



# Embedded Systems and Role of Linux in Electronics



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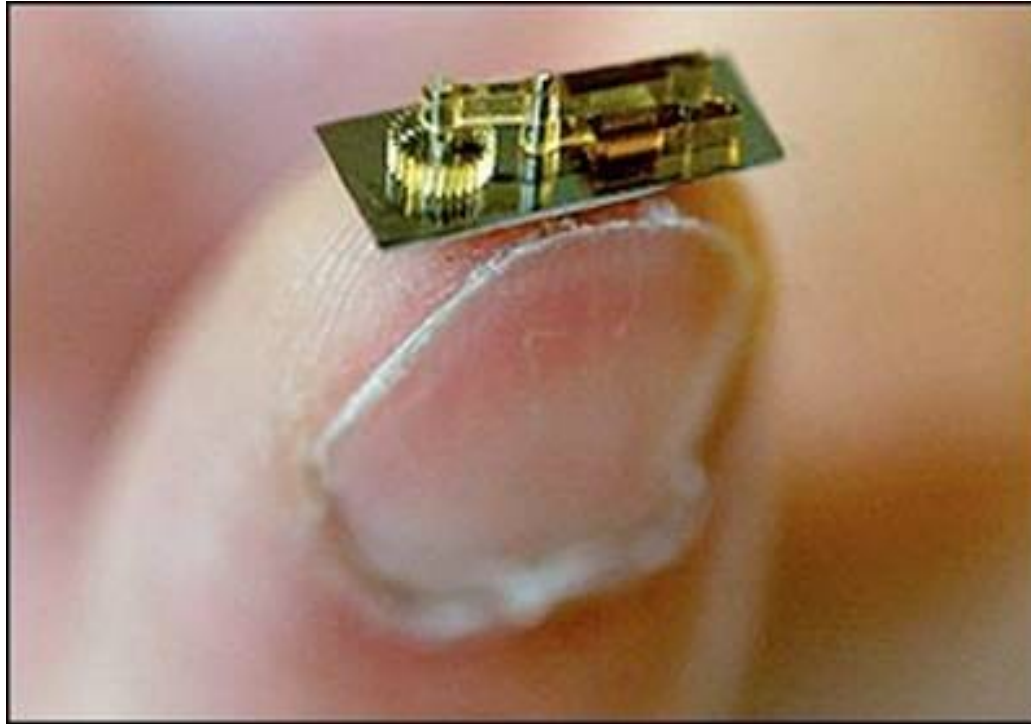
# Preamble

- ◆ Nothing against Microsoft or commercial or proprietary software.
- ◆ Focus more on embedded software.
- ◆ Less emphasis on technical aspects of Linux, Electronics etc.
- ◆ Links and references will be provided wherever possible.
- ◆ Must be a duplex communication.

# Agenda

- Introduction to Embedded Systems
- Role of an OS in Modern Electronic Gadgets
- Open Source Software in these systems???
- Career Opportunities in Embedded Systems
- Info on Free Development tools (For Elec guyzzz mainly)
- Free Gift to all!!! (Conditions Apply ;) )

# Guess What ????????????????



A mini Petrol Engine with an Onboard Embedded System  
Monitoring the fuel injection etc..

# Introduction to Embedded Systems

## What is an EMBEDDED SYSTEM??

**“Application specific computing and control software implemented on a hardware designed to perform the specific functions”.**

