

The state of Embedded Linux . . . *who, what, where, when, how?*

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**Why use Linux in
embedded apps?**

Moore's Law effect -- Embedded systems becoming increasingly powerful & complex . . .

- **Blazingly fast CPUs -- 500+ MHz**
- **Expanding RAM -- 256+ MB**
- **Storage in Flash (e.g. DiskOnChip)**
- **Multi-gigabyte hard disks**
- **User-friendly GUIs**
- **Wired/wireless communications/Internet**
- **Proliferation of protocols -- PCI, USB, FireWire, Bluetooth, TCP/IP, WAP, . . .**

Incessant & accelerated chipset obsolescence & innovation . . .

- **PC chipset lifecycle = ~ 6-12 months**
- **Constant redesign of hardware/software**
- **Constant upgrades to OS/drivers**
 - ➔ **only the best-supported OSes will survive**

Result: Embedded developers rely on well supported OSes . . .

- **The OS manages increasingly complex system resources**
- **The OS virtualizes the hardware; protects the developer from full-time driver porting & maintenance**
- **The OS enables use of off-the-shelf function libraries, drivers, utilities, and application S/W**

Disadvantages of “traditional” embedded operating systems . . .

- **Stand-alone code:** too simplistic for today’s functional & resource requirements
- **Plain old DOS:** can’t keep up with today’s functional & resource requirements
- **Roll-your-own kernels:** technology curve too steep; expensive to develop & maintain
- **Windows:** perceived as fat, expensive, unreliable
- **Proprietary RTOSes:** lack of standards; expensive development & license costs
- **UNIX:** not particularly embeddable

Linux has raised the embedded OS bar . . .

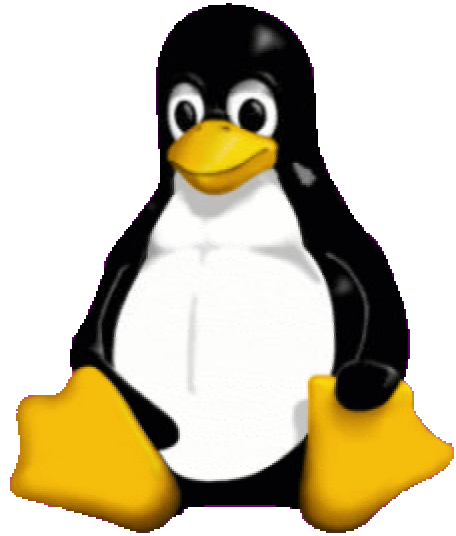
- **Open source & royalty free**
- **Perceived as powerful, robust, reliable**
- **Excellent support for networking, graphics, protocols, storage, peripherals, multitasking**
- **Configurable, scalable, modular, customizable**
- **Supported by tens of thousands of developers**
- **Large & growing choice of development tools**
- **Popular enough to track the technology curve**
- **The only “multi-vendor OS”**

Linux comes in a myriad of sizes and flavors . . .

- **“Commercial” standard Linux distributions:**
 - Caldera, Debian, Mandrake, Red Hat, SlackWare, SuSE, TurboLinux, . . .
- **“Commercial” embedded / RT Linux distro’s:**
 - Lineo, MontaVista, LynuxWorks, PalmPalm, Coventive, FSM Labs, TimeSys, REDSonic, . . .
- **“Non-commercial” embedded / RT versions:**
 - uClinux, emdebian, RTLinux, RTAI, ELKS, KURT, LEM, LOAF, LRP, LinuxPPC, mLinux, ThinLinux, . . .

Linux has dramatically altered the embedded OS landscape!

- **Stand-alone / roll-your-own ?**
- **Proprietary RTOSes ?**
- **Windows ?**
- **Linux & “Linux-like”**



Linux . . .

***From “cool idea”
to “disruptive technology”
in a few short years . . .***

Embedded Linux . . .

*From 0 to 125
in one short year!*



125 Member ELC . . .

• 45 Corporate Executive “Founding” Members . . .

Accelent Systems, Inc. *	implementa	QNX Software Systems *
Accelerated Technology	Infomatec IAS *	Reasoning, Inc.
Agilent Technologies	Internet Appliance, Inc.	Red Hat *
Alcatel	Lineo *	Synergy Microsystems, Inc.
Amirix Systems, Inc.	Linuxcare	Sysgo Real-Time Solutions
Cendio Systems AB *	Linuxdevices.com * Linuxone	TimeSys Corp *
Centura Software *	LynuxWorks *	Transvirtual Technologies *
Century Software, Inc.	Mercury Computer Systems, Inc.	TrollTech *
Coollogic, Inc. *	Metrolink	Wind River Systems *
Espial Group	Metrowerks *	WinSystems
Force Computers	Microtronix Datacom *	WireSpeed, a Red Hat
FS Forth Systeme	MontaVista Software *	company
Hewlett-Packard	Moreton Bay (now Lineo	xwave solutions
I-Logix	Australia) *	ZF Linux Devices
IBM *	NewMonics *	ZiLOG
	QLogic *	

125 Member ELC (cont'd)

- **Other Corporate Executive Members . . .**

3Com Corp

Access Systems America, Inc.

Arcom Controls

ARM Limited

DevelopOnline.com

Embedded Linux Journal

g.a.m.s. EDV Dienstleistungen GmbH

GMATE, Inc.

Insignia Solutions

Jabber.com

LINBOX

Linux DA, Inc.

Merinta, Inc.

Motorola Computer Group

National Semiconductor

NetSilicon

PalmPalm Technology Inc.

PEP Modular Computers, Inc.

Phoenix Technologies Ltd.

RoyalStone

Samsung Electronics Co., Ltd.

SuSE, Inc.

Tuxia, Inc.

125 Member ELC (cont'd)

- **Corporate Affiliate Members . . .**

3COM Corp

Applied Data Systems, Inc.

Birdstep Technology

Contemporary Controls

DOALL INFOTECH.,INC.

EMJ Embedded Systems

ETRI

ISDCorp

Lineo Industrial Solutions Group

MetaWare, Inc.

Neoware Systems, Inc.

Rabbit Semiconductor

RidgeRun, Inc.

SiliconPenguin.com

Slangsoft

TrainingCity.com

Wipro Technologies

WordWalla, Inc.

