Know your OS options

By Jerry Gipper and Don Dingee

As a natural outgrowth of the trend for more and more software content in products, software often leads the decision on which hardware to choose for an embedded applications design. For projects tightly coded in a small microcontroller, designers may be able forgo an Operating System (OS) altogether. But for most projects, an off-the-shelf OS offers benefits, most of which become stronger the larger the project gets. The right choice of an OS can make or break a project.

If you get to choose which OS you use in your next project, there's good news – many software alternatives are available to sort through. Evaluating and selecting an OS can be a fun and challenging exercise for those who know what to look for.

We've examined the range of OSs from simple to complex with some real-time characteristics and separated them into three basic classes:

- Linux (and its near cousin, BSD)
- Real-Time Operating Systems (RTOSs)
- RTOS extensions that work with Windows

Evaluation criteria

Which questions should designers ask when evaluating OS choices? Let's run through some of the areas to consider. (Note: We didn't attempt to tabulate these in our list, so consult individual vendors for current information.)

- **Distribution rights, runtime royalties, and development seat costs.** Some OSs are free and others are licensed on a per-copy, per-seat, or per-project basis or a hybrid cost model. Consider this up front: For small projects, development seat costs can be prohibitive, and for medium to large volume projects, be sure to include any royalties in the total cost of your application. The licensed models usually come with some form of vendor support, while the free models usually have support from a community that contributes fixes and new development.
- **Processors supported.** Designers should review which processor architectures and models are supported when reviewing RTOS choices. Hardware and software teams should coordinate closely to ensure the OS and processor architecture are compatible. Look for OS suppliers that have a strong working relationship with the processor vendors – most list these relationships in formal partnering programs. A long track record with a processor family is a huge plus. You want the OS to be able to leverage the features of the processor to your advantage.
- **Features.** These OSs were usually developed for a specific job and have varying strengths and weaknesses. Features are numerous and differ widely among OSs. With an understanding of your application and its requirements, prioritize required features to narrow the search. Items to consider include kernel size, interrupt response, context switching time, memory management, networking protocol support, development language support, debugging, and others.
- **Customer support.** To some developers, this can be a decisive factor. How big is your project? How familiar are you with the RTOS you are using? Answers to questions like these can point to a supplier with a solid and well-established support team that can assist you through some difficult design issues and save much time and effort. Sometimes, communities can be very helpful, especially if you're a contributor in good standing. But generally, timely and experienced customer support is not going to be free – expect to pay to get priority response.
- **Development tools supported.** Development tools can be a major decision, especially on large projects with numerous developers. Many companies have corporate-wide mandates for certain tool chains, thus limiting your RTOS choices. Some smaller RTOS suppliers don't have much in the way of development tools, a good compiler may be all you get. Other suppliers offer fully featured development environments. Your development team will be spending a lot of time with the tools so be sure you choose wisely. Consider Eclipse-based tools so they can be customized to meet current and future requirements. (For more insight direct from industry experts on this topic, read the Eclipse Perspective and News column, one of our regular features, on page 11.)
- **Source code access.** Access to source code can be very important to some programs. Open source OSs by definition come with this. Linux again provides a great example of a community of developers that has kept the source code in the public domain and harvested the "best of the best" to provide a solid OS. Vendors of proprietary code often provide snippets to help with driver development or configuration, but licensing source is a different story – it's usually quite

expensive. Many defense programs require access as sort of an insurance policy to business disruptions and emergency maintenance. Some developers like access to source so they can fully understand the RTOS's underpinnings. Be sure you understand the vendor's policy on source code.

- **Supplier reputation.** "Let the buyer beware" applies here. The big suppliers have been around for a long time for good reason – customers have succeeded in using their products. A number of small suppliers, some backed by only a single software person, provide OSs. Look deep and see what's there. Ask for references if necessary. Consider what kind of risks you are willing and able to accept. Some great solutions come from the smallest of suppliers, but your project could face huge risks if the supplier fails or you get in over your head and can't get the right support.

