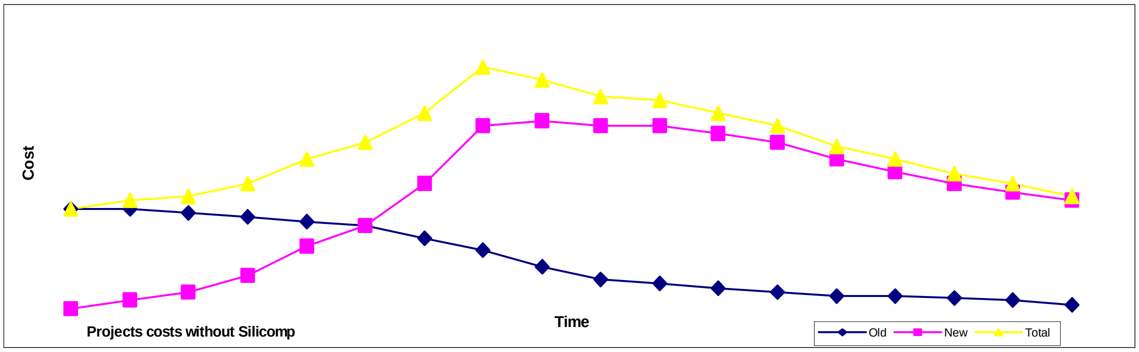
This is the highest level of support. This level of support fits the needs of Silicomp customers who want to have the highest level of satisfaction for their own customers. It includes all of the items from Gold support level and includes in addition:

- Silicomp will maintain an online bug database accessible on the Silicomp Web site with a secure entry point. You will be able to track the defects that have been fixed
- Silicomp will generate and maintain a test suite for you. If the BSP project involved the design of a particular test suite, Silicomp will apply the test suite and ensure there is no regression on each delivery. The test suite can include your own applications. In this way, you are guaranteed that successive releases do not break your applications.
- Silicomp will enhance the test suite, adding new tests to verify that each defect fixed is regression tested in future releases.
- Silicomp will be available for discussions with your own customers if needed, to resolve problems

Silicomp Migration Service

It may be the case that you are interested in migration to an open source solution but you anticipate a time lag and a period of time when you will phase out your existing application. It may be the case that you cannot abruptly discontinue your existing product and transition to a new one and it is an issue to simultaneously maintain your existing product line and ramp-up towards a new product line based on open source.

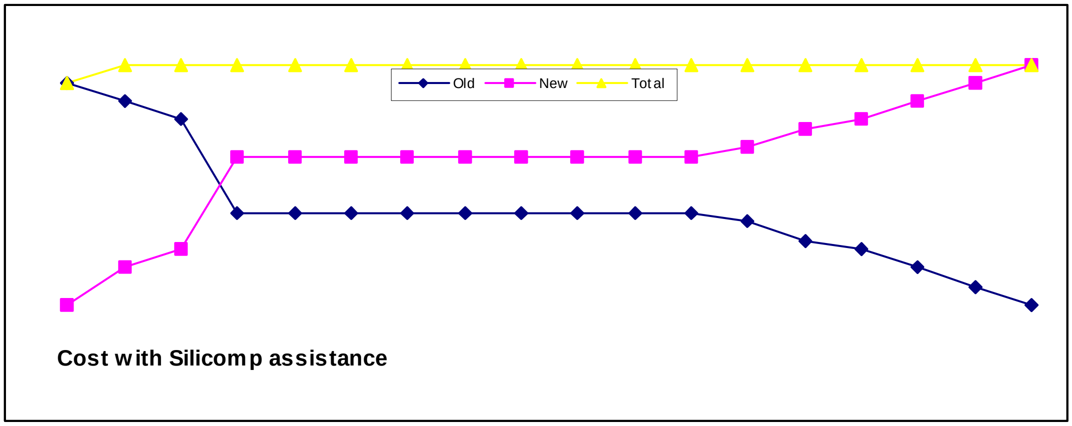
The diagram below shows the level of resources that would be needed, over a fictitious example of an 18 months period gradually phasing out the old application and phasing in the new project with a full development team 6 months later.



Silicomp can help you to smooth out your resource requirements and ensure your migration to open source will be a success. We can help you in this by taking charge of:

- Maintenance of your application. We can take over the maintenance of your old application on your old platform as you ramp up your resources towards the new product and will phase it out as you deem necessary.
- We will absorb what would be a high cost for you if you were to transition alone in your migration towards EL/IX. Because of our expertise on EL/IX and eCos, we will be able to help you in transitioning with a smooth ramp-up.
- Overall your cost will remain constant.

The next diagram shows how you will be able to handle your costs with help from Silicomp



Pricing Information

Silicomp will quote a fixed price for the initial BSP delivery. This price clearly depends upon on the complexity of the hardware platform and the pre-existence of open source code for the hardware items used in the platform, in particular the existence of the GCC compiler for the target micro-processor. Typical BSPs range from 15,000 Euros to 100,000 Euros for 32 bit micro-processors.

BSP support price depends upon several factors:

- Complexity of the BSP. Support is more costly for sophisticated BSPs than for simple ones.
- Level of support needed: Bronze, Silver, Gold or Platinum
- Application maintenance cost is related to the size of your application and the upgrade expectations

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