



**Universidade Federal de Pernambuco
Deptº de Eletrônica e Sistemas**

Desenvolvimento de Sistemas Embarcados de Tempo Real

Prof. Hermano Cabral

Horário: Terça de 08:00h às 10:00h
Sexta de 08:00h às 10:00h

Site: <http://sites.google.com/view/hermano-cabral/rtos>

Avaliação: Listas de exercício (30%) e
projeto final (70%)

Metodologia

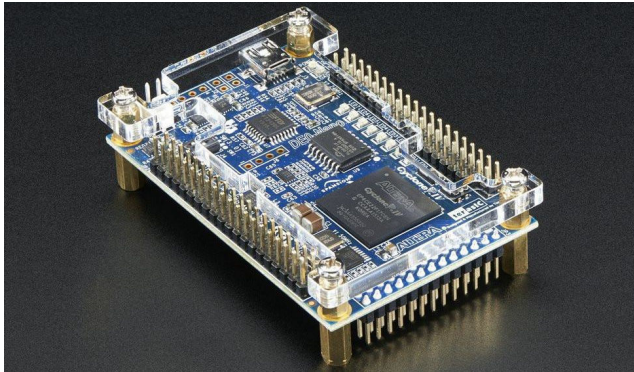
- Uso intensivo de desenvolvimento de programas para microcontroladores
- Os exercícios devem ser feitos e entregues de forma individual
- O projeto final será feito em duplas