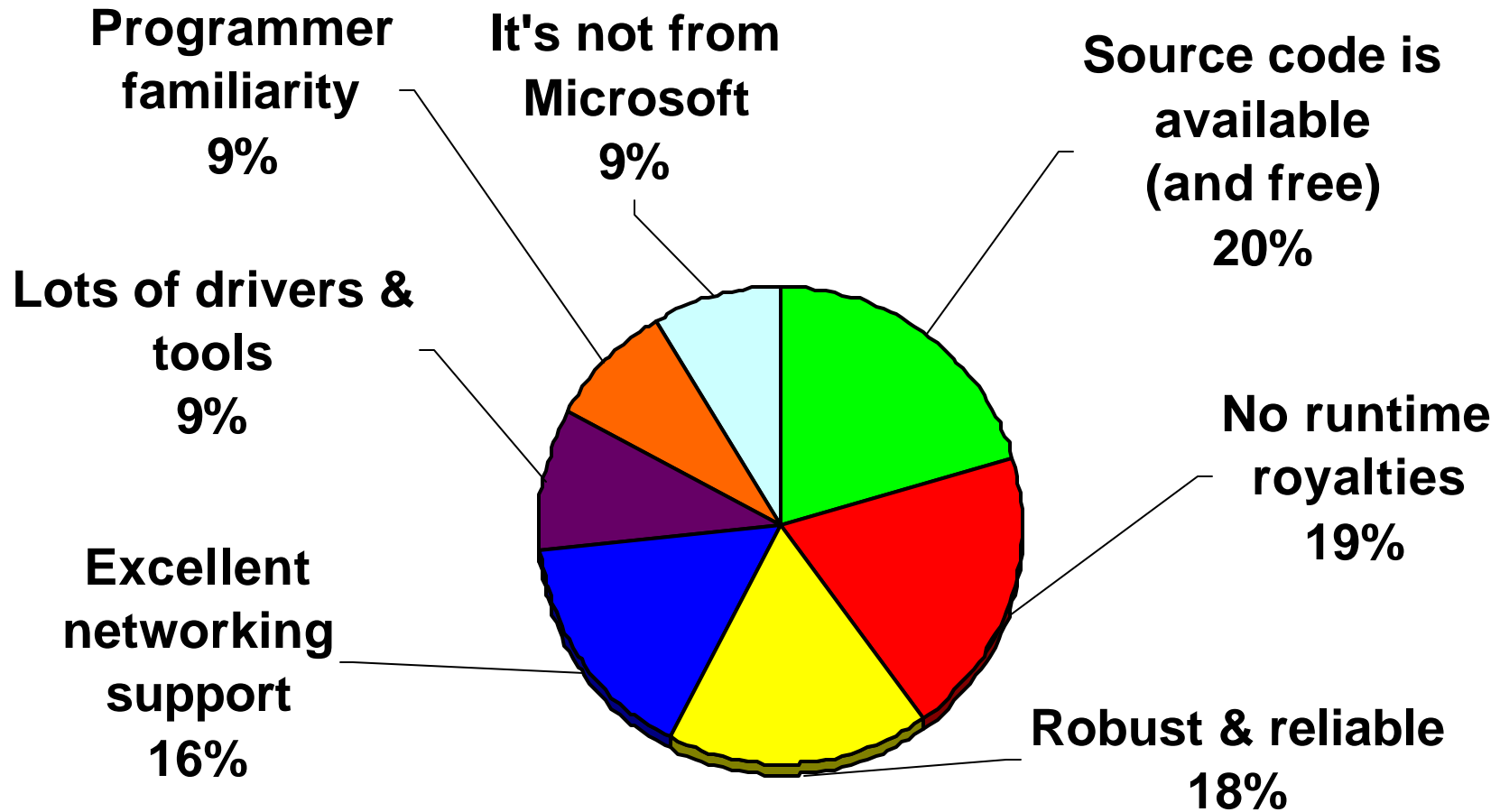
- **Non-corporate Members . . .**

The LinuxDevices.com

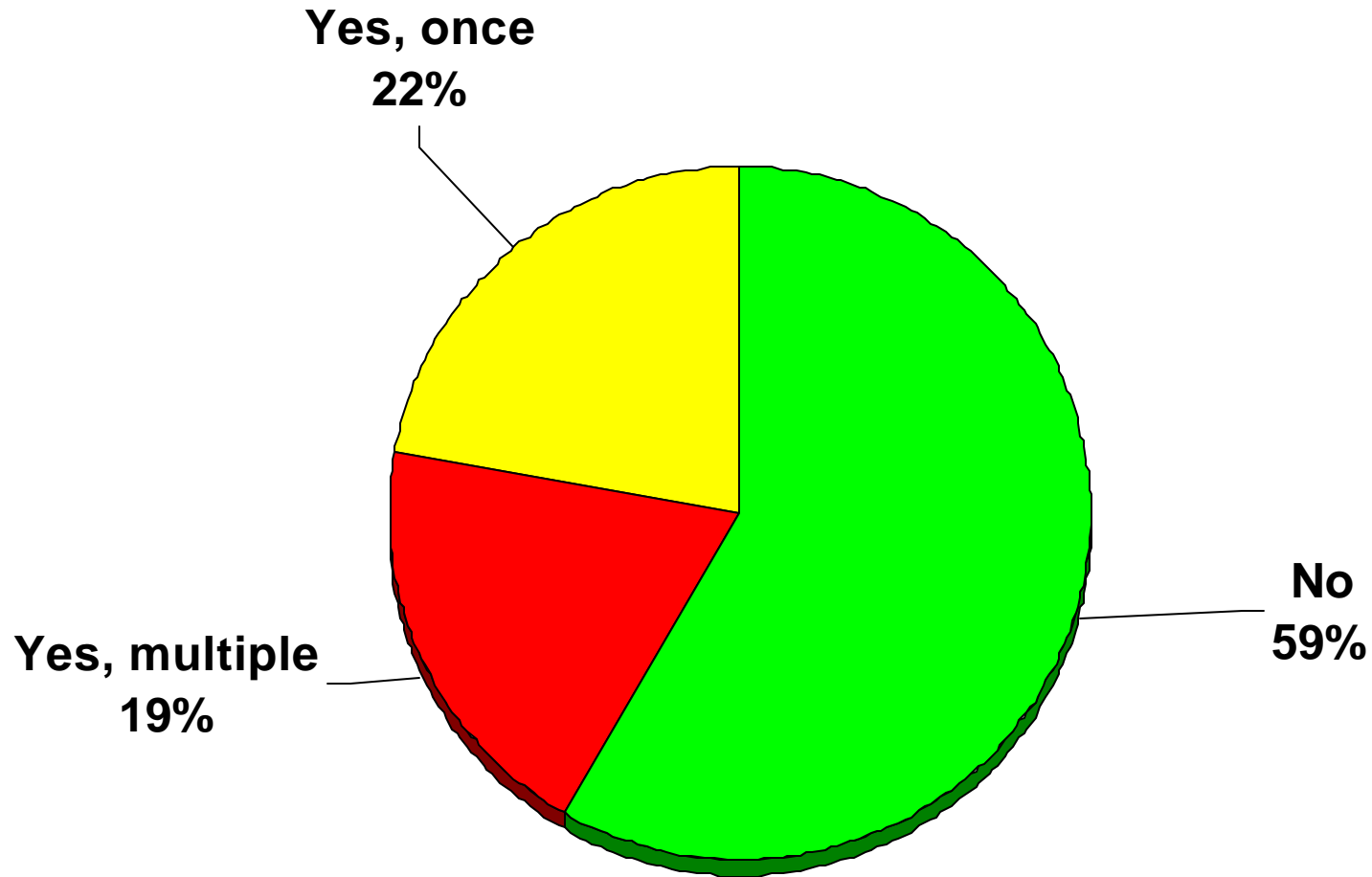
Embedded Linux

Market Survey

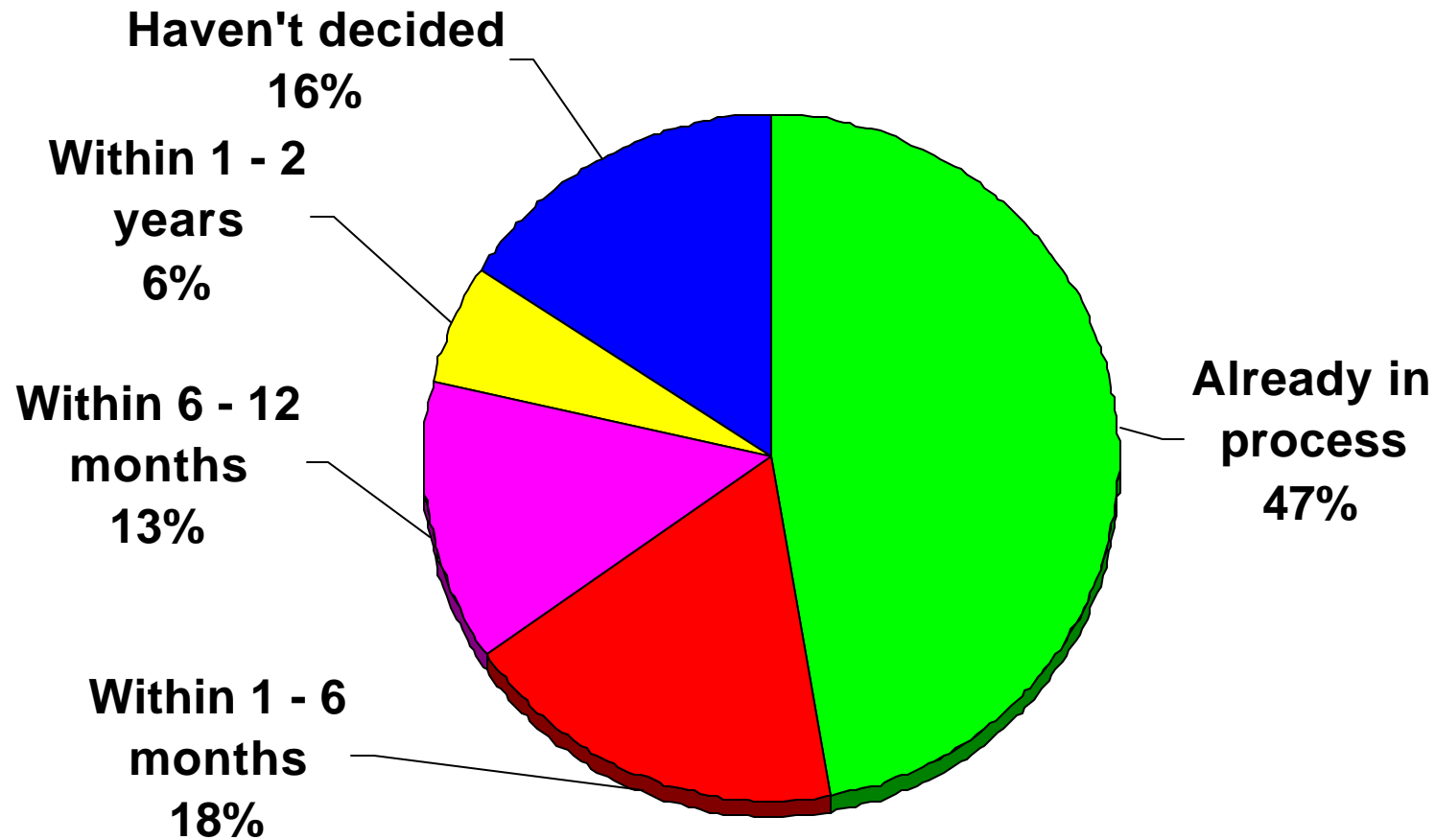
Why are you considering using Linux in an embedded Application?