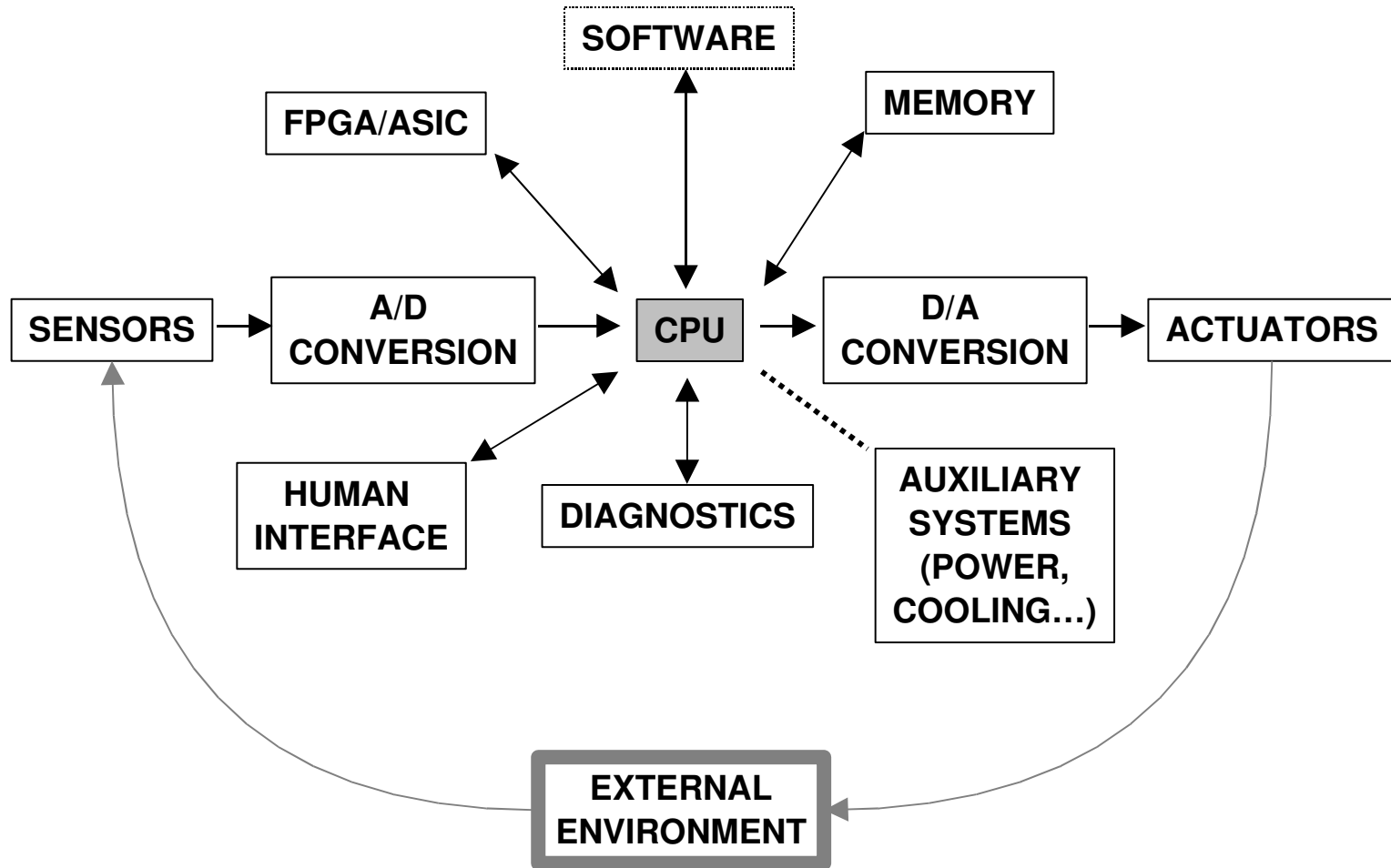
- Embedded within a larger automated system
- Not designed to provide “standard” computing services
- Primitive or no user interface
- Functional and performance requirements important
- Computer resources are at a premium
- Complex algorithms at the core