The RTOS roll call

Table 1 lists some of the choices available today. Many you may recognize, while others may be unfamiliar. While conducting our research, we tried to find a wide range of options from the simplest OSs to the most complex. Numerous individual university research projects could add more depth to the choices; we included choices supported by a community of researchers.

This list fluctuates as new alternatives emerge, old ones fall out of favor, and ongoing mergers and acquisitions change the landscape of the industry. Many did not make the list if we were could not confirm continued OS support. Some websites were dated and showed very few signs of life.

If you enjoy digging into the history of OSs, you can find some interesting reading at www.answers.com/topic/list-of-operating-systems, which captures some of the background on a long list of OSs that have come and gone and provides the roots to the popular choices of today.

Do your homework. Ask questions. Demo some code. Make informed decisions. ECD

Table 1

Operating System	Company	URL	Model	Type
µCLinux	Community	www.uclinux.org	Open source	Linux
µITRON	Community	www.assoc.tron.org	Open source	RTOS
µnOS	Miray Software	www.miray.de	Proprietary	RTOS
AMX	KADAK Products Ltd.	www.kadak.com	Proprietary	RTOS
BlueCat Embedded Linux	LynuxWorks, Inc.	www.lynuxworks.com	Proprietary	Linux
C EXECUTIVE	JMI Software Systems, Inc.	www.jmi.com	Proprietary	RTOS
CapROS	Community	www.capros.org	Proprietary	RTOS
Certified BSD	Wasabi Systems	www.wasabi.com	Proprietary	Linux
CEWin	Kuka Controls	www.kuka-controls.com	Proprietary	RTOS Extension
CMX-RTX	CMX Systems	www.cmx.com	Proprietary	RTOS
CMX-Tiny+	CMX Systems	www.cmx.com	Proprietary	RTOS
Contiki	Community	www.sics.se/contiki	Open source	RTOS
Coyotos	Community	www.coyotos.org	Open source	RTOS
E/OS LX	Community	http://meos.sourceforge.net	Open source	Linux
eCos	Community	http://ecos.sourceware.org	Open source	RTOS
ELinOS	SYSGO AG	www.sysgo.com	Proprietary	Linux
Emb OS	SEGGER Microcontroller Systems	www.segger.com	Proprietary	RTOS
Embedded Linux	Neoware	www.neoware.com	Proprietary	Linux
EPOC	Symbian	www.symbian.com	Proprietary	RTOS
ESF OS	EmINENT Microsystems Inc.	www.eminentmicro.com	Proprietary	RTOS
FreeRTOS	Community	www.freertos.org	Open source	RTOS
Fusion	Unicoi Systems Inc.	www.unicoi.com	Proprietary	RTOS
Haiku	Community	http://haiku-os.org	Open source	RTOS
Inferno	Vita Nuova Holdings Ltd.	www.vitanuova.com	Proprietary	RTOS
INTEGRITY	Green Hills Software, Inc.	www.ghs.com	Proprietary	RTOS
InTime	TenAsys Corporation	www.tenasys.com	Proprietary	RTOS Extension
iRMX III	TenAsys Corporation	www.tenasys.com	Proprietary	RTOS
Javaloution	Community	www.javaloution.org	Proprietary	RTOS
Linux 2.6	Community	www.kernel.org	Open source	Linux
LinuxDA	Empower Technologies Corporation	www.linuxda.com	Proprietary	Linux
LinuxLink	TimeSys Corporation	www.timesys.com	Open source	Linux
LynxOS	LynuxWorks, Inc.	www.lynuxworks.com	Proprietary	RTOS
MaRTE OS	University of Cantabria	http://marte.unican.es	Open source	RTOS