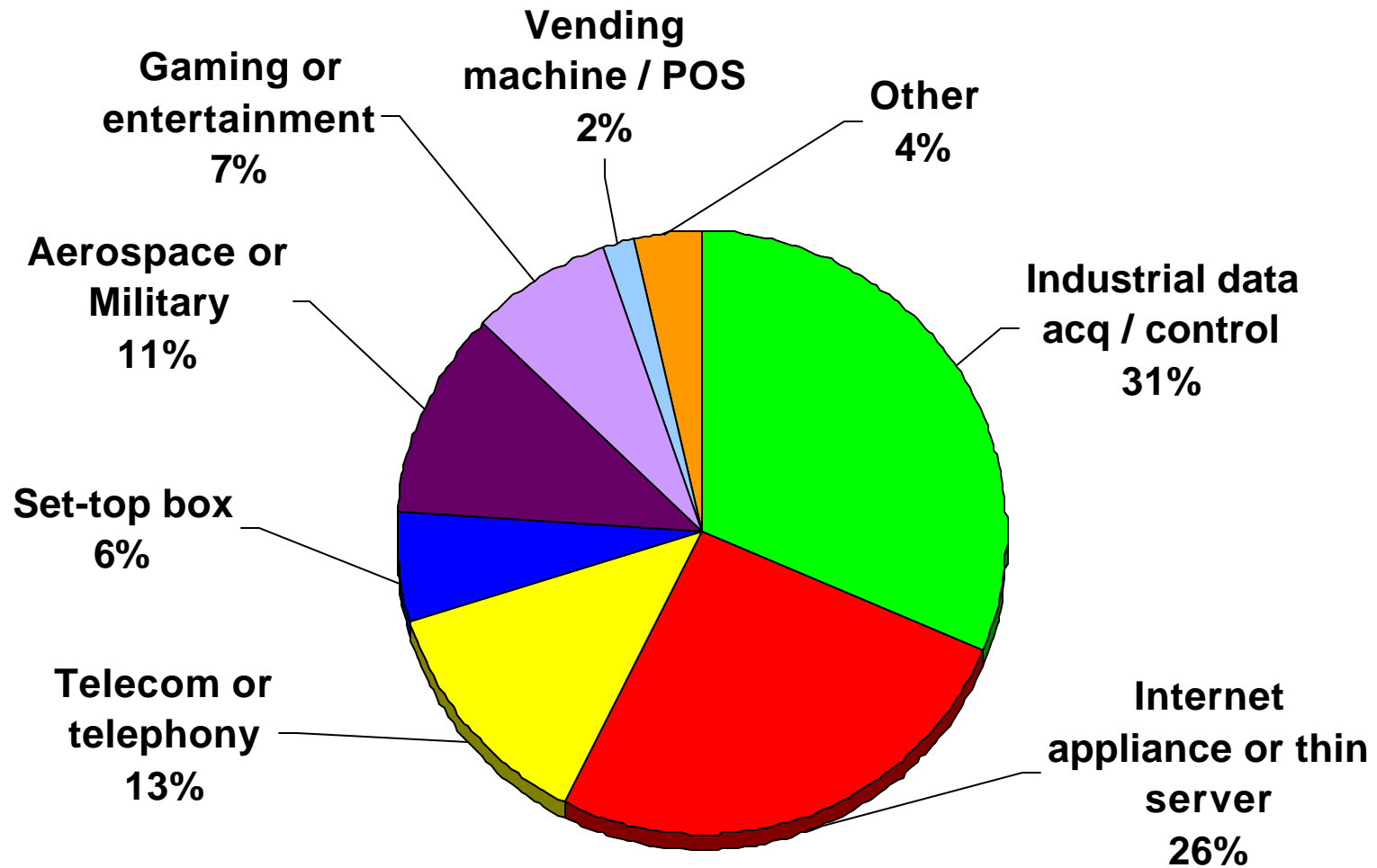
Have you already used Linux in an embedded application?



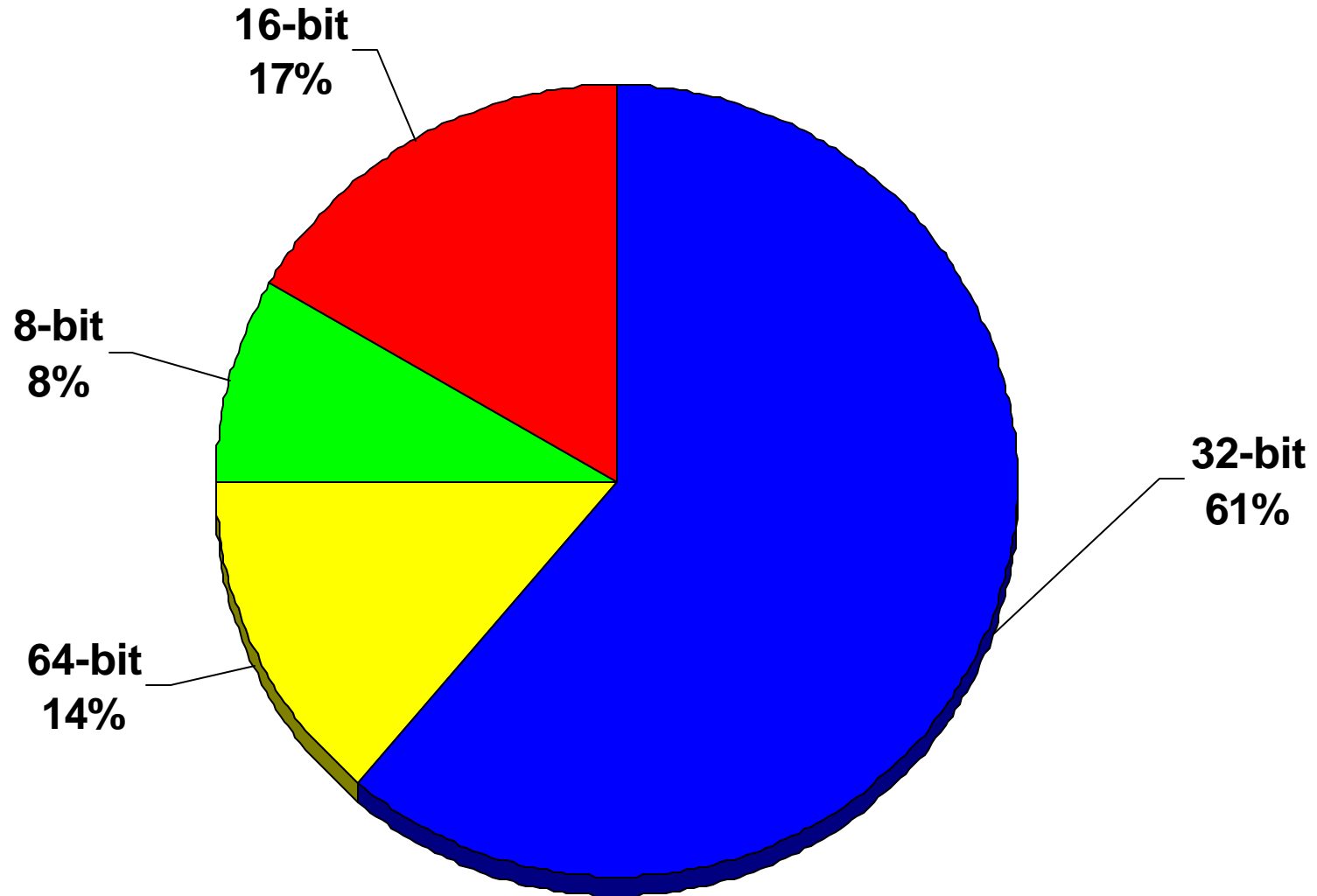
When do you expect to begin your first embedded Linux project?