# Software Intensive System: Definition

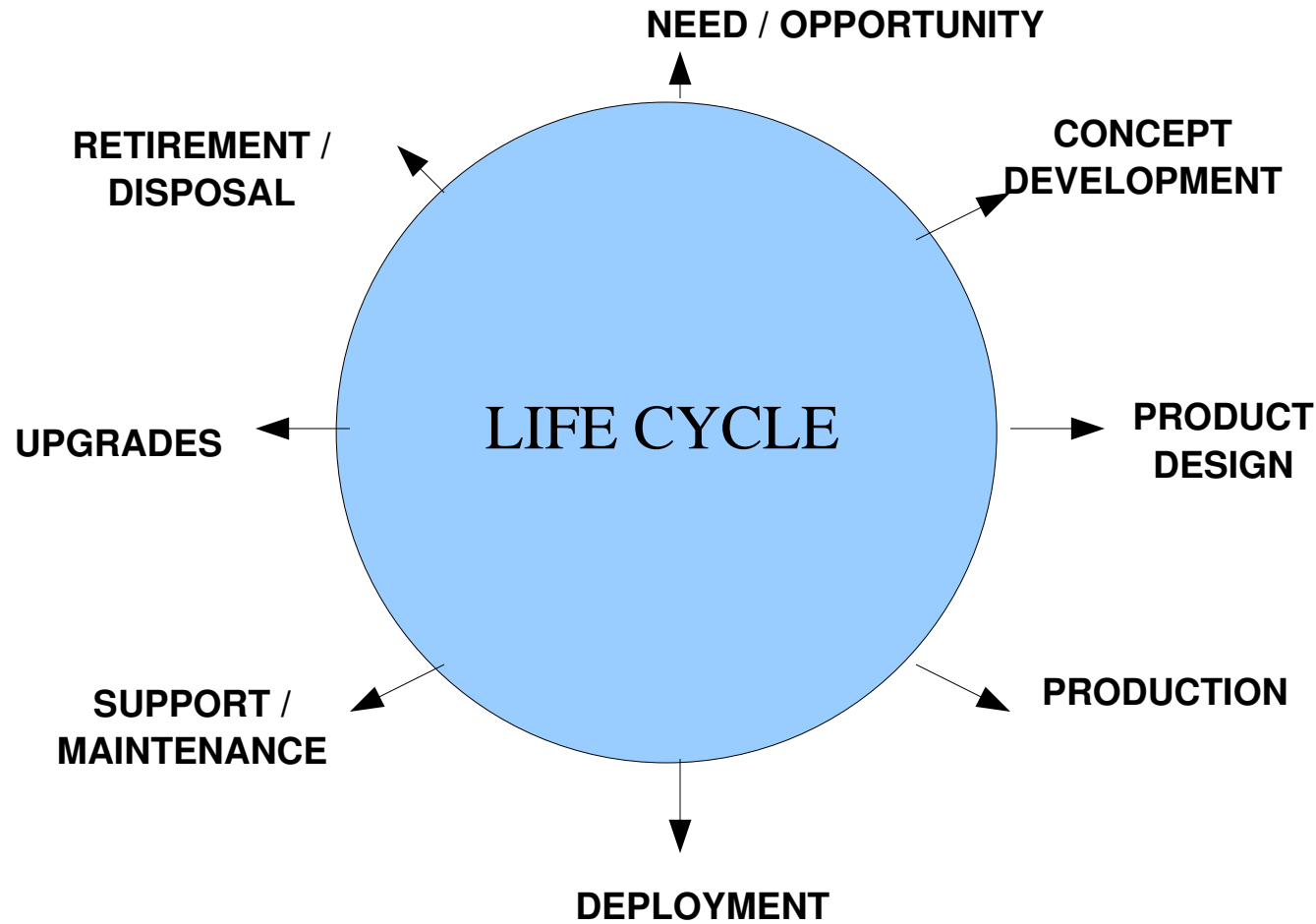
**“A Software-Intensive System is a system in which software represents a significant segment in one or more of the following areas:**

- System development cost
- System development risk
- System functionality or
- Development time”.

# Embedded System Organisation



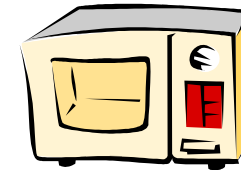
# Embedded System LifeCycle





# Embedded Systems: Typical Applications

- Microwave ovens / Coffee makers
- Washing machines / Dryers
- Televisions / VCR / DVD players
- Telecommunications
- Mobile telephones / Answering machines
- Pocket PCs / PDAs
- ATM machines
- Automobiles (Ofcourse !!)



And many more...