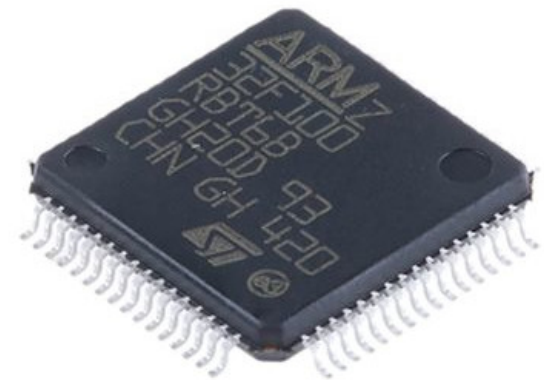
**O que é um
sistema
embarcado?**



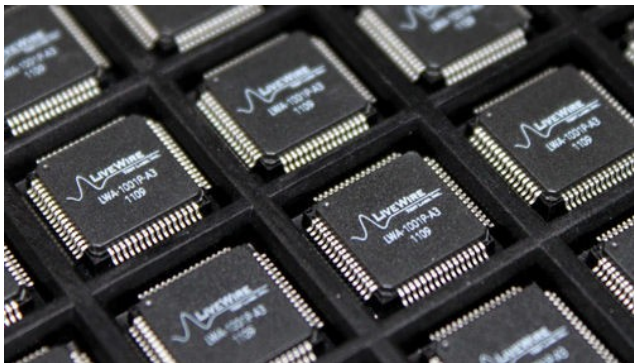
Tecnologias para embarcados



FPGA



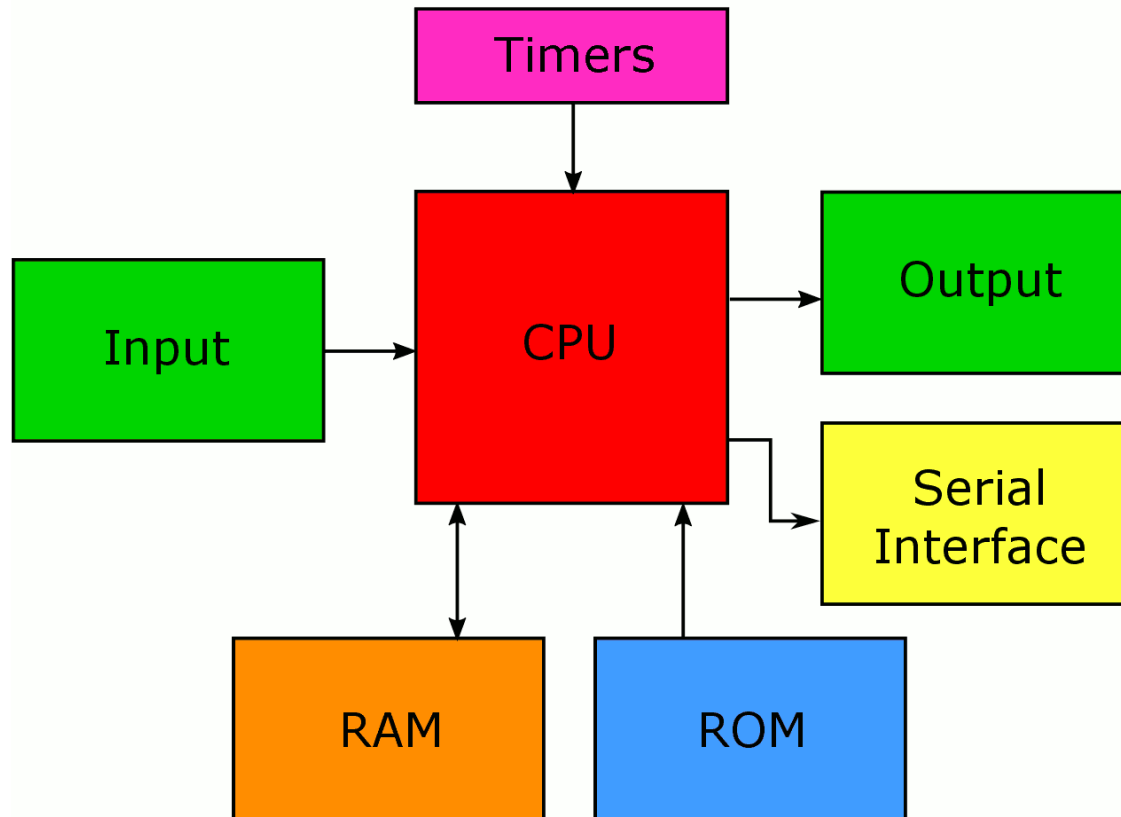
Micro-