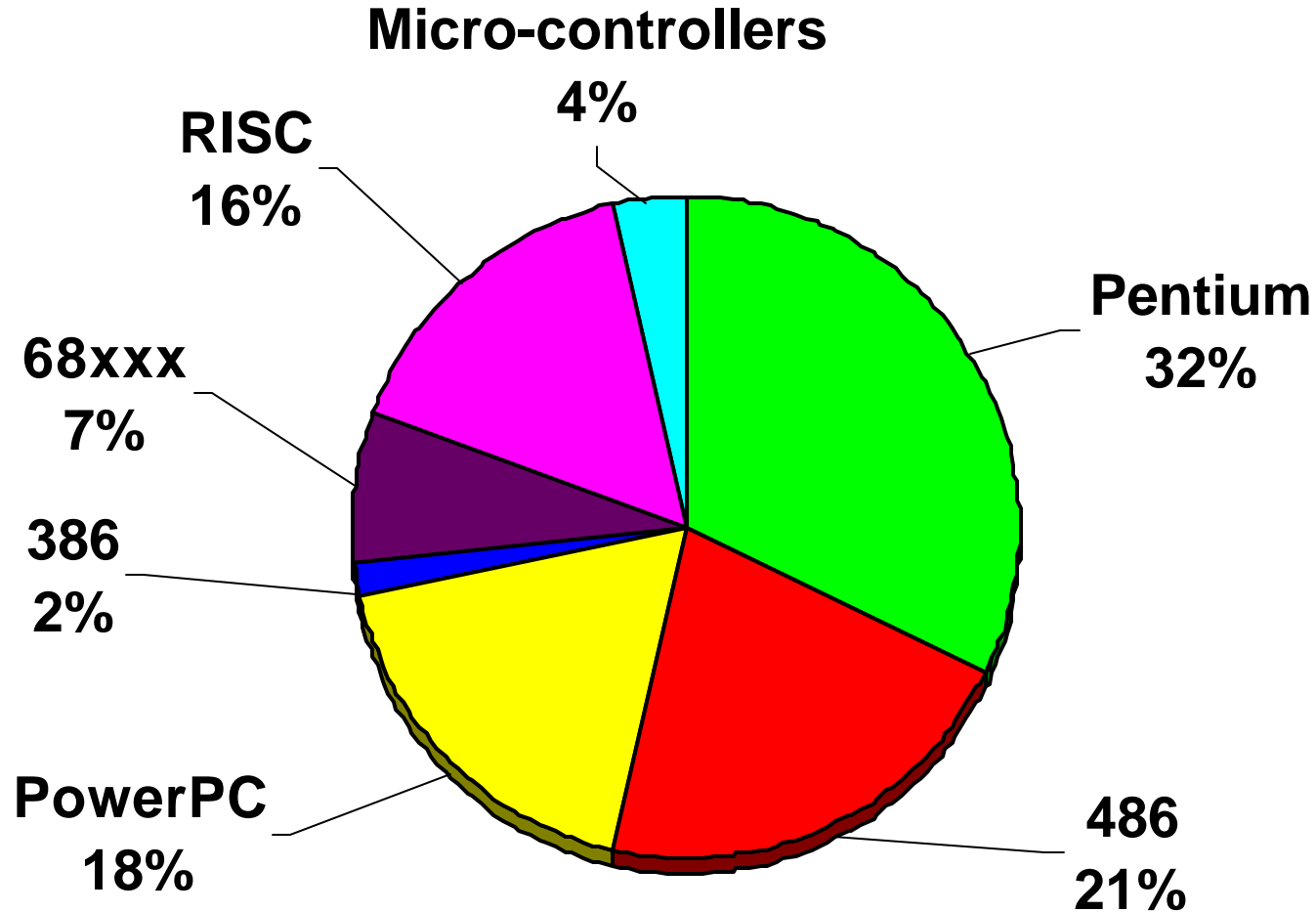
What kind of application is it?



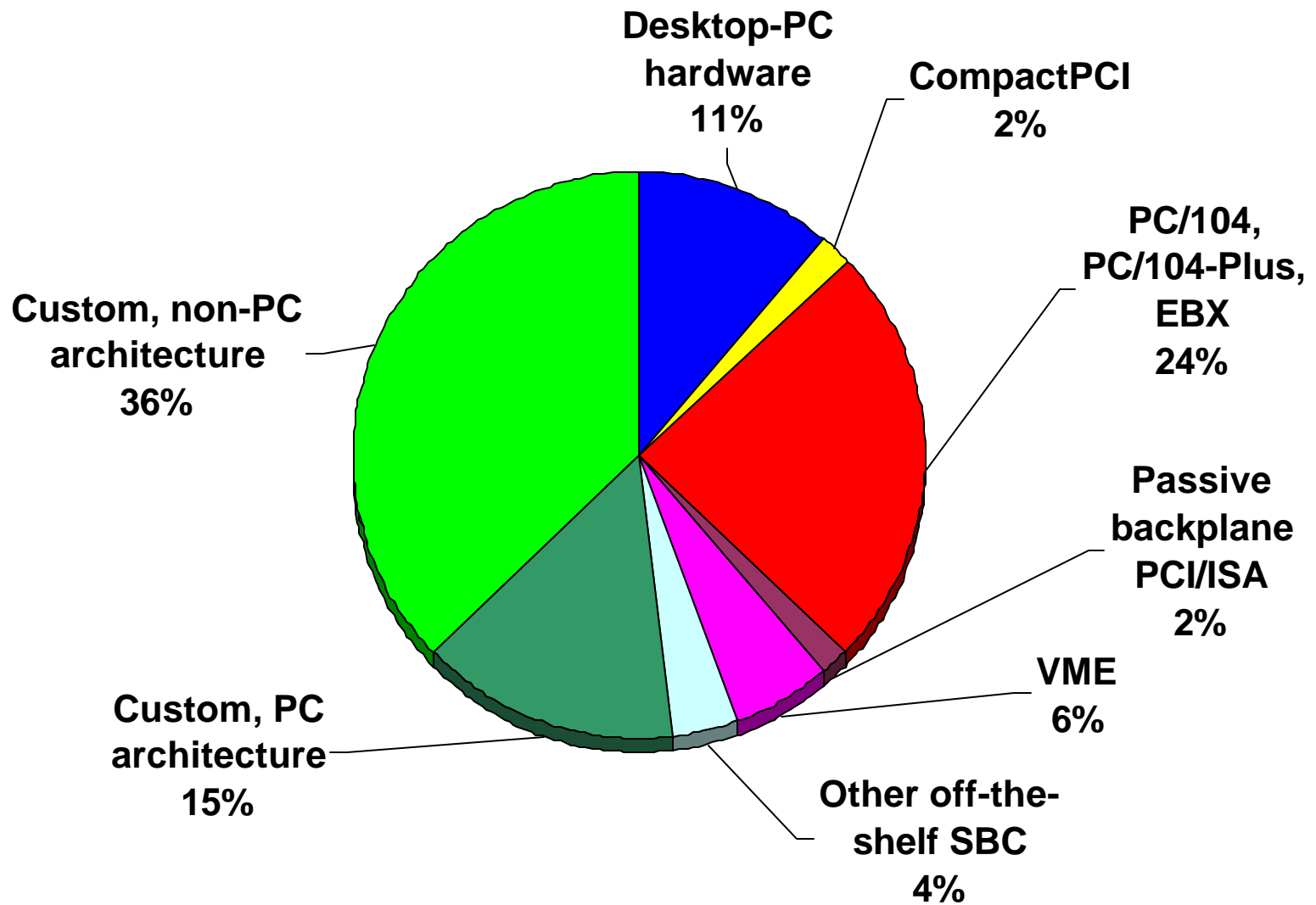
What target CPUs will you use in the next 24 months?