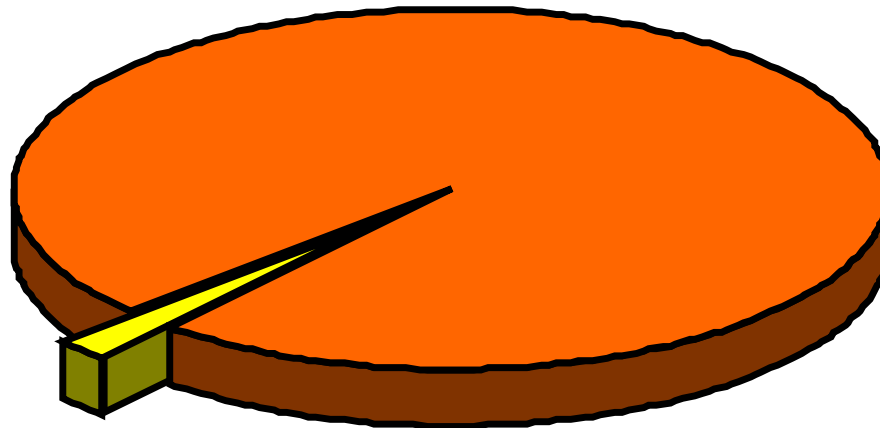
# Embedded System: Typical Applications

## The vast majority of processors!

- 200 million PCs and servers
- 8000 million embedded processors!



“Desktop”  
2%



“Embedded”  
98%

# Real Time Systems: Definition

**“A class of embedded systems capable of meeting execution deadlines, thereby able to meet the real time constraints associated with such systems”.**

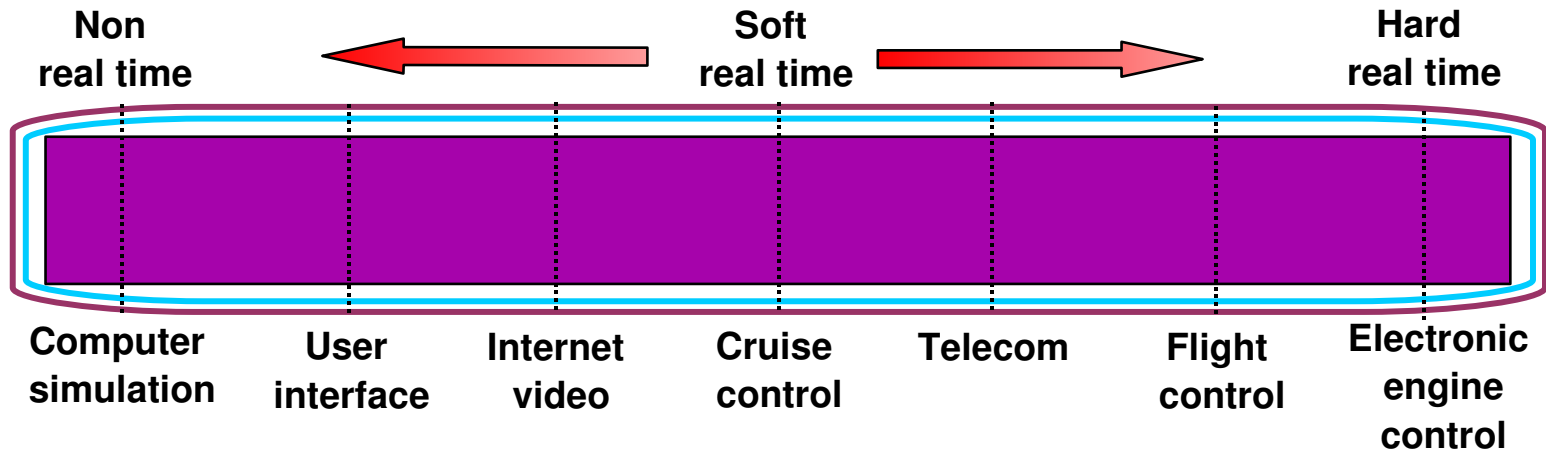
***“The right answer late is wrong”***



Real time does not mean fast; it means that a system has timing constraints that must be met to avoid failure.

