

Bill Weinberg and Jon Masters trace the role that Linux plays, often without our knowledge, in the shiny toys and small devices that connect, direct, inform and entertain us all

Ask the “man on the street” (or woman) when he or she last used Linux and they could be forgiven for exhibiting a blank and hurrying away. Many millions of people likely interact with Linux-based systems in one form or another without being aware of the role of the Open Source OS in their day-to-day life. Such anonymous encounters don’t always arise from the use of a distant Google web server or an ATM transaction routed through a bank’s enterprise Linux servers, but on ubiquitous gadgets and gizmos strewn around the average home, office, desktop - and shirt pocket. Increasingly, Consumer Electronics devices - those shiny toys that connect, direct, inform and entertain us - build on and deploy with Linux.

Consumer Electronics for the 21st century

Linux for a GNU generation of devices

MUSIC
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GAMES

Consumer Electronics (CE) is a massive and growing global market filled with devices which aim to make our lives easier (or more fun) by automating and integrating various tasks and functions and diversions into sexy and increasingly portable devices. The CE market itself has multiple segments, each with a range of sub-segments and application types.

face many of the same issues, but also suffer from a paucity of engineering resources and customers who prefer "ship it now" to "ship it right". Let's examine each of these challenges and how Linux helps device OEMs rise to meet them.

THE EXPLODING BOM
Manufacturers of intelligent CE

burdensome royalties. While very few intelligent devices deploy ONLY with Linux and other FOSS components, the use of open source at the base of the stack can buy OEMs US\$5-\$10 formerly spend on proprietary OS, networking, file system and other software components. Another way that Linux enhances margins is in memory use. While Linux-based devices certainly need

TO MARKET, TO MARKET

Once upon a time, embedded projects of all types limped through conception, prototyping, design, development, integration, QA, productization and deployment in stately 24 month cycles. A good product could thrive in the marketplace for 1-2 years and live out its last 9-12 months in profitable pastures as a cash cow.

Today, even high functionality CE devices zip through all phases of their development cycle in as little as 6-9 months, and if they manage to squeak into that magical "market window" they can deliver sales and profits to their makers for a comparable period.

Linux helps device OEMs accelerate their design and deploy times by letting manufacturers leverage the mass of Linux enterprise and desktop software, as well as a growing catalog of both commercial and FOSS software components and application specifically purposed for embedded applications. While some studies show that first-generation embedded applications with Linux can take longer to build and deploy than

software, not the hardware that runs it, that enables device OEMs to compete with truly differentiated, value-added features and functionality. With the use of FPGAs and SoCs, embedded hardware is increasing coming to resemble the commodity blades that power modern infrastructure, with concomitant cost savings from using Linux and open source on them.

Device OEM product teams, however, are still organized with a hardware-centric worldview. In many CE companies, each product or line builds on unique hardware and deploys unique OS, middleware and applications, eschewing the obvious economies of scale and simplification those same companies leverage in their manufacturing processes.

As a strategic platform for embedded computing, Linux just makes sense. It lets device OEMs manage increasingly large and complex application loads, using the same capabilities that make Linux such a good enterprise OS. It helps those same companies streamline their development teams and processes, cutting training,

In the first quarter of this year Linux outstripped Windows Mobile and Palm OS by three to one in design wins

companies from the past have to juggle the cost of maintaining their own software solutions and third party add-ons, Linux is able to benefit from having a "million eyeballs" working on it and on a multitude of software stacks which can be used by embedded devices built upon it. The hardware vendor who chooses to use Linux in their home gateway router device is benefiting more so from the extensive networking software available for Linux than simply from using Linux in the first place.

MY LITTLE DEVICE IS BETTER/FASTER/SMARTER/CUTER...

Feature/function and price are the mainstays of CE marketing. In the past, it was very difficult and expensive for device manufactures to continue to offer growing feature/functionality sets, generation after production generation with highly custom hardware and software.