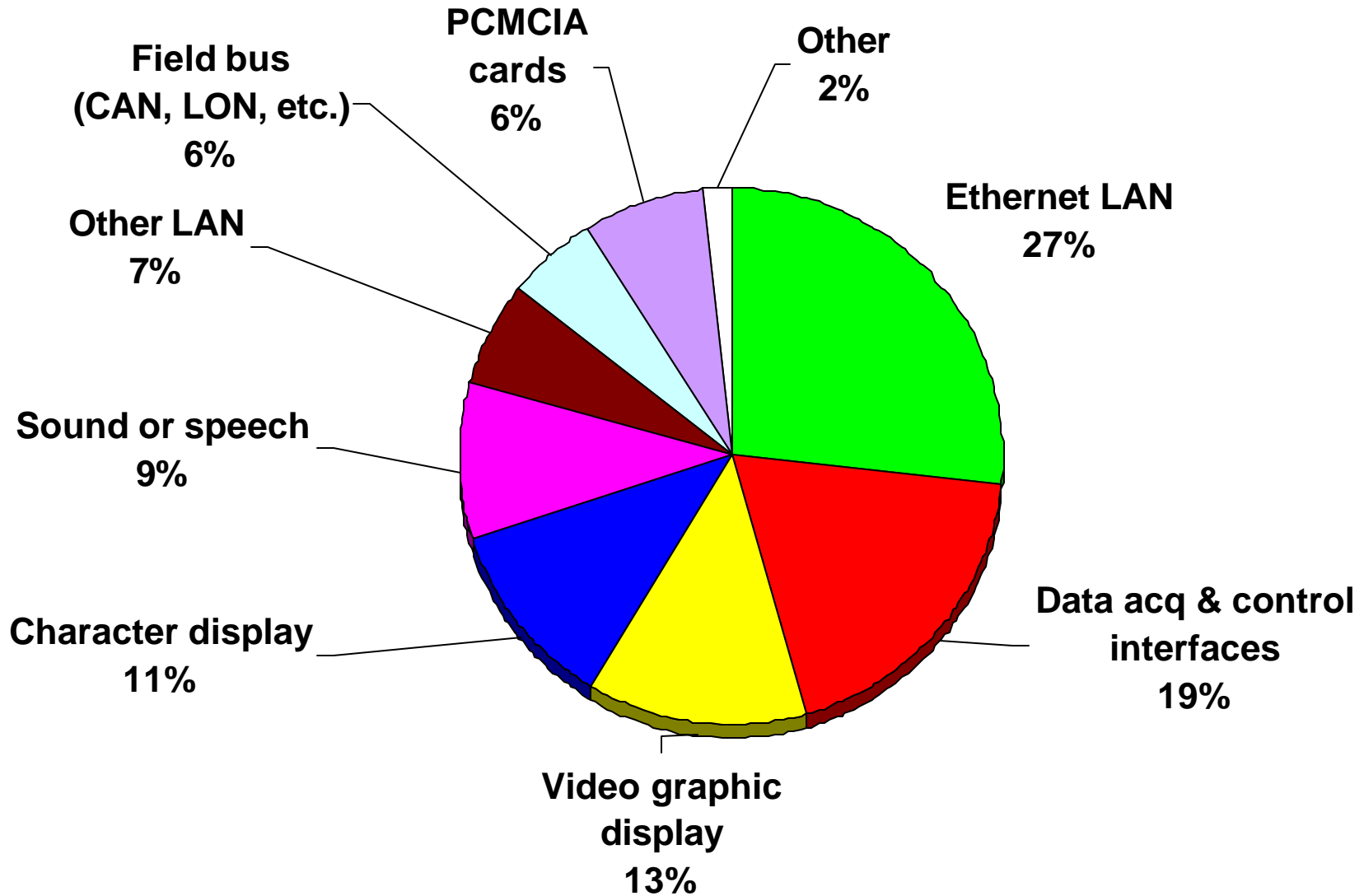
What CPU do you expect to use?



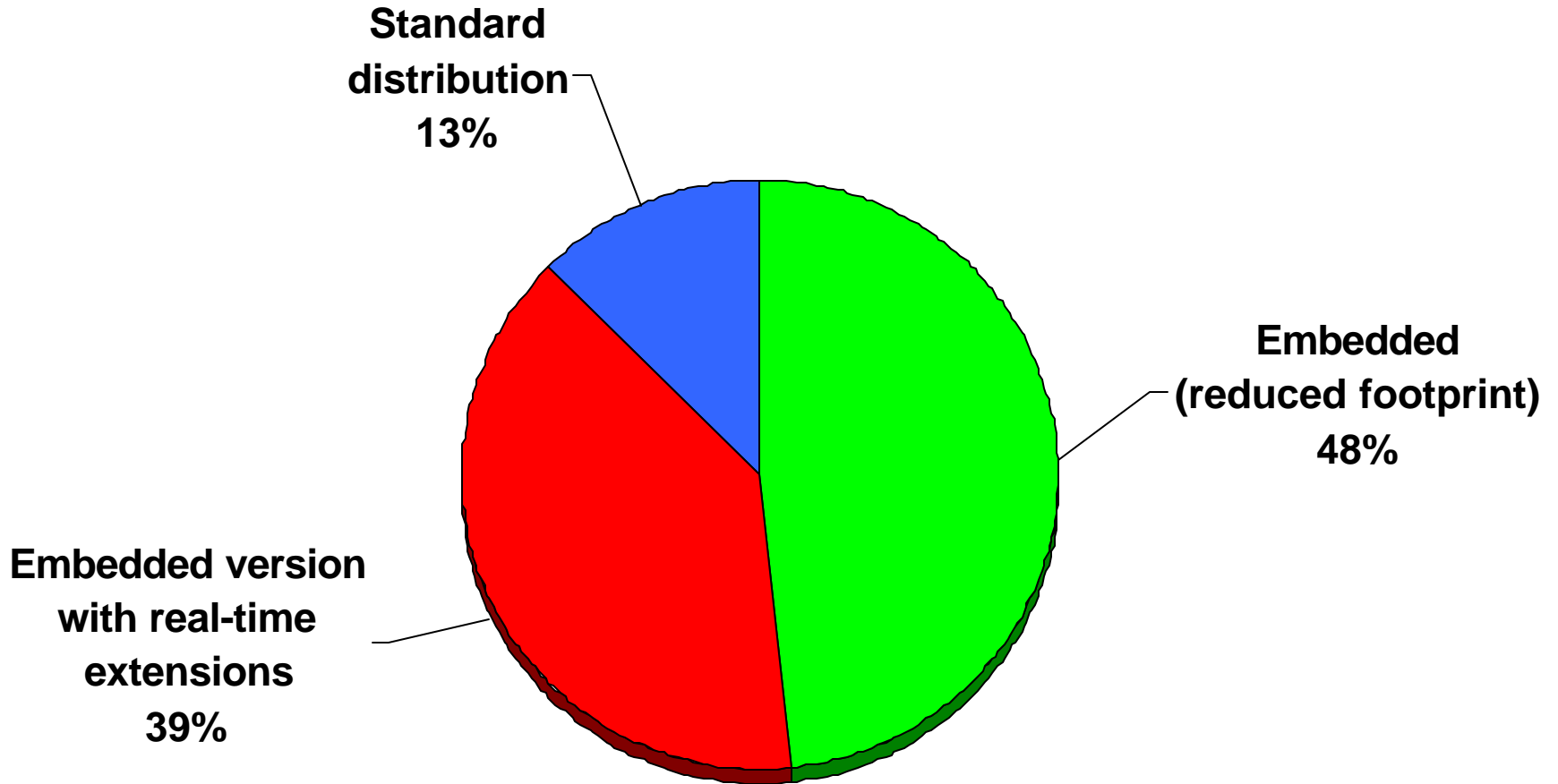
What hardware platform do you expect to use?