# Real Time Systems

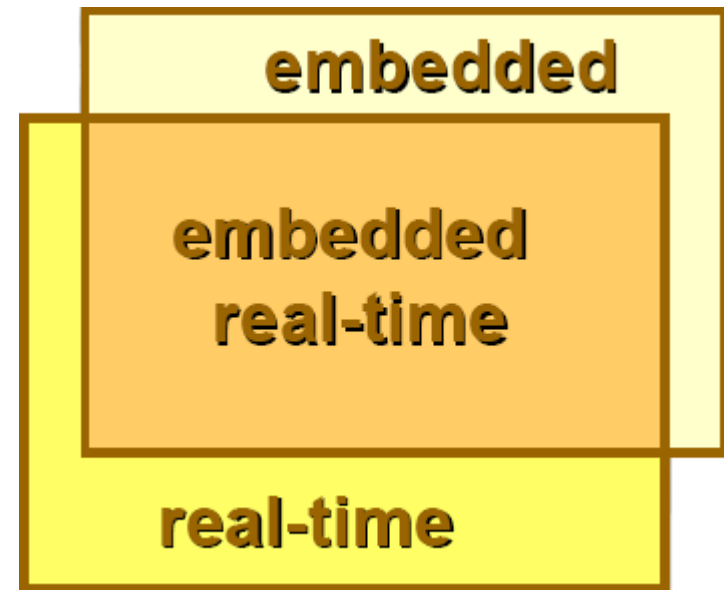
- Hard Real time systems
- Soft Real time systems



# Embedded and Real Time Systems

## Embedded and Real time - Synonymous?

- Most embedded systems are real time
- Most real time systems are embedded



# Embedded Systems: Developer Perspective

- Knowledge of Hardware
- Understanding of RTOS
- Performance improvement techniques
- Knowledge of deployment configuration
- Cross platform development experience
- Experience writing Time critical software
- Experience writing Mission critical software
- Experience writing Resource critical software
- More complex to develop than conventional systems

# Embedded Systems: Safety Aspects

## Why worry about software?

- Software cannot directly cause harm (not toxic...)
- Can cause failures through systems it controls
- Can mislead operators
- Software implicated in relatively few accidents
- Radiation therapy machines (Therac 25)
- Ariane 5 disaster
- Getting more authority
- Brake assists on modern automobiles
- Centre of gravity and stress control on aircraft

# Embedded Systems: Safety Aspects

## Therac 25

The Therac 25 was a SW controlled radiation therapy machine used to treat people with cancer.

- Overdoses of Radiation due to SW bug – mishandled race condition
- Normal Dosage is \_\_\_\_\_
- It is estimated that \_\_\_\_\_ dosage was given to \_\_\_\_ people
- \_\_\_\_ of these people died !

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# Embedded System: Safety Aspects

## **Ariane 5 Launch Failure**

On June 4, 1996, an unmanned Ariane 5 rocket launched by the European Space Agency exploded just 40 seconds after lift off

Value of the Rocket and cargo: \$500 million !

**The Ariane 5 explosion was the result of an unsafe floating point to integer conversion in the rocket's software system**

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# RTOS Overview

**Operating system:** “System software that manages the underlying hardware resources and provides access services to the application code”

**Real Time Operating system:** “An operating system that works in a real-time computing environment”

## **Necessary requirements for an RTOS:**

- Efficient
- Easily configurable
- Robust set of system services
- Flexible task scheduling system
- Places fewer demands on resources

# Selection of RTOS

- Footprint
- Language support
- Development environment
- Standard (OSEK Standards)
- Licensing arrangement and pricing
- Support for processor of your choice
- Scalability to match varied application requirements

# Features of RTOS

- Deterministic response time
- Multi-tasking
- Priority based scheduling
- Preemptive kernel
- Reliability
- Size (Good things come in small packages)
- Perform real-time activities