Operating System	Company	URL	Model	Type
MC/OS	Mercury Computer Systems	www.mc.com	Proprietary	RTOS
MicroC/OS-II	Micrium	www.micrium.com	Proprietary	RTOS
MontaVista Linux	MontaVista Software Inc.	www.mvista.com	Proprietary	Linux
MQX	MQX Embedded (ARC International)	www.metaware.com	Proprietary	RTOS
NetBSD	The NetBSD Foundation, Inc.	www.netbsd.org	Open source	RTOS
Neutrino	QNX Software Systems	www.qnx.com	Proprietary	RTOS
NicheTask Embedded OS	InterNiche Technologies, Inc.	www.freertos.com	Open source	RTOS
Nimble	Eddy Solutions	www.eddysolutions.com	Proprietary	RTOS
Nucleus OS	Mentor Graphics Corporation	www.mentor.com	Proprietary	RTOS
Nut/OS	Community	www.ethernut.de	Open source	RTOS
On Time RTOS-32	On Time Informatik GmbH	www.on-time.com	Proprietary	RTOS
OpenMoko	OpenMoko	www.openmoko.com	Open source	Linux
OS-9	RadiSys Corporation	www.radisys.com	Proprietary	RTOS
OSE	Enea	www.enea.com	Proprietary	RTOS
OSEK-OS	OSEK.org	http://portal.osek-vdx.org	Proprietary	RTOS
PERC	Aonix	www.aonix.com	Proprietary	RTOS
Phar Lap ETS	Ardence (Citrix Systems, Inc.)	www.ardence.com	Proprietary	RTOS
PikeOS	SYSGO AG	www.sysgo.com	Proprietary	RTOS
Prex	Community	http://prex.sourceforge.net	Open source	RTOS
PSX	JMI Software Systems, Inc.	www.jmi.com	Proprietary	RTOS
ROM-DOS	Datalight	www.datalight.com	Proprietary	RTOS
RT Linux	FSMLabs, Inc.	www.fsmlabs.com	Proprietary	Linux
RTA OSEK-OS	ETAS Group – LiveDevices	http://en.etasgroup.com	Proprietary	RTOS
RTAI	RTAI.org	www.rtai.org	Open source	RTOS Extension
RTCoreBSD	FSMLabs, Inc.	www.fsmlabs.com	Proprietary	RTOS
RTEMS	On-Line Applications Research Corporation	www.rtems.com	Open source	RTOS
RTOS-UH	Institute for Automatic Control	www.irt.uni-hannover.de	Proprietary	RTOS
RTX	Ardence (Citrix Systems, Inc.)	www.ardence.com	Proprietary	RTOS Extension
RTXC Quadros	Quadros Systems, Inc.	www.quadros.com	Proprietary	RTOS
Rubus OS	Arcticus Systems AB	www.arcticus-systems.com	Proprietary	RTOS
Salvo	Pumpkin	www.pumpkininc.com	Proprietary	RTOS
SCIOPTA	SCIOPTA Systems AG	www.sciopta.com	Proprietary	RTOS
simpleRTJ	RTJ Computing	www.rtjcomputing.com	Proprietary	RTOS
smx	Micro Digital Inc.	www.smxinfo.com	Proprietary	RTOS
Solaris	Sun Microsystems, Inc.	www.sun.com	Open source	Linux
SUSE Linux Enterprise Real-Time	Novell	www.novell.com	Proprietary	Linux
TargetOS	Blunk Microsystems	www.blunkmicro.com	Proprietary	RTOS
T-Engine	T-Engine Forum	www.t-engine.org	Proprietary	RTOS
ThreadX	Express Logic, Inc.	www.rtos.com	Proprietary	RTOS
TTP-OS	TTTech Computertechnik AG	www.tttech.com	Proprietary	RTOS
VelOSity	Green Hills Software, Inc.	www.ghs.com	Proprietary	RTOS
VLX	VirtualLogix	www.virtuallogix.com	Proprietary	RTOS Extension
VxWorks	Wind River	www.windriver.com	Proprietary	RTOS
VxWin	Kuka Controls	www.kuka-controls.com	Proprietary	RTOS Extension
Wind River Linux	Wind River	www.windriver.com	Open source	Linux
Windows CE Platform Builder	BSQUARE	www.bsquare.com	Proprietary	RTOS Extension
Windows Embedded CE	Microsoft Corporation	www.microsoft.com/windows/embedded	Proprietary	RTOS
Windows XP Embedded	Microsoft Corporation	www.microsoft.com/windows/embedded	Proprietary	RTOS
Xenomai	Community	www.xenomai.org	Open source	RTOS