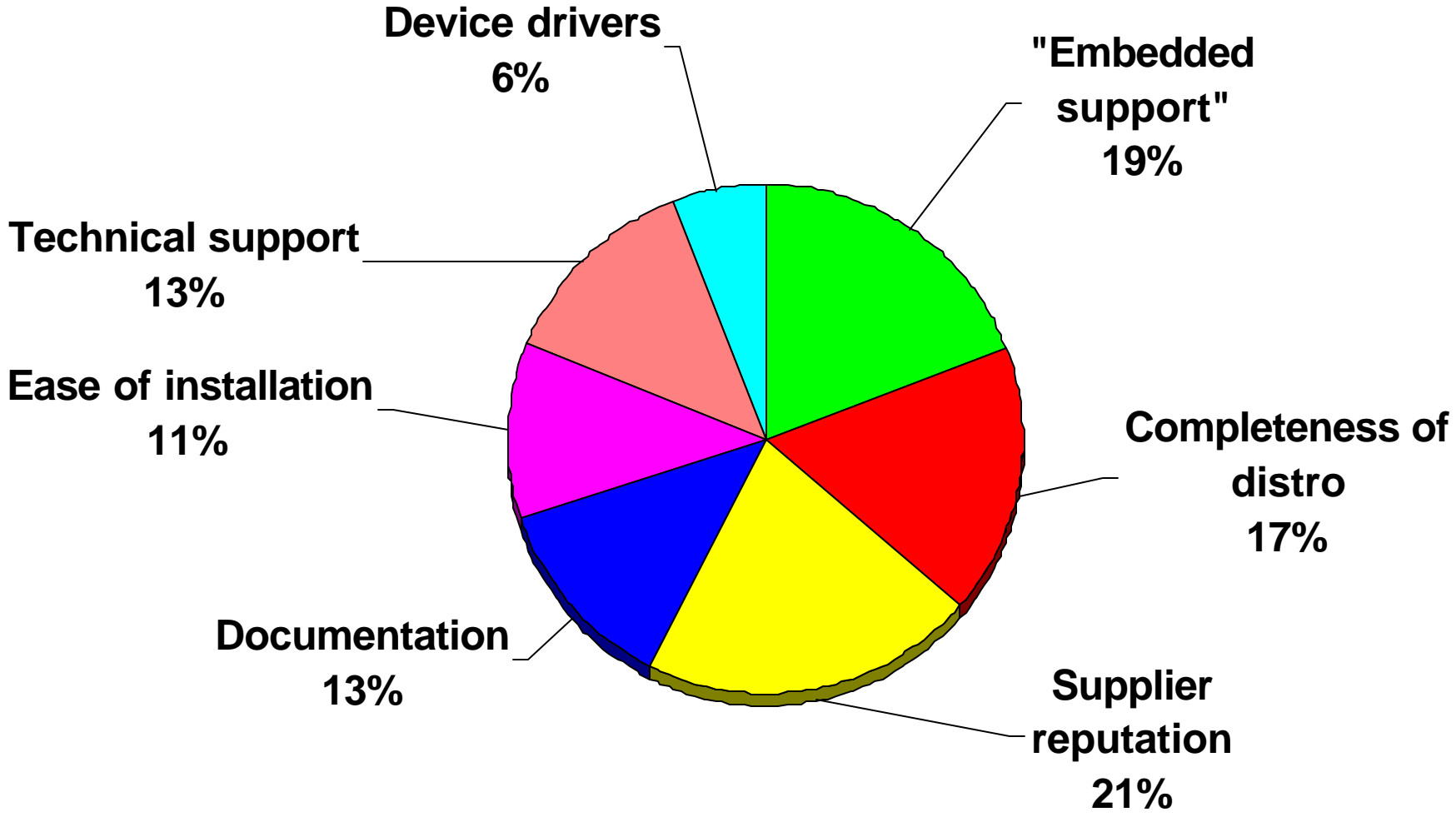
What peripherals will be in the end system?



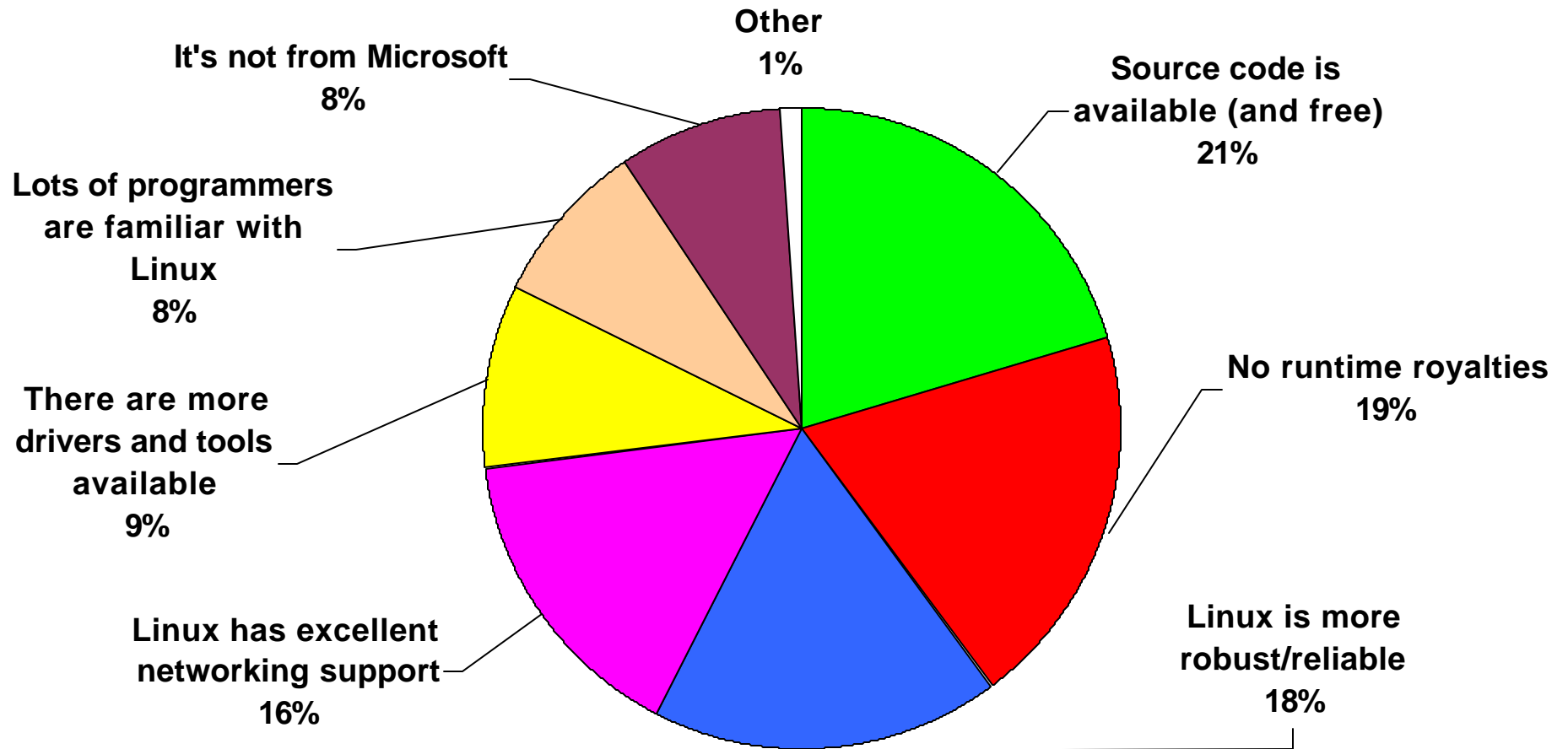
What type of Linux OS will you need?