Today, Linux enables CE manufacturers to set aside concerns about base capabilities and to compete on features and functionality in a standards-based environment. Moreover, Linux is a solution which

MOBILE AND WIRELESS	TV AND HOME ENTERTAINMENT	AUTOMOTIVE TELEMATICS AND IN-CAR ENTERTAINMENT	HOME NETWORKING AND CONTROL	SMALL OFFICE AND IMAGING
Mobile Phones Wireless PDAs Portable Media Players Portable Game Consoles Intelligent Remote Controls Digital Still and Video Cameras	Digital/HDTV PVR/DVR Set Top Box Digital Audio Receivers Musical Instruments Karaoke Game Consoles	Navigation Systems Vehicle Management Digital Radio Digital Media Players Hand-free Mobile Phones Wireless Data and Media Sharing	Home Gateway Broadband Access Home Automation Security & Monitoring Domestic Robotics	Laser and Inkjet printers Fax & Scanners Intelligent Copiers Multi-function Peripherals Network Printers Routers, Firewalls, VPN IP Telephony Clients Audio & Video Conferencing PBX & Voicemail

Manufacturers of equipment in all of these segments and applications types are building current and next-generation devices with Linux. In fact, VDC (Venture Development Corporation, the leading embedded market research firm in Natick, Massachusetts) reports that CE is the number one application area for embedded Linux (see Figure 1).

Summing together Consumer Electronics, Office Automation, Automotive and Home Automation, a whopping 43 per cent of all embedded Linux applications fall, broadly speaking, into Consumer Electronics.

CHALLENGES FACED BY CE MANUFACTURERS

Top tier global, branded CE device manufactures face a series of challenges in common:

- slim margins on complex Bills of Material (BOMs)
- short product life-cycles and shorter time-to-market
- burgeoning software content (doubling every year) and accompanying integration challenges
- diverse product lines and divergent technology behind intense price/feature competition in a global marketplace
- the need to build brand and conserve brand equity.

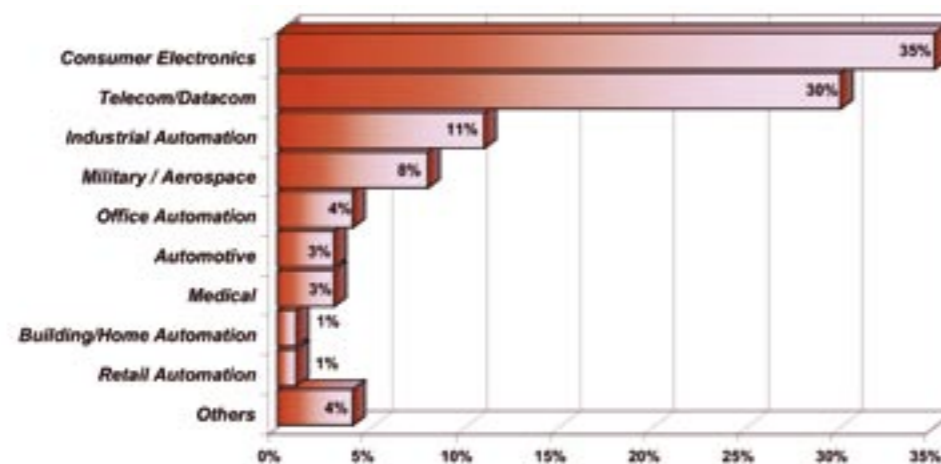
Tier II and regional CE companies, as well as ODMs and many integrators,

devices face a constant battle to maintain margins in the face of huge pricing pressure in the mass marketplace. As more and more features become commonplace, the complexity and item cost of the BOM continues to rise, making it increasingly difficult for device OEMs to turn even a small profit on each device. Devices that operate as service delivery vehicles (phones, cable boxes, satellite radios) often leave the factory with negative margin for the manufacturer, only yielding profit over the life of their deployments from a cut of services and content revenues from operators deploying the devices.

Linux dampens BOM shock waves by reducing both development costs and most significantly the COGS (Cost of Goods Sold) with its freedom from

more memory than legacy RTOS-based designs, Linux is more scalable and more parsimonious of RAM and flash than a number of competing solutions. For example, Microsoft Windows Mobile is designed to deploy in 28-32 MB and cannot easily be decomposed and scaled into small footprints (remember - the browser is part of the OS, or so Microsoft told the US Department of Justice). Depending on the application, a Linux platform can deploy in less than a megabyte, with highly functional platforms and stacks running well in 12-16 MB. Memory saved enhances OEM margins either through savings in RAM and flash chips, or by letting OEMs use freed up memory for differentiating functionality.

Figure 1



proprietary legacy, once companies conquer the learning curve, they proceed to wring increasing benefit from the switch.

A STRATEGIC PLATFORM TO TAME COMPLEX CONTENT

A decade ago, all categories of embedded applications were dominated by their hardware content. Embedded OSes and the software that ran on them received the same treatment as the resistors and capacitors that shared board-space and BOM-space with software-support chips like CPUs and RAM.