controladores



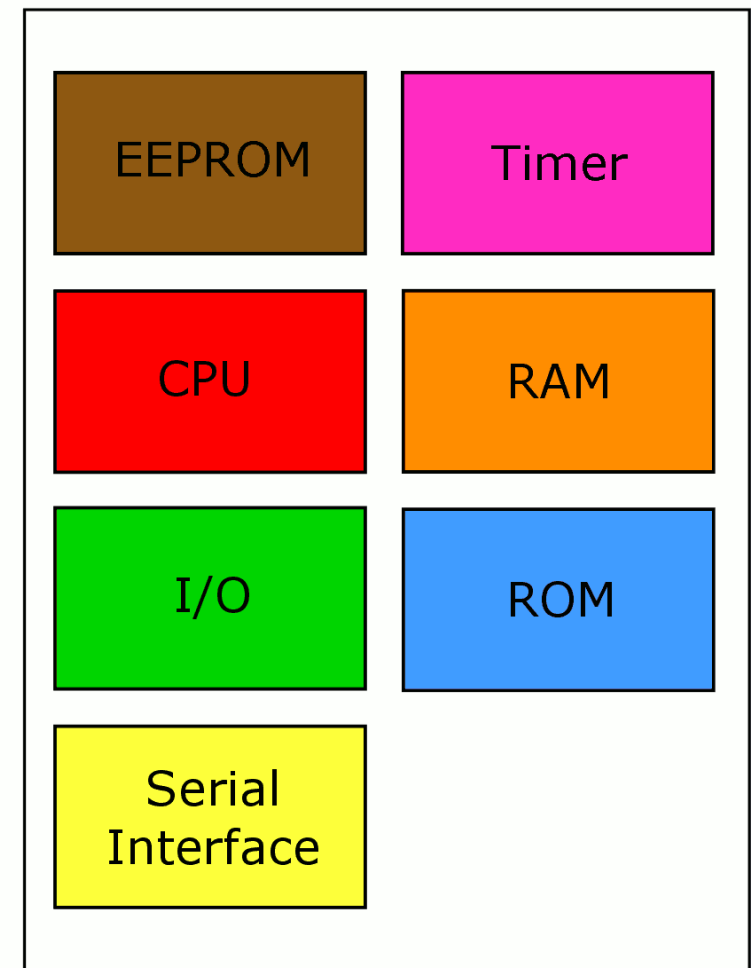
ASIC

Arquitetura de um microcontrolador

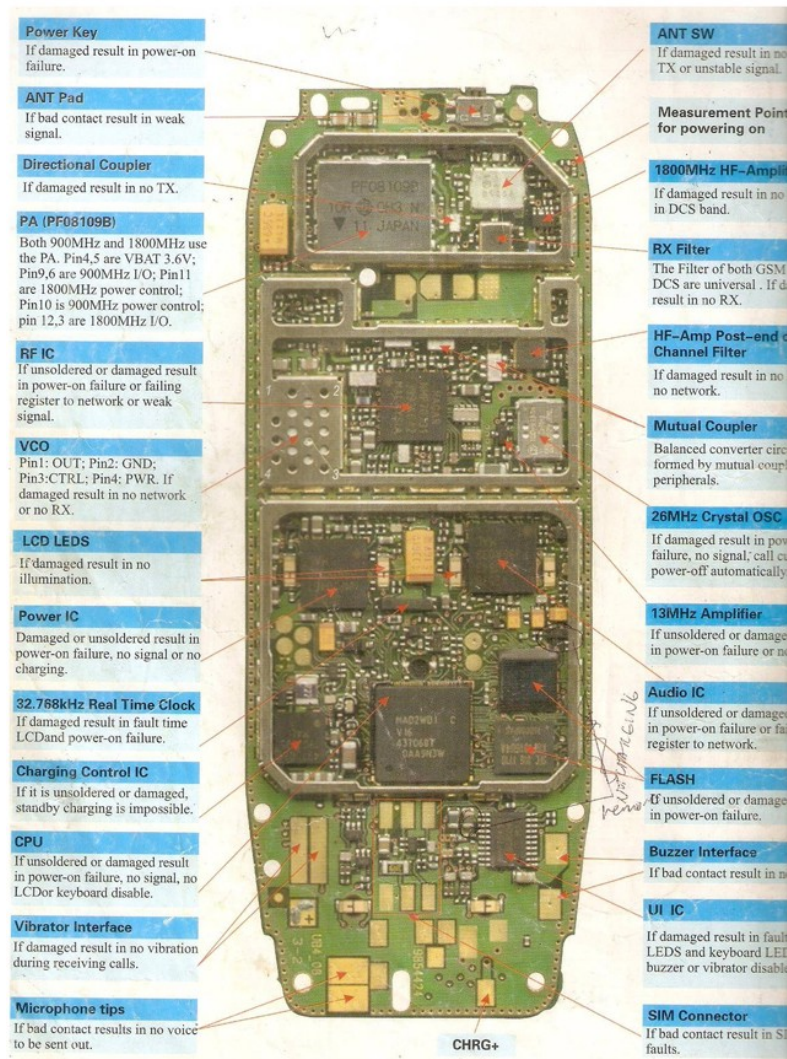
Microprocessadores



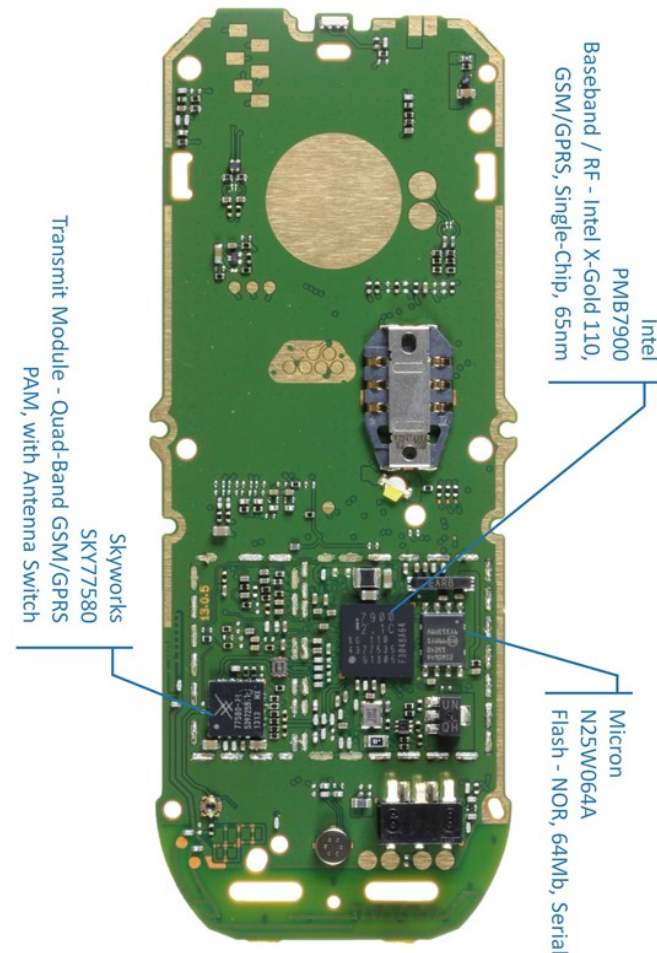
Microcontroladores