# Why Embed Linux???? :( :)

- Embedded market – Vroommmm!!! (Fast paced)
- Selection of processor dictated by application goals..
- All OS vendors dont support all platforms.
- Some vendors do have OS products. But only as a fallback!
- In many of these cases little or no support offered(next generation systems)!! :(
- Build ur own OS?? (Naaaa.. Then who will build the product?? is industry's mantra)
- **BEST SOLUTION: Adapting LINUX to the embedded application gives the developer a better option around which the embedded solution can be developed.**

# Sample Embedded Linux!!!!!!

- uclinux is a LINUX for Microcontrollers

[www.uclinux.org](http://www.uclinux.org)

## Features of uclinux...

- Free source :)
- Lightweight
- Supports a wide variety of Micro-controllers.

# Companies that work on Embedded LINUX

- Hewlett Packard
- Wind River
- Motorola
- IBM
- Sasken, Hexaware, Samsung, MIDAS
- Will be hearing more in the next presentation by Shakthi!!

# Embedded Linux based Products

- PDAs (based on embedded Linux)

*Sharp, IBM, Invair Technologies (Germany) etc. and Simputer (Indian Product)*



- Mobile Phones (Motorola, Erricson, Panasonic etc.)

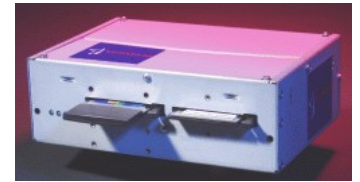
*Motorola A760 Linux/Java handset offering combines the functions of a mobile phone, PDA, digital camera, video player, MP3 player, speakerphone, messaging, Internet access, and Bluetooth wireless technology*





# Embedded Linux based products

- ◆ Samsung also has a smart phone based on embedded Linux.
- ◆ In September 2003, Wind River Systems, by far the world's largest embedded software company, launched its first official support for embedded Linux.