Today, by all measures, software content dwarfs hardware content. It is

development, and maintenance costs by providing a common development and deployment platform that crosses CPU hardware and application boundaries, reducing redundancy of effort (and headcount) while enabling OEMs finally to enjoy the promised benefits of software re-use across product lines.

Moreover, since Linux was not been developed by one single company, there's no need for any one vendor to recoup the tremendous R&D cost associated with writing the kernel and user applications from scratch, as many device OEMs did for their own embedded OSes and stacks. Whereas the mainstay embedded systems

The iconic Tivo was one of the first Embedded Linux devices. Originally based around the PowerPC 403/405 processors, it was also one of the first mainstream products featuring Linux which didn't have yet another Intel processor inside.

has become viable as embedded hardware has improved and become better suited to the demands of a full scale operating system.

Traditional embedded computing has been very much focused on cutting down the available software and cramming it into as small a space as possible - gaining cost savings in storage and processing at the cost of flexibility in design. Today's marketplace cannot tolerate this kind of "thinking small". Not only must embedded devices be extremely flexible and full featured, but they often need to be field-upgradable to take advantage of technology improvements over the life of the



product. It is almost always cheaper to ship a unit based on standard components running Linux than to try to re-implement all of its required functionality on a slightly cheaper hardware platform.

CE DEVICES AND QUESTIONS OF INTELLECTUAL PROPERTY

Perhaps one of the biggest talking points amongst embedded developers over the past few years has been that of Intellectual Property and the education process necessitated for a full understanding of what can and can't legally be done with Linux. Several high profile incidents of corporate embarrassment have followed from shipping products which contain Linux (or components from Linux - such as the Netfilter packet filtering networking stack) without making relevant source code and modifications available alongside it.

As often as not, FOSS licensing violations occurs most often simply as a result of naivety (not malice) on the part of those who not observing the niceties of the GPL and other licenses.

A HISTORY OF OBSCURITY

Many embedded device companies, especially CE OEMs, have traditionally been reluctant to release source code, seeking to protect their investment in "trade secrets" - algorithms and software tricks presumably couched in the

The Nokia 770 Internet Tablet is Nokia's first consumer electronics device based upon Linux. Nokia is no stranger to the Linux community and it is hoped that this is the first of many such devices to be seen from this Finnish cellular phone giant. The 770 spawned an Open Source community based around the Maemo development platform which was produced by Nokia and others for this device.

source code that are "up for grabs" under public scrutiny. As such, adjusting to the Open Source development model in which some or all software changes are made available can be disconcerting and disjoint with both traditional practices and best practices laid down by corporate legal teams. So ingrained is obfuscation that some device OEMs, when forced to make their changes available have even gone so far as to deliberately obscure their source code, such that it can be compiled but is not made available in a form which is readily modifiable.

Such neurotic behaviors result, then, from a mix of tradition, fear, corporate edict, and ultimately a lack of understanding of those rights given (and protected) under the GPL and other FOSS licenses.

CE APPLICATIONS AND THE GPL

The GPL mandates that when a (re)distribution of GPL-licensed code occurs, that source code accompany binaries, or that an offer of source code accompany them. For traditional desktop and server applications, the distribution mechanisms for source and binary code is most commonly CD-ROM, and today is increasingly web-based. With embedded applications, however, the notion of distribution media is particular to the device in question. In most cases, the flash ROM or other persistent storage medium in a