Arquitetura de um microcontrolador



2000



2013

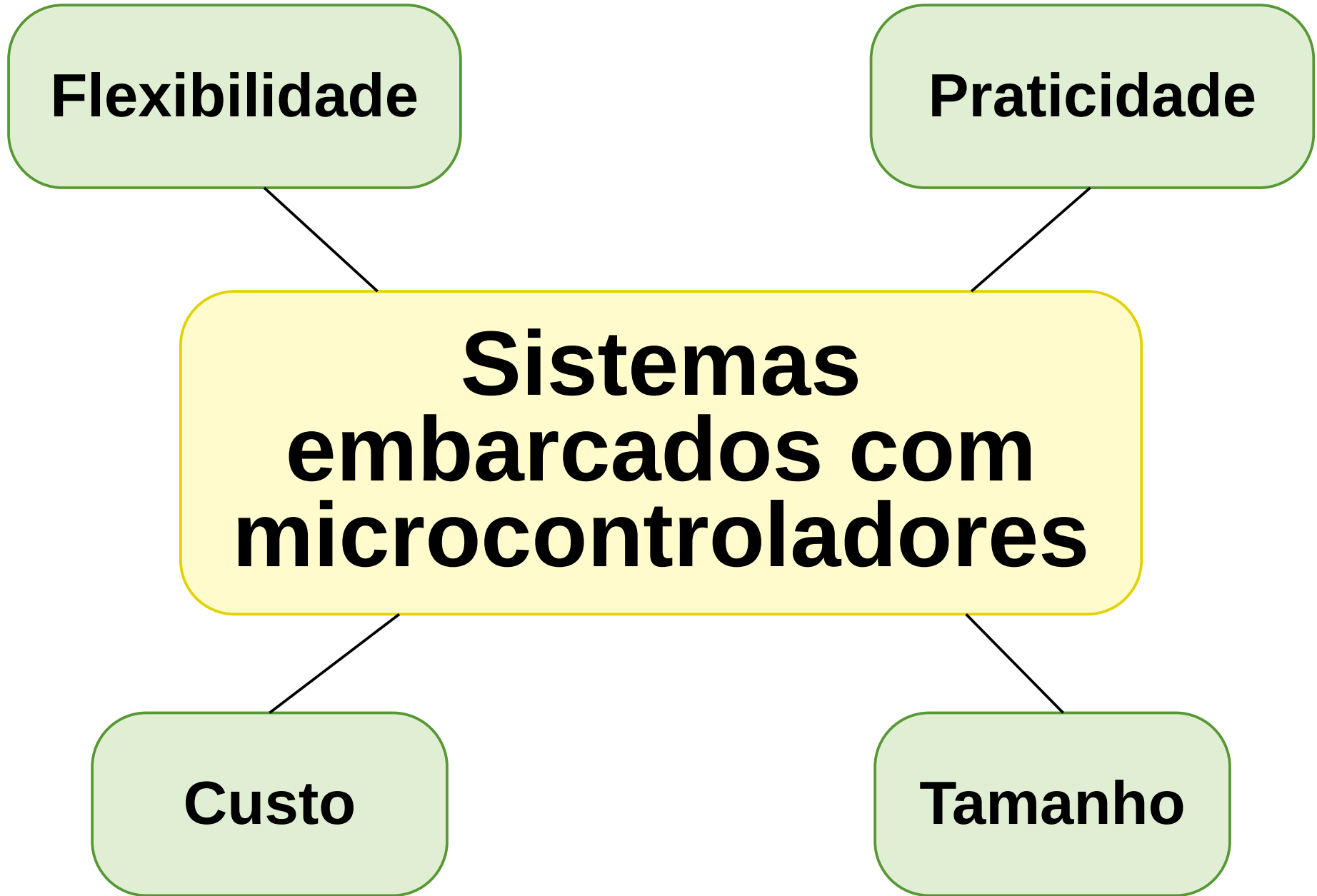
Flexibilidade

Praticidade

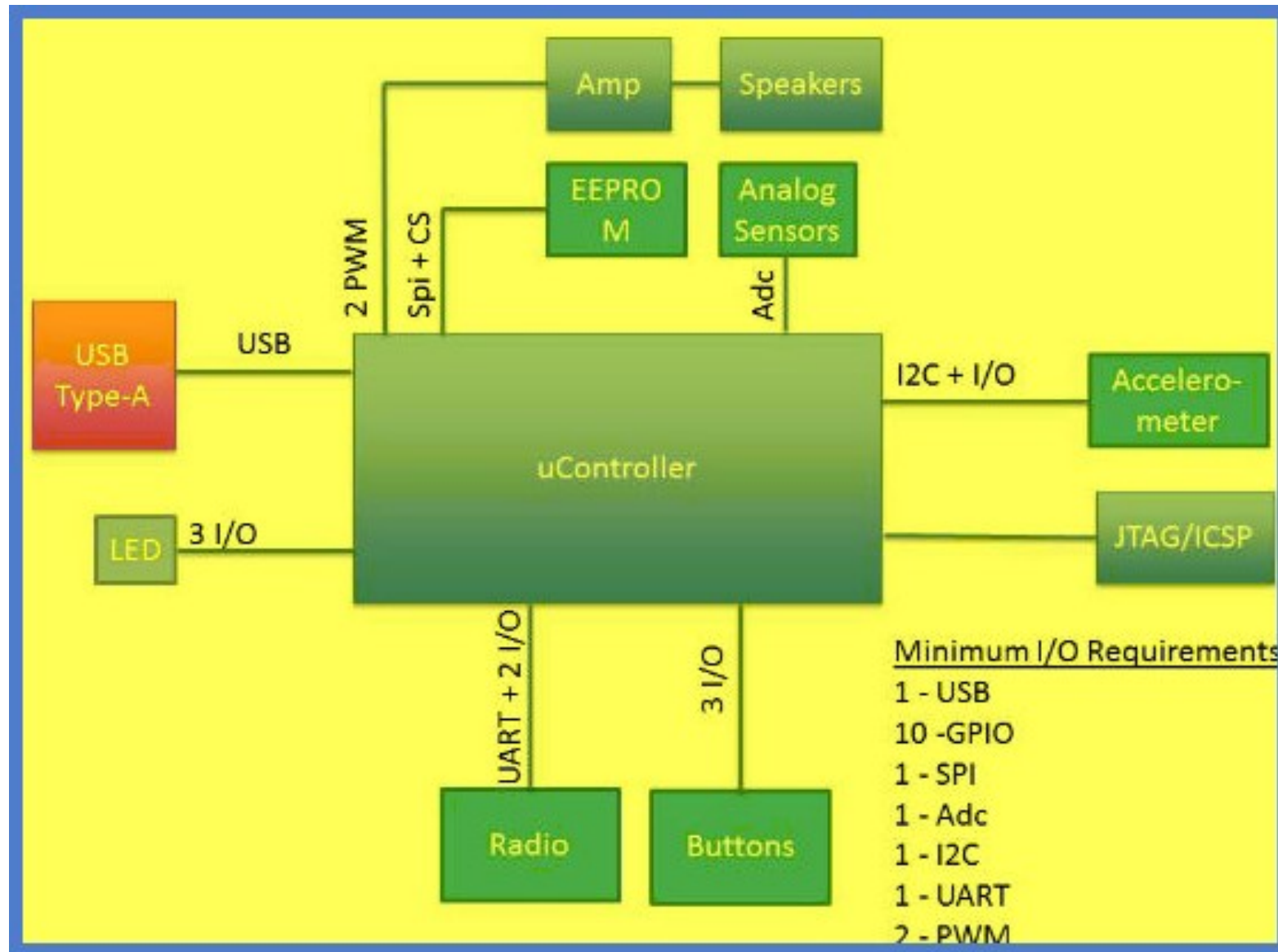
**Sistemas
embarcados com
microcontroladores**