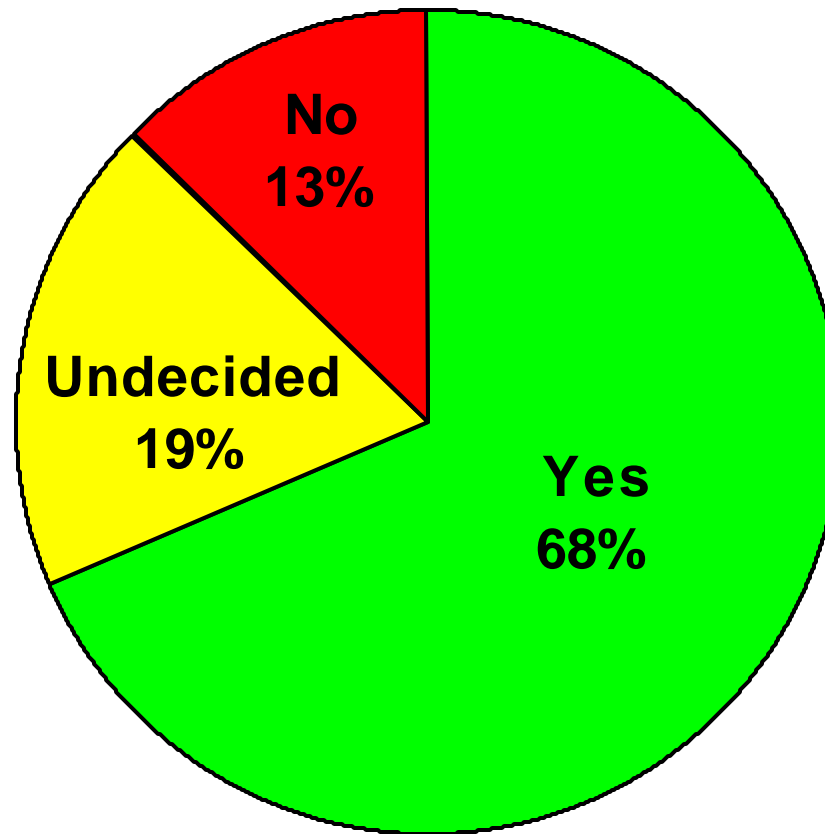
Which factor(s) will have the greatest influence on your choice?



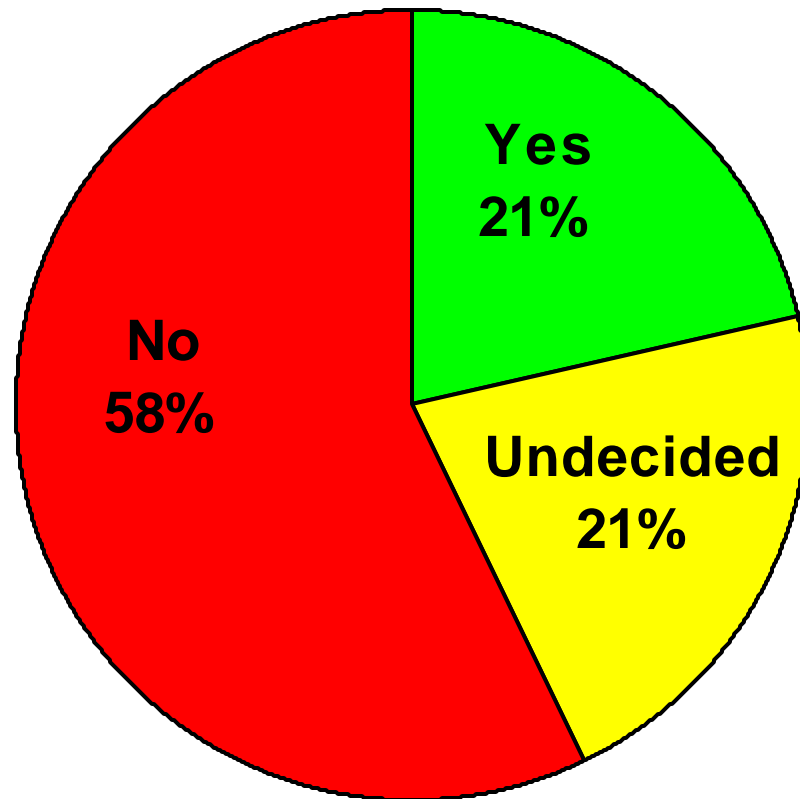
What do you value most about open source?



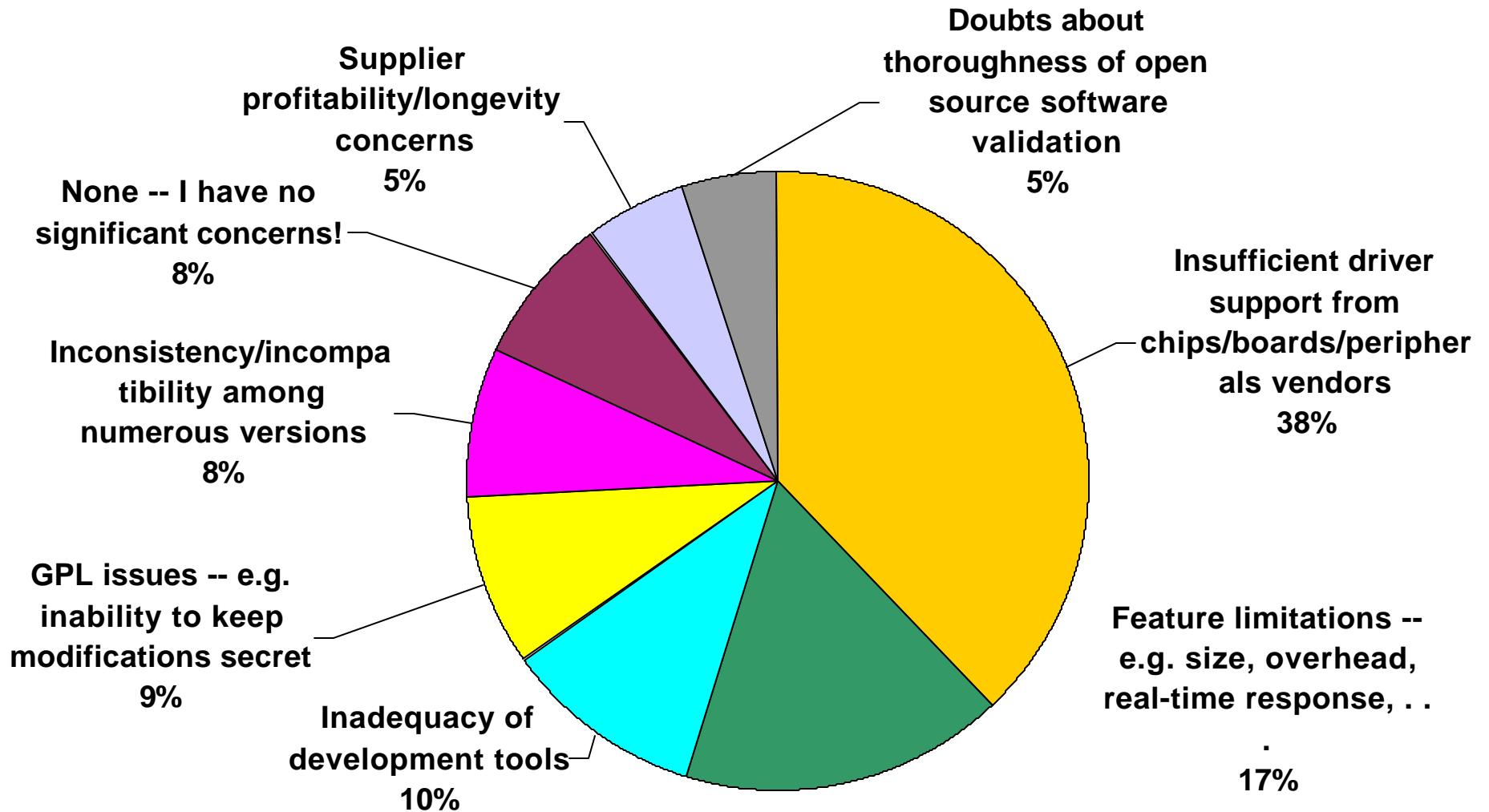
Would you consider paying for Embedded Linux development/support services?