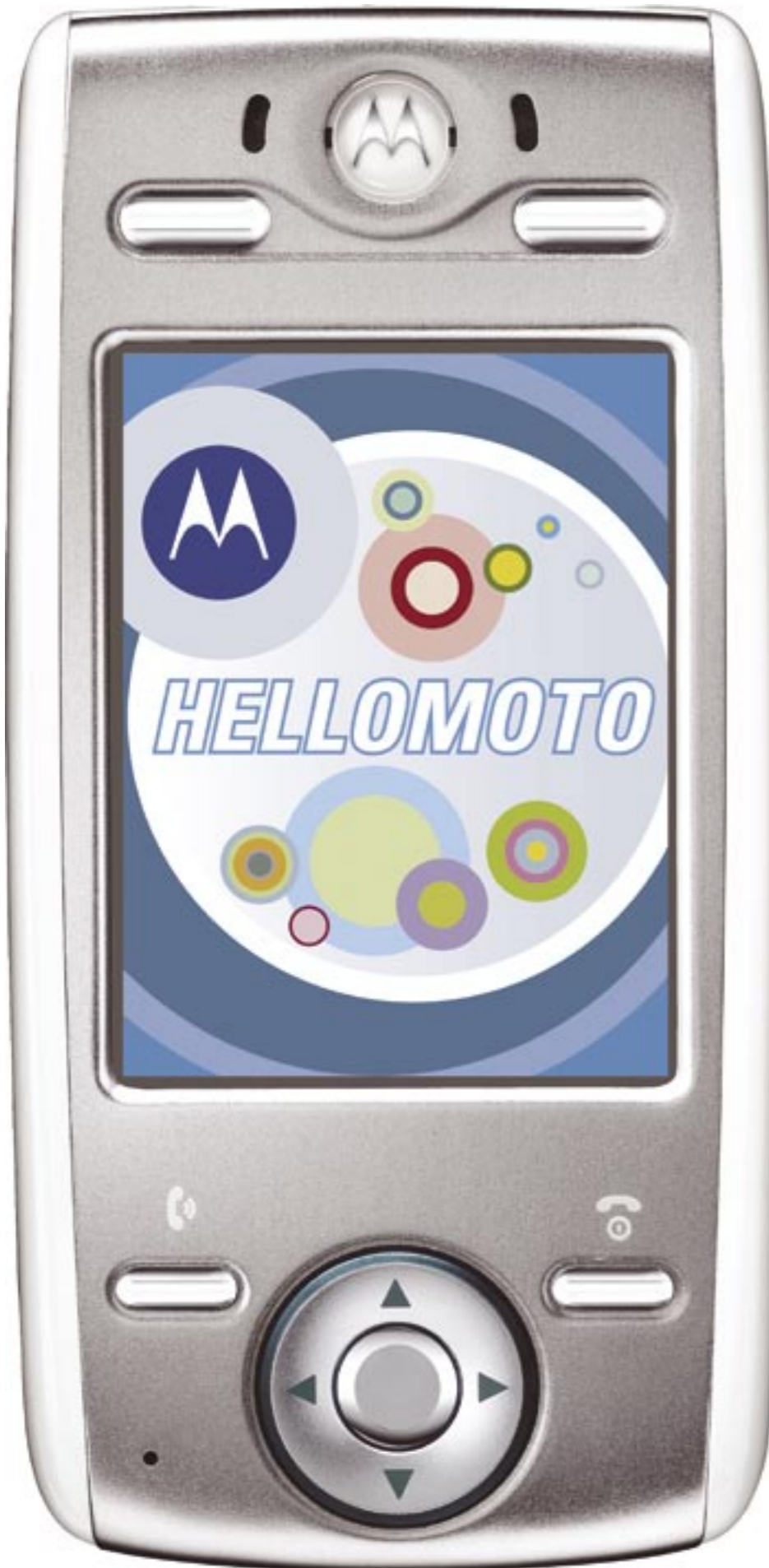
phone, audio player, car dashboard or other gadget is brimming with binary code that includes the OS and value-added applications. Devices shipping with 64 MB of RAM and 32 MB of ROM simply do not accommodate gigabytes of source code. So, most commonly, device OEMs elect to supply source on accompanying media (e.g., a CD-ROM in a box, via remote media (on a web server) or by leveraging the GPL's option for (re)distributors to make an offer to supply source code to all those who buy the device. The GPL does not in itself force the vendor to establish a website with all of their software patches available for download, nor does it force the vendor to make it easy for those using their source to build a competing product.

TECHNOLOGY ISSUES

Linux may have a low per unit cost and be highly configurable but another key reason for its growth in popularity stems from its support for a diversity of available modern hardware. In the age of System-On-A-Chip and programmable logic - where increasingly higher numbers of peripherals are being integrated right onto the processor chip - it's important that the OS is able to keep up with the pace of hardware development. Linux supports almost every exotic SoC on the market today and its driver support for the on-chip peripherals has been further strengthened by various new technologies which have entered into the latest 2.6 stable kernel.