Custo

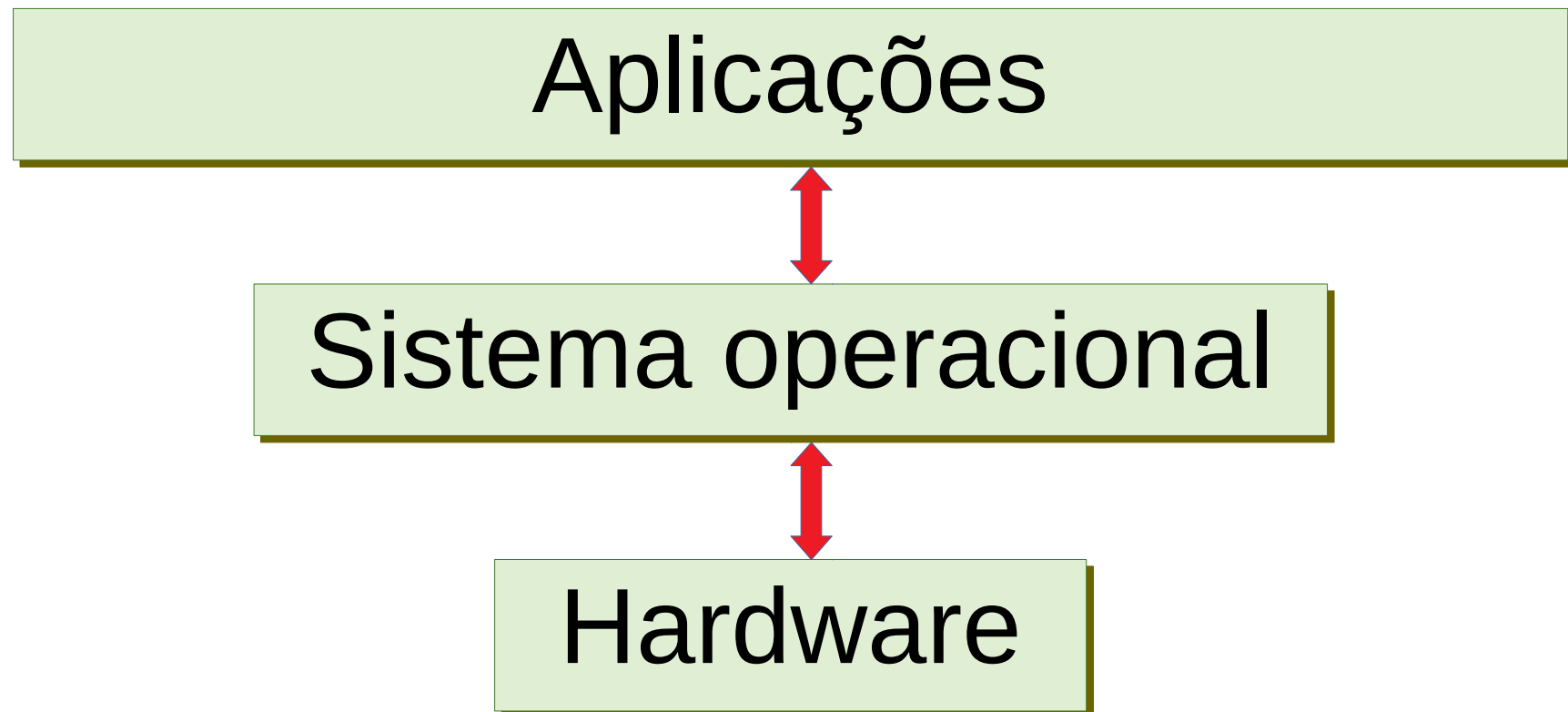
Tamanho



Interfaces em um sistema embarcado



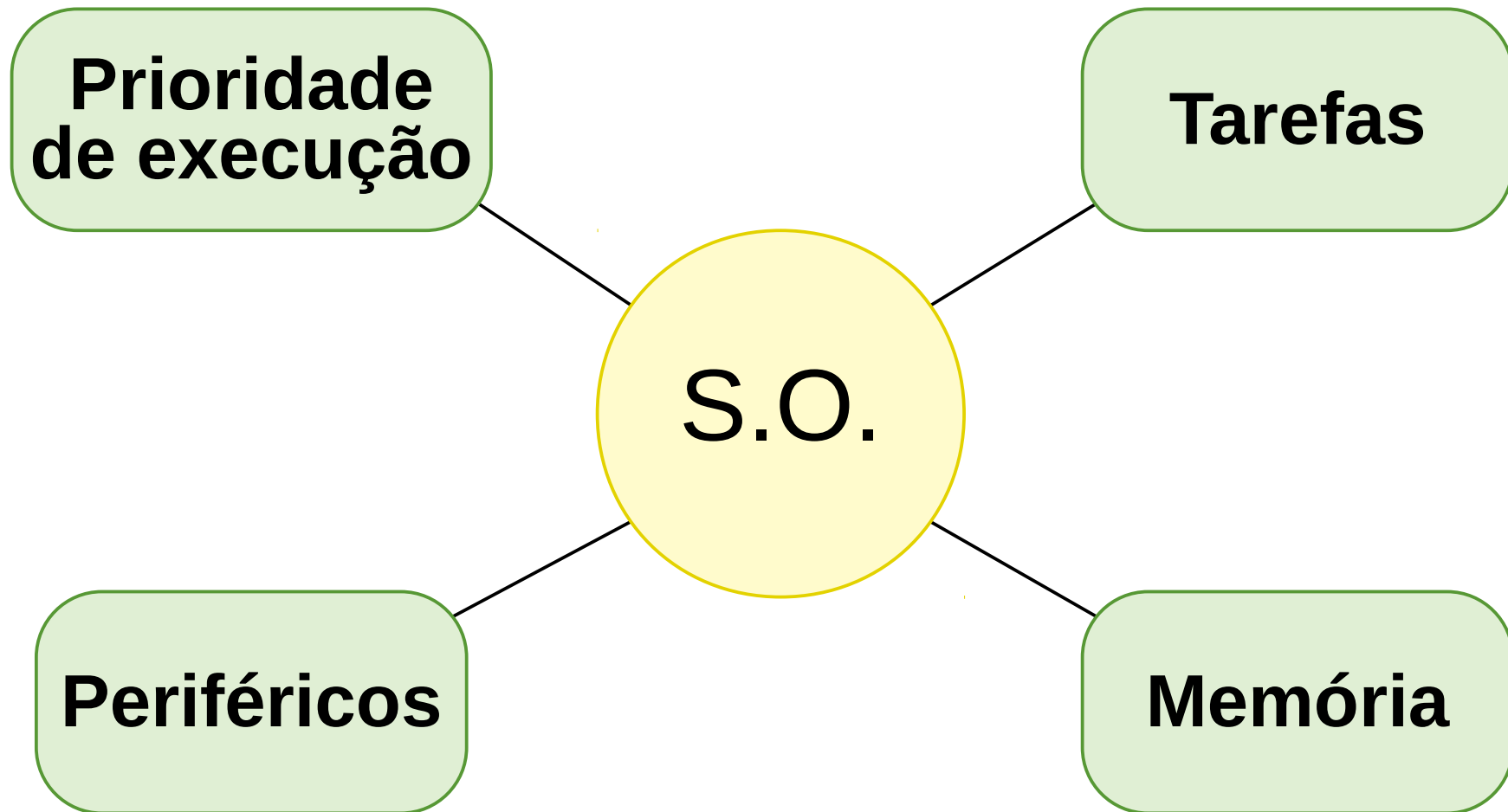
Sistema operacional



Sistema operacional

- Também provê funcionalidades usadas por várias aplicações

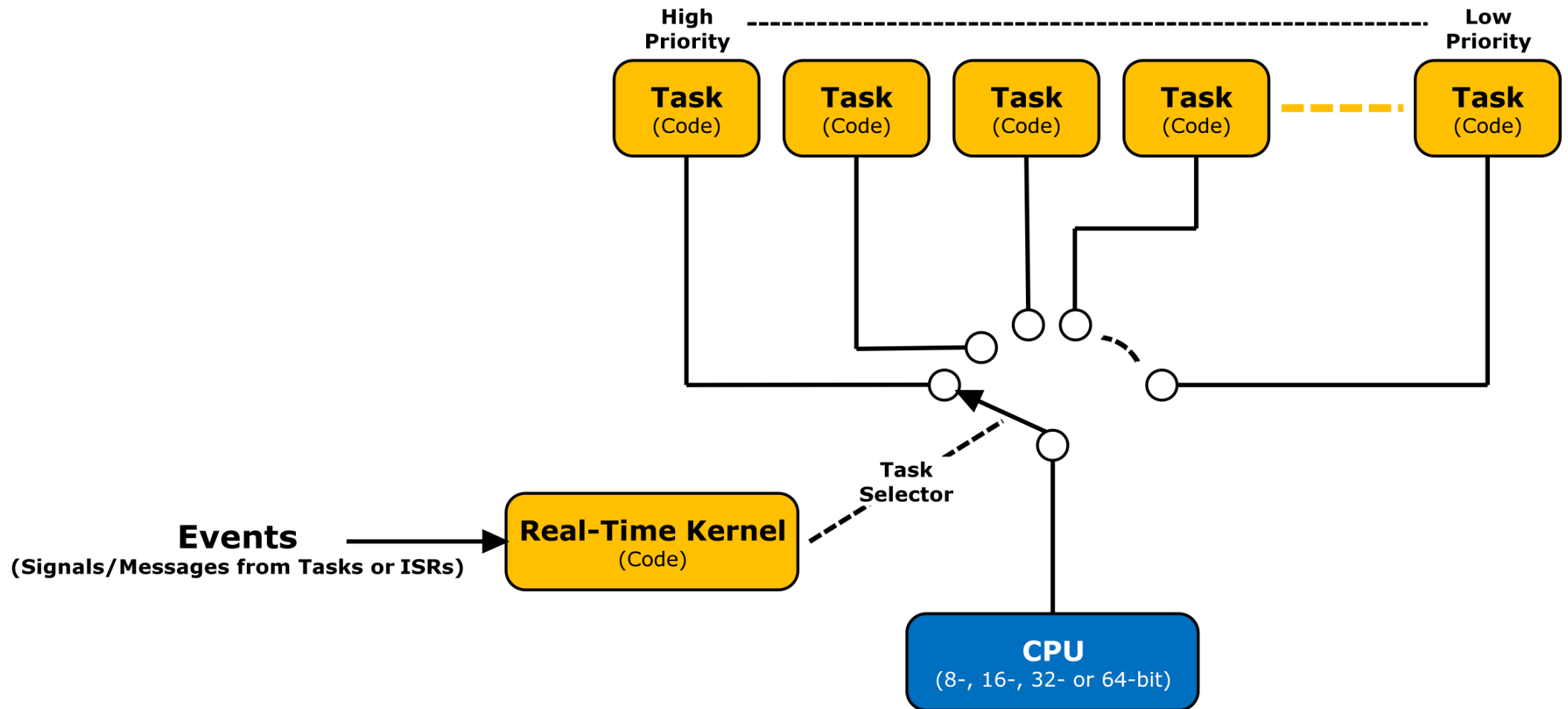
Funções de um sistema operacional



Sistema de tempo real



Sistema operacional de tempo real



Tipos de RTOS



Rígidos

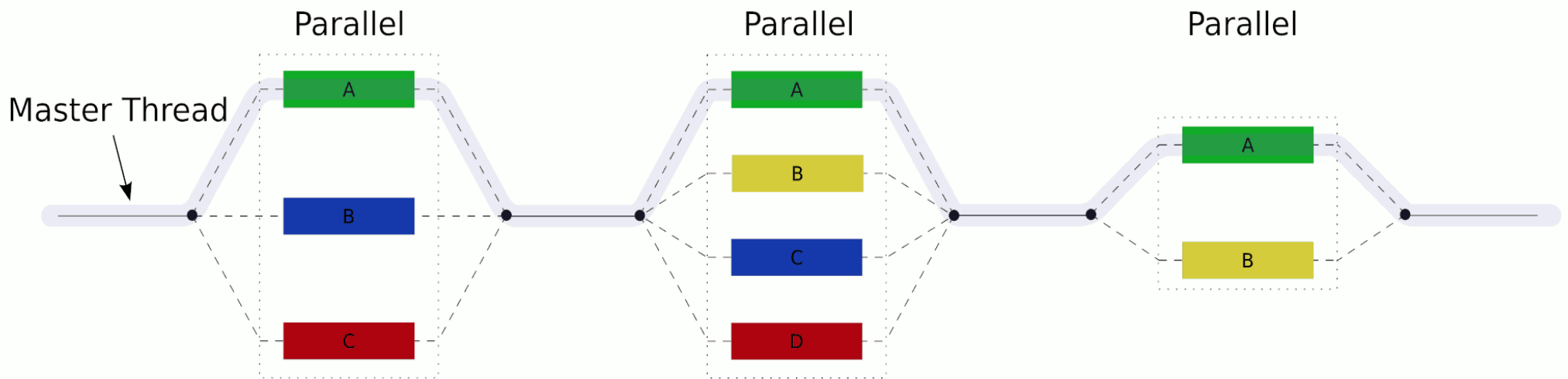
Suaves



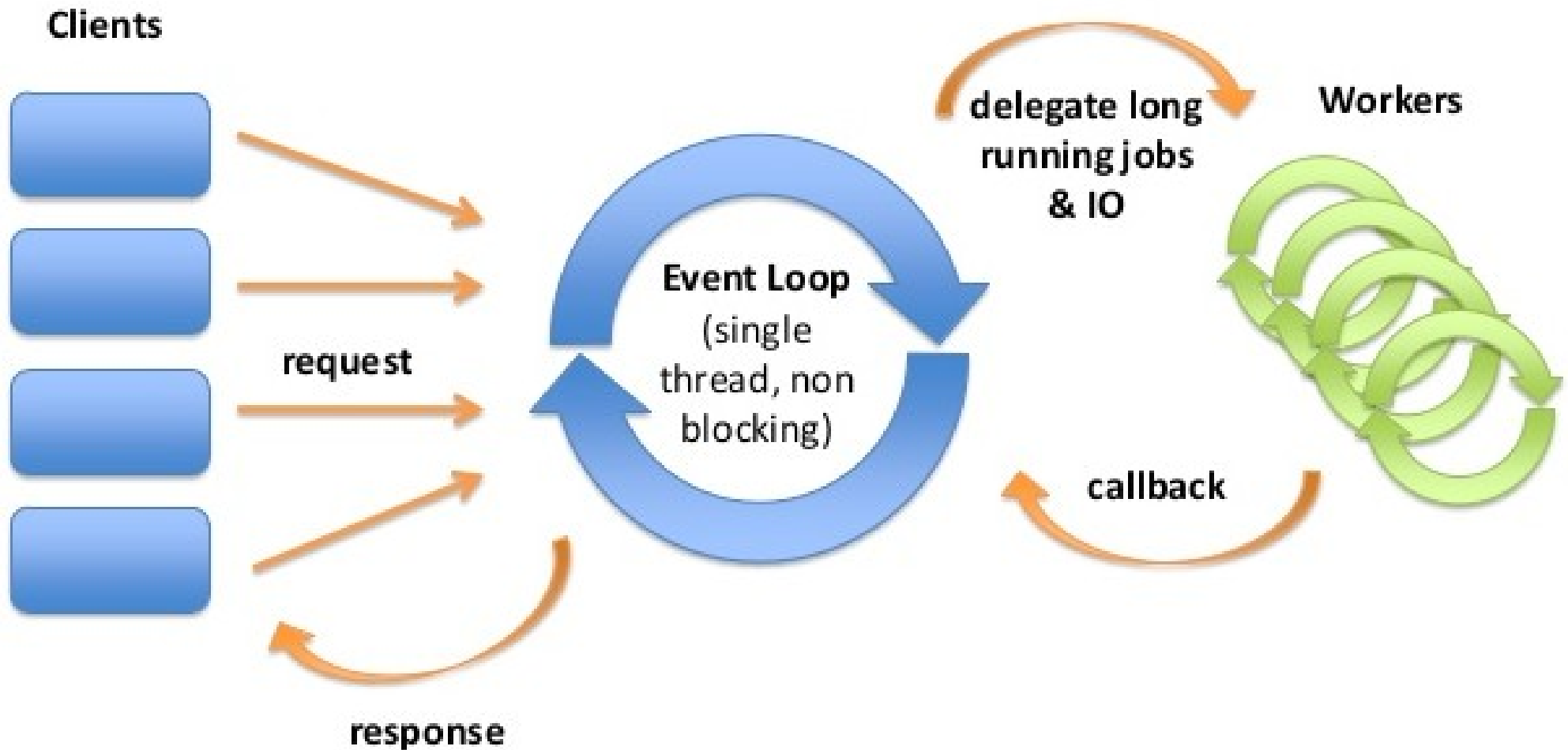
Programação paralela

Sequential

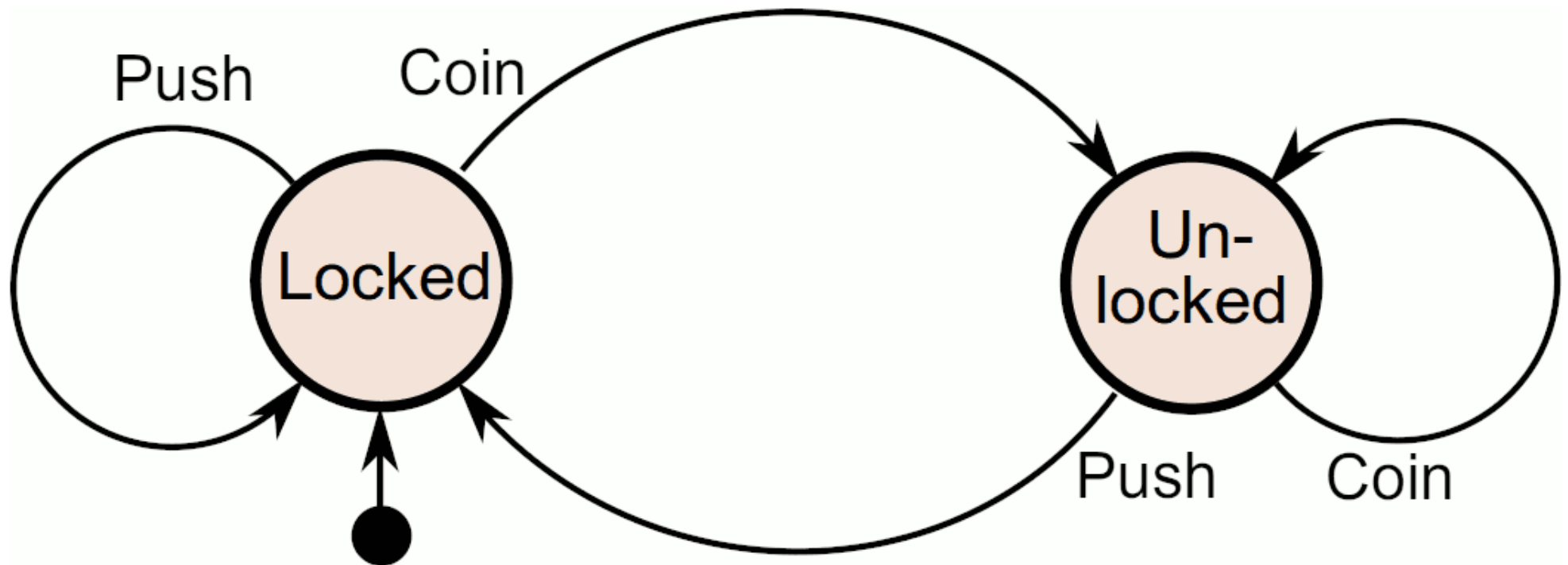
Master Thread



Programação reativa