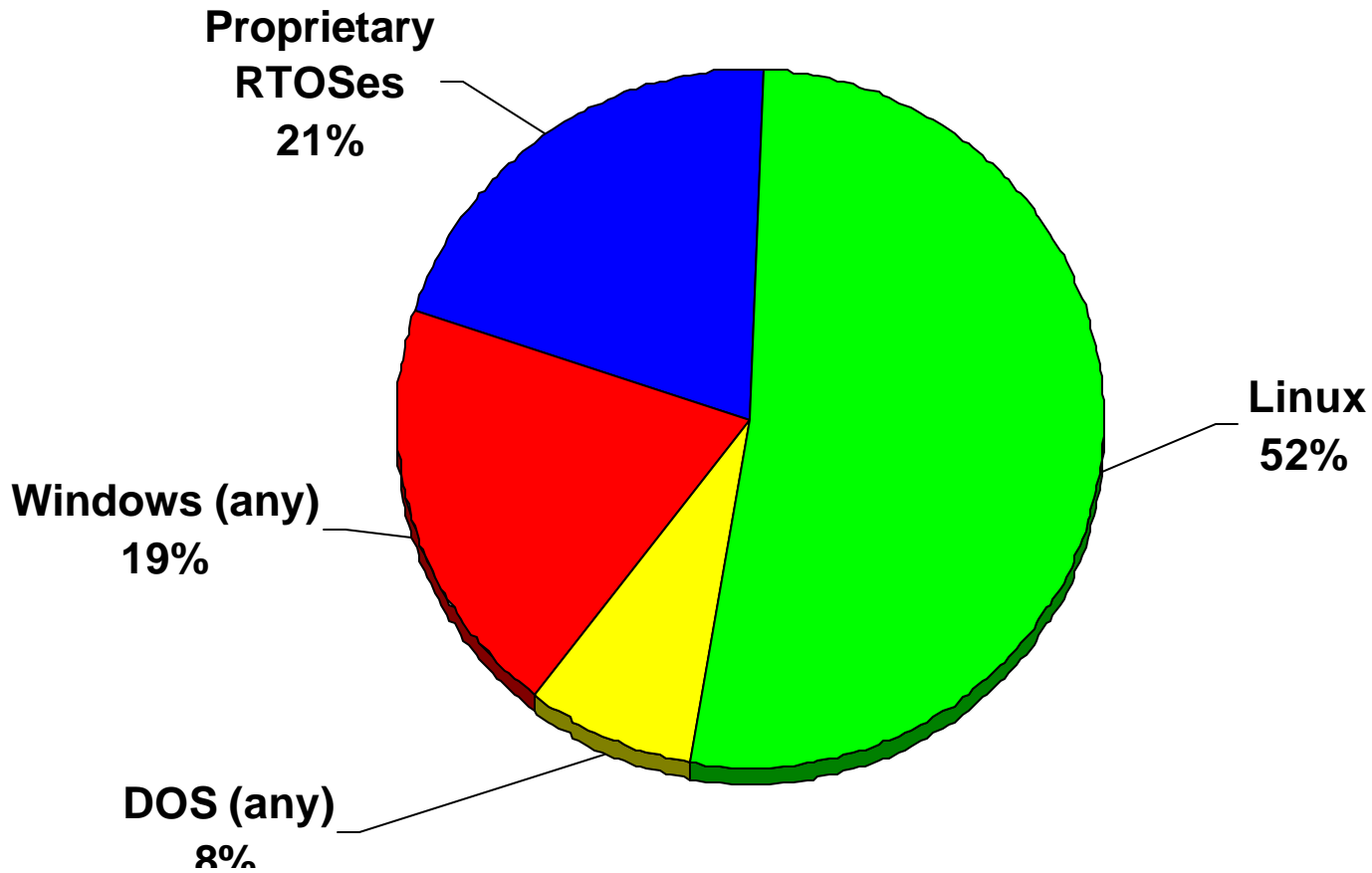
Would you consider paying per-unit royalties?



What are your main concerns about using Linux in embedded applications?



What target OSes will you use in the next 24 months?



“Show me the devices!”

. . . with Embedded Linux inside

(a dozen examples)

Agenda VR3 PDA

- CPU: NEC VR4181 @ 66 MHz
- RAM: 8MB
- Flash: 8MB
- GUI:
- Browser:



G.Mate Yopy PDA



- CPU: 206 MHz StrongARM
- RAM: 16M
- Flash: 32M
- GUI:
- Browser:

Ericsson Cordless Screen-phone



- CPU: 206 MHz StrongARM
- RAM: 32M
- Flash: 32M
- GUI: Qt/Embedded
- Browser: Opera



frontpath ProGear web-pad

- CPU: 400 MHz Transmeta CPU
- RAM: 64M
- Disk: “diskless” or 64GB HD
- GUI: Qt/Embedded
- Browser: Opera

Screen Media FreePad



- CPU: 166 MHz MediaGX
- RAM: 32M
- Flash: 16M
- GUI: Microwindows
- Browser: Opera



TiVo Personal Video Recorder

- CPU: 54 MHz PowerPC 403GCX
- RAM: 64M
- Disk: multi-gig HDD
- GUI: n/a
- Browser: n/a

Nokia Set-top Media Terminal



- CPU: 366 MHz Celeron
- RAM: 32M
- Disk: multi-gig HDD
- GUI: ??
- Browser: ??



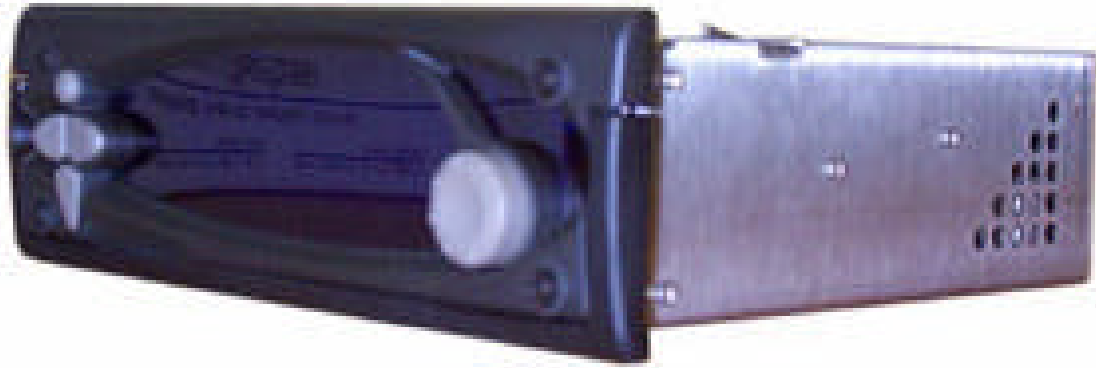
Indrema Set-top Gaming System

- CPU: 600 MHz x86
- RAM: 64M
- Disk: multi-gig HDD
- GUI: Extrema
- Browser: n/a

Kerbango Internet Radio



- CPU: 80 MHz Motorola PowerPC
- RAM: 8M
- Flash: 8M
- GUI: KAOS
- Browser: n/a



empeg car MP3 player

- CPU: 220 MHz StrongARM
- RAM: 12M
- Disk: multi-gig HDD
- GUI: n/a
- Browser: n/a

PhatNoise PhatBox car MP3 player



- CPU: 74 MHz Cirrus EP7212
- RAM: ??M
- Disk: multi-gig Flash cartridge
- GUI: n/a
- Browser: n/a



Aplio/PRO Internet phone

- CPU: 100 MHz ETRAX (RISC)
- RAM: 4M
- Flash: 2M
- GUI: n/a
- Browser: n/a

The LinuxDevices.com

Embedded (& real-time) Linux

Quick Reference Guide

Quick reference guides . . .

Embedded Linux intro & overview

Embedded Linux distributions

Real-time Linux software

Embedded GUI & windowing software

Linux-friendly system-on-chip processors

Linux-friendly single board computers

Embedded Linux “Cool devices”

Linux-PDAs and PDA-Linux



Rick predicts . . .

- **Embedded Linux share of embedded S/W market > 50% by 2004**
- **Consolidation of “commercial” embedded Linux to 3-5 vendors by 2002**
- **> 95% of real-time requirements supported by mainstream Linux kernel by 2002**

Keep in touch!

<http://www.linuxdevices.com>

rick@linuxdevices.com