PROCESSOR CHOICE FOR CE APPLICATIONS

While desktop and server versions of Linux run primarily on Intel IA-32 and emerging 64-bit CPUs, AMD 32 and 64 bit architectures, and also on a variety of 32/64 bit Power Architecture CPUs, embedded applications deploy Linux on over a dozen different CPU families and several dozen processor variants. These include ARM, IA-32/x86, M68000, MIPS, PowerPC, SuperH, Xtensa and others. Consumer Electronics applications and the particular requirements needed thereby dictate a smaller subset of processor families, with particular emphasis on certain CPU variants:



Mobile and Wireless

ARM: Intel PXA Processors (XScale), Motorola MX, and overwhelmingly, TI OMAP

TV and Home Entertainment

ARM, MIPS and PowerPC

Telematics and In-Car Entertainment

ARM and SuperH

Home Networking and Control

ARM - especially Intel IXP network processors

Small Office and Imaging

ARM, MIPS, PowerPC

SOCS AND FPGAS

The latest highly integrated processors came about as a way of reducing cost and the per-unit BOM (Bill Of Materials). It would seem obvious enough that reducing the number of physical components on a circuit board will ultimately reduce its complexity and cost to manufacture. It is then little wonder that vendors have sought such high levels of integration that whole processor families are dedicated to a type of device in which they will function and the peripheral devices needed in such systems. One such family of processors is the Texas Instruments OMAP range of flexible processors, used in a range of multimedia and handset platforms. These chips include memory controllers, audio CODECs, frame buffer controllers and the like, but they also allow the programmer to rewire which devices are connected together (and in what fashion) at runtime. These flexible chips are being used in applications where a dedicated DSP (Digital Signal Processor) would have been the normal just a few years ago.

MULTI-PROCESSING

Integration has led to whole new generations of technology with specific functions in mind. The average cellphone on the market today has at least one microprocessor running an application Operating System but many higher-end models

Motorola's latest Linux based device, the e680i features all the bells and whistles one would expect of a modern smartphone without the typical PDA GUI software environments we have come to expect. It is almost impossible to tell it's Linux inside.

rely upon several processors to offer the features we have come to expect from intelligent devices like the Smartphone. This is because it has traditionally been difficult to provide a fancy user interface while simultaneously running all of the lower level protocol communications software necessary to maintain a GSM call. Recent processor designs feature a single microprocessor combined with assistive peripherals which can work in tandem with a real time Linux variant to achieve the same performance with less hardware.

THE CE OS LANDSCAPE

While Linux is doing well in Consumer Electronics, it is neither alone in the field nor even a leader among its competition (see Figure 2). While across the whole gamut of embedded applications, Linux enjoys a leading position with 29 per cent percent of all new 32 and 64-bit designs (VDC), in CE applications it must vie with some very strong and entrenched competition, usually in a per-application arena.

For example, on one hand Linux is making huge gains in the mobile hand set arena, specifically on so-called smartphones.. According to Gartner, for Q1 2005, Linux outstripped Windows Mobile and also Palm OS by three to one in design wins. Great news, except that Linux niche success pales when compared to the dominance by SymbianOS, with over three quarters of smartphone design wins.

Moving down the ladder to feature phones and lower-end models, the emphasis shifts away from SymbianOS, whose start-up costs and licensing expense would cripple financial models for basic function handsets. Instead, the dominant platform is Nucleus, a proprietary (legacy) RTOS from the Accelerated Technology division of Mentor Graphics. Until Linux can master issues of real-time and very small footprint, it will be hard to compete with this ubiquitous royalty-free realtime operating system.

WHO'S WHO - CE LINUX CAST AND CREW

To really understand development and deployment of Linux in intelligent consumer devices, it is important to survey the players involved: device OEMs and their suppliers - software platform and tools providers, ISVs,

silicon vendors; key consortia and of course CE-focused Open Source project teams.

INTELLIGENT DEVICE MANUFACTURERS - A GLOBAL COMMITMENT TO LINUX

Top-tier Device OEMs are not only building their best and brightest baubles with Linux, they are eager to disclose their choice of OS and development paradigm. Over two dozen household-name companies have made public statements emphasizing their commitment to consumer applications, and to Linux - and countless Tier 2 manufacturers, ODMs and integrators have followed suit.

Acer	Linksys	Samsung
BenQ	Matsushita (Panasonic)	Sanyo
BMW	Mitsubishi	Sharp
Canon	Motorola	Siemens
Casio	NEC	Sony
D-Link	Nokia	Sylvania
Epson	Palm	3COM
Ericsson	Philips	Tivo
Haier	Pioneer	Toshiba
Hewlett Packard	Roomba	Volvo
Kenwood	Royal	Yamaha
LG		

Joining their ranks are many Telecommunications and Networking equipment suppliers (TEMs and NEPs) who seek to augment revenues from switches and access equipment with high-volume sales of wireless access points, set-top boxes, and cell phones. These "new age" CE

manufacturers include Cisco and China's Huawei and Datang.