Máquinas de estados



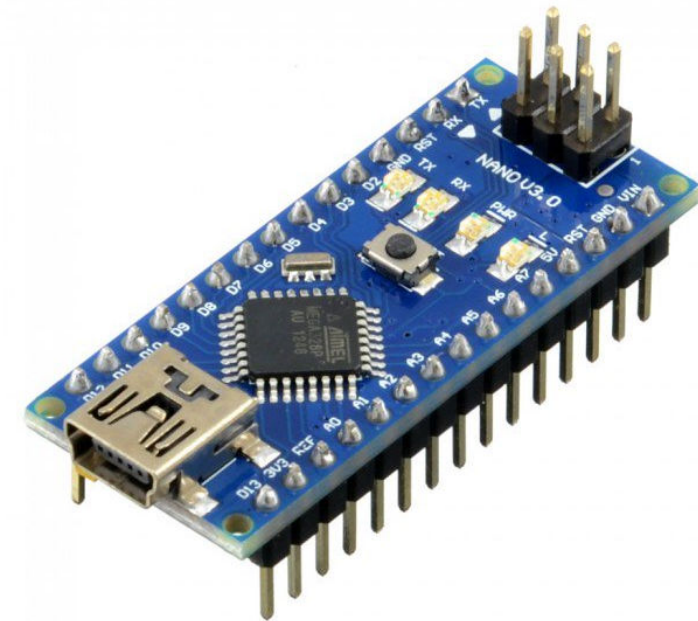
Objetivos da disciplina

- Compreender as características de um sistema de tempo real
- Usar ferramentas e ambientes de desenvolvimento para sistemas operacionais de tempo real em sistemas embarcados

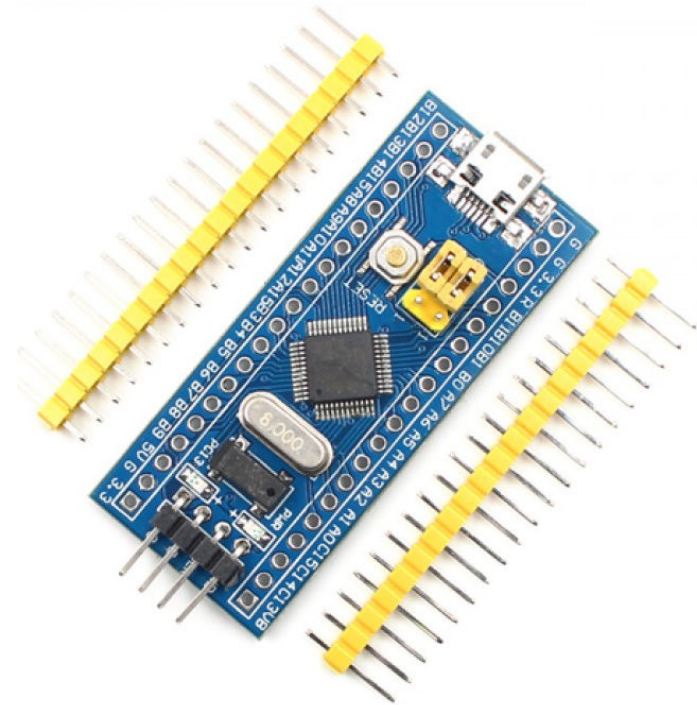
Objetivos da disciplina

- Programar microcontroladores com um sistema operacional de tempo real usando técnicas de programação paralela
- Realizar um projeto de sistema embarcado usando um sistema operacional de tempo real

Hardware utilizado



Arduino Nano
Atmel ATmega328p



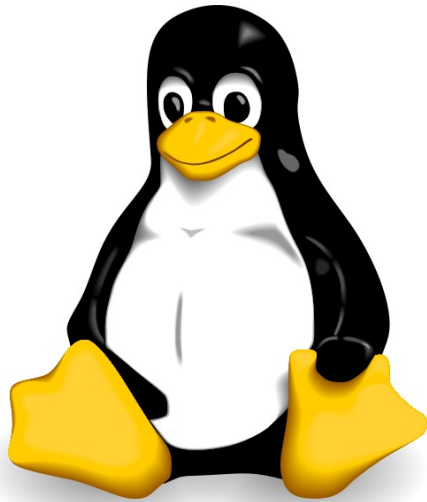