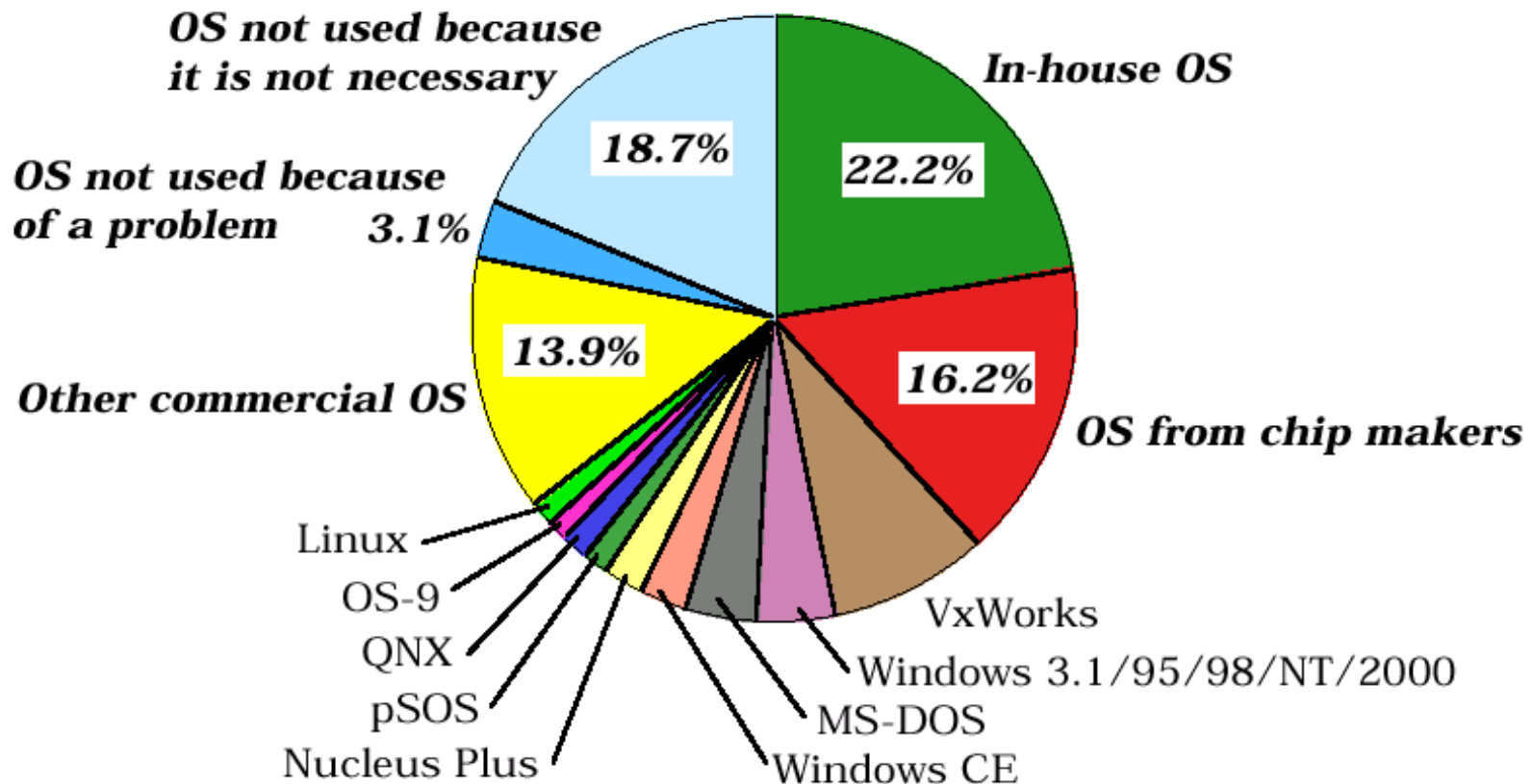


- ◆ Sensoria's mGate is an open in-vehicle telematics platform based on Hitachi's SuperH RISC architecture.

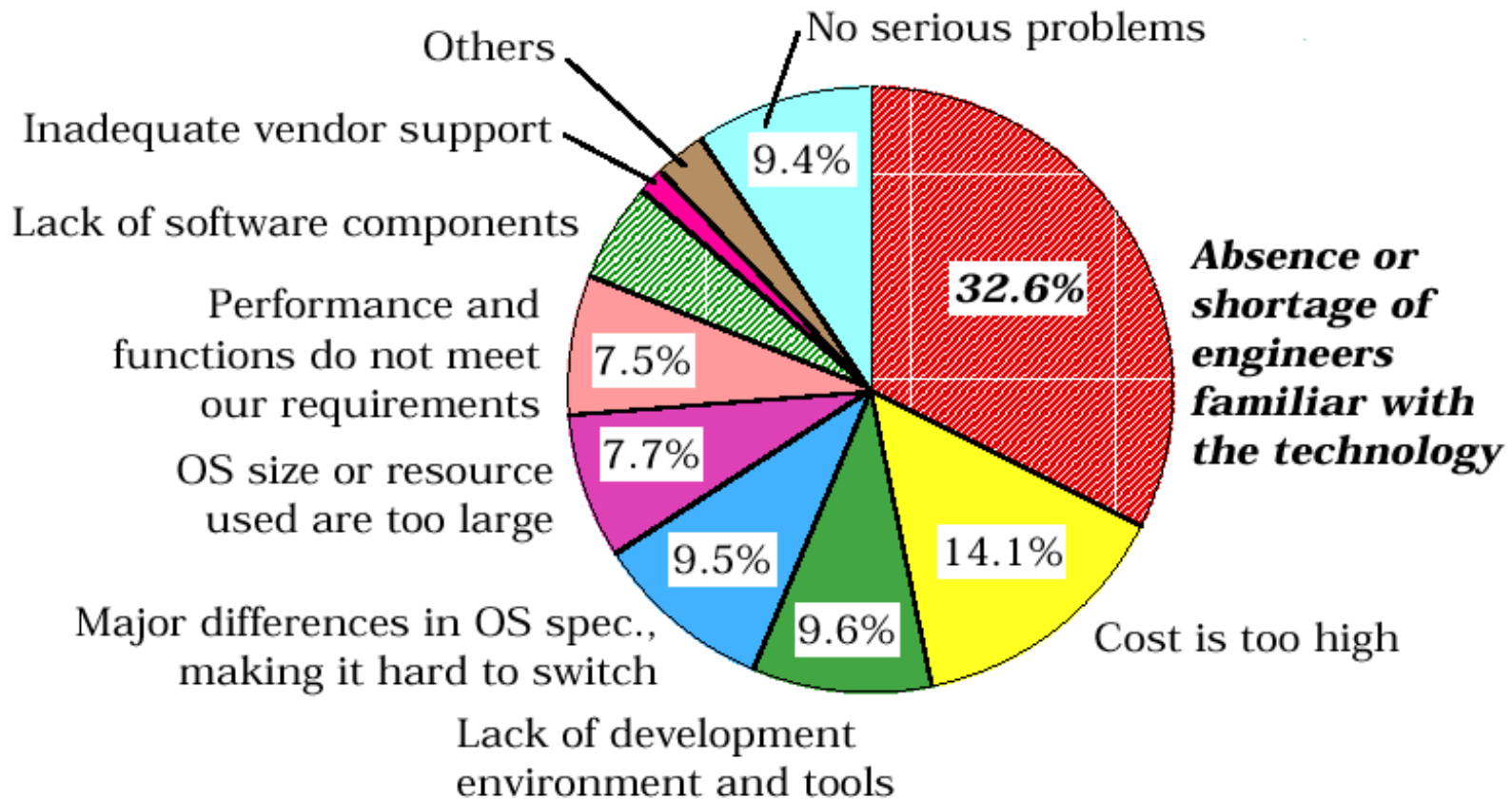
It contains an embedded Linux operating system and JVM with drivers and APIs for telematics related peripherals such as the vehicle bus, GPS, and cellular modem.