PLATFORM PROVIDERS - DISTRIBUTIONS FOR INTELLIGENT DEVICES

While there are dozen, perhaps even hundreds Linux distros that target desktop and server systems, Linux-based OS platforms for embedded applications are but a select few. Most are commercial distributions, with a few purely FOSS alternatives focused on embedded:

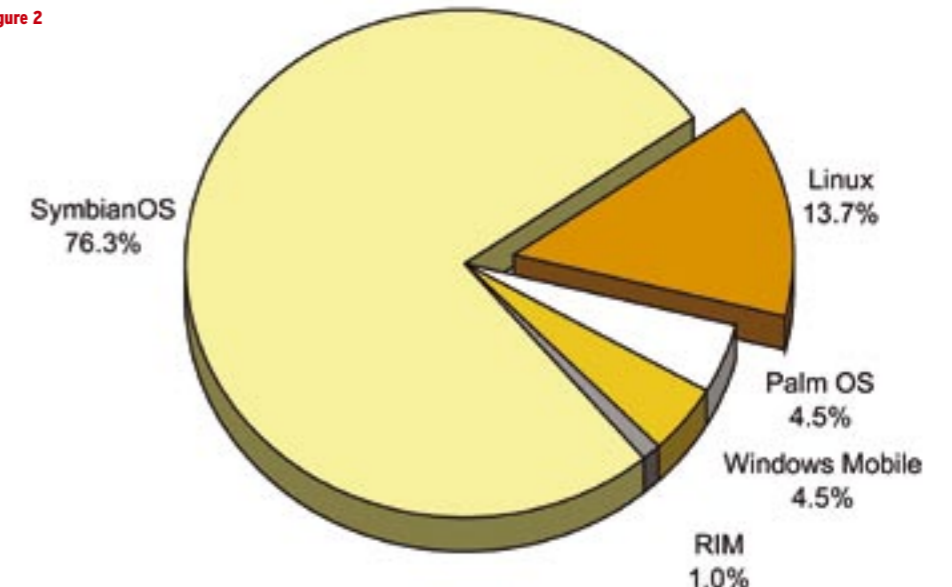
MontaVista Software

The brand leader for embedded Linux has done much to enable device

OEMs to build their wares with Linux and open source. In particular, they offer versions of MontaVista Linux targeted at verticals like mobile phones on the commercial side, while also investing heavily in community-based initiatives for real-time, power management, fast boot, and flash file systems. "The flexibility of Linux, combined with its technical strengths, enables consumer

electronics companies to build and deliver innovative, cost-effective products," notes Jacob Lehrbaum, CE product manager at MontaVista, whose team "continues to enable adoption through developments improving boot time, power management, and hard real-time

Figure 2



performance.”

MontaVista Linux today powers a range of CE application, from Sony TVs and media devices to Yamaha musical instrument systems to Linksys wireless routers. Most notably, MontaVista Linux is the platform of choice for nearly a dozen smartphone designs from Motorola, NEC and Panasonic, with others in the pipeline.

Wind River

Embedded software market leader Wind River is building Linux into the mix the company calls “Device Software Optimization”. Wind’s DSO product line includes their mainstay proprietary RTOS VxWorks, today complemented by development tools for Linux bring-up and debug and recently by Linux-based platforms for CE applications. While a newcomer to Linux, they are old hands at other FOSS components. In fact, their first embedded products were built around Berkeley TCP/IP components; after their acquisition of BSD itself in 1999, they offered BSD/OS for embedded COTS hardware; and today they are an active member of the Eclipse consortium.

Moving forward, Wind seeks to differentiate their Linux and tools offerings with a quality distribution, comprehensive Eclipse-based tools (“Workbench”) spanning from h/w bring up to development of firmware, drivers, and application software, through verification/test and manufacturing. They also offer a strong partner ecosystem and global services practice.

PalmSource

PalmSource, the longtime licensor of the proprietary PalmOS PDA platform to companies like Palm, Garmin, Sony, Seal, Trio and others, recently announced that moving forward, PalmSource would build its PalmOS platform on top of the Linux kernel.

The company’s commitment to Linux is customer driven, “they are tracking “significant new interest” from both current and prospective customers. “PalmSource is committed to Linux because we believe it provides the best foundation on which to build our middleware, user experience and applications,” avers John Ostrem, PalmSource lead scientist (and founder/CTO of China MobileSoft). “Benefits for PalmSource from Linux

Linux brings the stability, security, and ecosystem of enterprise computing to the once-backward domain of embedded computing

include enabling us to concentrate our resources on the differentiating parts of our technology, faster time to market, and support for a broader range of hardware.”

ARM Ltd

ARM, the licensor of ARM CPU core technology to companies like Altera, FreeScale (MX), Fujitsu Semiconductor, Intel (XScale), Philips Semiconductor, Samsung, Texas Instruments (OMAP), and over one hundred other licensees, also contributes strongly to the ARM architecture sub-tree of the Linux kernel and also to a variety of projects above the kernel, especially in the area of tools. ARM funds the maintenance of the ARM source tree and invests in leading-edge research to support next-generation ARM silicon (eg., ARM11).

Interestingly, ARM has made great strides in building SMP support into the ARM tree to target performance hungry but slow-clocked power-managed applications (like cell phones) needed more MIPS/watt. Even more investment at ARM goes into power management.

Embedded Debian, uCLinux, ELDK and UBOOT

A wide range of “pure” open source solutions exist for basic embedded development. Embedded Debian (www.emdebian.org) and uCLinux (www.uclinux.org) strive to address minimal system configurations,

especially those based on low-end 32-bit microcontrollers with on-chip MMUs. ELDK, from German embedded stalwart Wolfgang Denks (of Denx) focuses on making usable cross development tools available for embedded development. The same folks also help maintain UBOOT, a family of small boot-ROMs and loaders for embedded applications. See www.denx.de for more info.

Others

Other providers of Linux platform software and tools are Tier II Linux distributors like Lineo Japan, TimeSys, and Viosoft. Proprietary OSE RTOS vendor ENEA just entered the Linux fray, hoping to be able to companion and bolster falling OSE sales with Linux in complex designs.

Also contributing to the corpus of embedded and CE Linux technology are global semiconductor suppliers, who seek to boost chip sales by providing ready-to-use versions of Linux and other open source software together with their h/w reference platforms. Some of the “semis” invest significant budget to support their own platforms; some work with commercial distribution suppliers to create viable demonstration, evaluation and even deployment platform, and some just offer a “bucket of bits” together with their h/w as proof of concept that Linux “just works” on their slick silicon (and it often just does work).

The TomTom Go series of popular GPS navigation systems are based upon an Embedded Linux environment driving an interactive 3D display. TomTom initially failed to disclose all source modifications but have in recent times been supportive through their website.



FROM LINUX-BASED PLATFORM TO CE SOLUTION STACK - ISVS AND INTEGRATORS

A key advantage of established proprietary software platforms is the vendors investment in building an ecosystem of applications and middleware suppliers to support end-users and OEMs in building on and deploying with their OSes. This has certainly been the strategy of Microsoft and Sun, whose myriad ecosystem partners offer tens of thousands of applications and tools off-the-shelf for Windows and Solaris operating systems.

Embedded is a more specialized domain than enterprise software and CE a more rarified realm than even the rest of embedded, but ISVs face the same challenges in addressing embedded applications as they do in the enterprise: that Linux is a moving target and diversity (read fragmentation) among competing commercial and open Linux platform implementations.

The good news is for device OEMs. With Linux, they are no longer limited to a rarified set of software suppliers to augment their internal competence in creating value-added stacks. Instead, they can leverage a broader array of both embedded and enterprise ISVs as well as a range of purely open software components and projects.

For example, CE manufacturers needing a graphical output solution would have a very limited choice with their legacy RTOS. With Linux, they can choose from open solutions based on GTK/Gnome or commercial offerings built on Qt/



DRIVING ADOPTION AND STANDARDISATION - CE AND EMBEDDED LINUX CONSORTIA

Linux and other open source technologies have for the most part evolved organically. That is, they advance and fulfill developer and end-user needs as needed in response to particular requirements, as often as not, of the developers themselves. However, the operative impetus behind much open source development from that which is

implementations of the Linux kernel and stacks to address a variety of CE applications, including media players and cell phones. Today CELF comprises over 50 companies that invest in every type of CE applications in Asia, Europe and North America.

CELF's stated goals are to publish specifications for enhancements in Linux desired by its membership, and to create a set of changes (patches) to Linux, approved by the Forum, and made available in the form of a CE Linux Forum source tree. These

other members to discuss and promote the needs of CE manufacturers, and is reaching out to other .orgs to build better community bridges, particularly in the area of testing.