For more updates and more.. [www.linuxdevices.com](http://www.linuxdevices.com)

# Usage of RTOS in Embedded Systems



# Difficulty in using a RTOS



# Where could you end up!!!

- Automotive systems
  - perhaps developing Car Multimedia Systems (like me ;) )
- Telecommunications
- Consumer electronics
  - cellular phones, MP3 devices, integrated cellular/walkman/PDA/kitchen sink
  - Set-top boxes and HDTV
  - Home appliances
  - Internet appliances
    - your washer will be on the internet more than you are!
- Defense and weapon systems
- Process control
  - gasoline processing, chemical refinement
- Automated manufacturing
  - Supervisory Control and Data Acquisition (SCADA)
- Space applications
  - Satellite communications

# Free Embedded Tools for Development!!

- ScratchBox (A cross compilation toolkit)

[www.scratchbox.org](http://www.scratchbox.org)

- QEMU (Fast Emulator supports arm, ppc) [www.qemu.org](http://www.qemu.org)

- Some ARM emulators

SKYEYE --> <http://skyeye.sourceforge.net>

SOFTGUN --> <http://softgun.sourceforge.net> (Supports many virtual onboard peripherals and boots uclinux)

# Other useful tools for Elec. guyzzz!!!

- ICARUS VERILOG ([www.icarus.com](http://www.icarus.com))
- GTKWAVE (Waveform viewer)
- GEDA Community (Provides a lot of Free EDA tools for development)
- ECLIPSE IDE with Verilog Plugin (Brilliant!! )
- For submission of your LEGALLY developed and innovated project LATEX Documentation app is also available!!

# Very useful sites.. not for geeks though!!

- [www.linuxdevices.com](http://www.linuxdevices.com)
- [www.free-electrons.com](http://www.free-electrons.com)
- [www.freshmeat.net](http://www.freshmeat.net)
- [www.opencores.org](http://www.opencores.org)
- [www.sourceforge.net](http://www.sourceforge.net)
- [www.shakthimaan.com](http://www.shakthimaan.com) “Very famous one among the Chennai LUG guys!!! “
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# Byeeeeeeee !!!!!!

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Thank Lord Almighty, my DAD, MOM and my Bro!!

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