Embedded Linux Consortium

ELC was formed earlier in the ascent of embedded Linux, with original high hopes of being able to promote and accelerate Linux adoption in an ambitiously broad array of application areas. After about a year of operating, ELC fell into the trap of dissatisfaction with its role as a trade organization and embarked on a lengthy and expensive effort to create and publish a standard to define embedded Linux itself. The fact that a published standard ipso facto constitutes IP further delayed the publication of what was to be called ELCPS - the Embedded Linux Consortium Platform Specification. When it finally reached publication in 2003, ELCPS proved to be serving a divergent set of clients. Two-thirds of ELCPS described OS platforms based on POSIX Profiles (PSE5x) that constituted such trivial subsets of Linux that no real Linux applications would ever run on them. The remaining third profile described a system so congruent with LSB that it was difficult to justify a separate standard. A few embedded distribution vendors begrudgingly provided proof of compliance and then everyone got back to work on "real" customer requirements.

Today ELC membership is greatly reduced, with most of its original membership striving to satisfy the ELC's stated goals through working with CELF or the OSDL. It is very likely that the remaining ELC members will merge with OSDL or another organization, who will also host and maintain ELCPS for reference/historical purposes.

Free Standards Group

The FSG's Linux Standards Base (LSB), until recently described the mostly common denominators among Linux distributions. With the publication of LSB version 3.0, it graduated from being a trailing standard to one in a position to drive compliance and so compatibility across distros, to the cheers of ISVs, end-users and developers alike. For that same reasons it is key to any discussion of standards-based embedded computing, since embedded Linux

platform providers, ISVs (and bodies like the OSDL) build their own products, APIs and specifications on LSB.

OSDL

The Open Source Development Lab, a non-profit consortium dedicated to accelerating Linux adoption, plays home to Linus Torvalds, Andrew Morton and Andrew Tridgell. OSDL is also home to initiatives focused on Linux on the desktop (DTL), in the data center (DCL), and on carrier-class communications equipment (CGL), as well as legal efforts like the Linux Defense Fund and the Patent Commons.

To date, OSDL closest foray to the world of CE has been at the "other end of the wire" with Carrier Grade Linux, implementations of which provide the infrastructure for a slew of wireless and multimedia client applications. OSDL membership and various third parties have been requesting that OSDL branch further into embedded to drive adoption with specifications for devices like cell phones and set-top boxes - stay tuned for developments in these areas from the Beaverton-base Lab.

LONG LIVE UBIQUITOUS COMPUTING

The visions of the PC as a the prototypical computing device is clearly on the wane. While the PC is not "dead", it is quickly being eclipsed for all types of communication (email, IM, etc.) and many types of applications (games, sales automation, CRM, etc.) by mobile devices and other CE clients. With a strong and growing share of the CE marketplace, Linux is both a beneficiary of this paradigm shift and a force behind it. As a beneficiary, CE applications will increase the global Linux installed base by two or more orders of magnitude and create new synergies between enterprise and embedded deployment. As a driver, Linux brings the stability, security, and ecosystem of enterprise computing to once-backward domain of embedded computing, giving once hardware-centric devices new intelligence by convey upon them peer-status with server and desktop systems.

In this new setting, Linux is already playing a key role, reinventing both enterprise and highly personal computing as a ubiquitous continuum.

"Take care of the luxuries and the necessities will take care of themselves" - Dorothy Parker

Qtopia/KDE from Trolltech; they can choose among myriad open window managers; they can use alternative graphical paradigms from PalmSource, Mojo, and Swell Software. And many device OEMs eschew using native graphics altogether and build with output schemes around either Java or use embedded web servers and CGI's to handle graphical configuration and management.

interesting as opposed to that which is required. It is for the required, slogging, infrastructure work and definition, the "glue" if you will, that consortia are formed.

CELF

The Consumer Electronics Linux Forum was formed by initially by Japanese giants Sony, Matsushita and NEC. Since its founding in 2003, CELF has focused on building reference

laudable goals have not been easy to realize. In particular, CELF has suffered from both a lack of dedicated and active resources within its membership, and a lack of community know-how to get its patches accepted into mainstream source trees. Without aggressive uptake of CELF patches, such a source tree can quickly devolves into a series of unsupported forks. CELF does serve as a lively forum for its founders and

"When I was young I used to think that money was the most important thing in life; now that I am old, I know it is"
Oscar Wilde

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