STM32f103

Software - Chibios/RT



<http://www.chibios.org>

Ambiente de desenvolvimento



Kubuntu / Linux

```
root@localhost:~# ls -la
total 88
drwxr-xr-x 10 root root 4096 Jul 14 12:09 ./
drwxr-xr-x 10 root root 4096 Jul 14 12:09 ../
drwxr-xr-x 1 root root  6 Jul 14 15:08 armb-adaption-state
drwxr-xr-x 1 root root 140 Jan 1 2013 bash_completion
drwxr-xr-x 1 root root 1455 Jul 14 12:09 bash_history
drwxr-xr-x 1 root root 14 Jan 1 2013 bash_logout
drwxr-xr-x 1 root root 106 Jan 1 2013 bash_profile
drwxr-xr-x 1 root root 246 Jul 14 11:34 bashrc
drwxr-xr-x 4 root root 4096 Jul 14 15:04 cache/
drwxr-xr-x 5 root root 4096 Jul 14 15:17 config/
drwxr-xr-x 1 root root 238 Jan 1 2013 cshrc
drwxr-xr-x 3 root root 4096 Jul 14 14:54 dmcc/
drwxr-xr-x 2 root root 4096 Jul 14 14:59 emacs/
drwxr-xr-x 3 root root 4096 Jul 14 11:32 kins/
drwxr-xr-x 3 root root 4096 Jul 14 18:17 local/
drwxr-xr-x 1 root root 277 Jul 14 12:09 mpdstate
drwxr-xr-x 1 root root 104 Jan 1 2013 tmshrc
drwxr-xr-x 2 root root 4096 Jan 1 2013 vmware
drwxr-xr-x 1 root root 927 Jan 1 2013 vmware
drwxr-xr-x 2 root root 4096 Jan 1 2013 vmtoolsd/
drwxr-xr-x 1 root root 54 Jul 14 12:09 xauthpads
drwxr-xr-x 1 root root 1479 Jan 1 2013 xinetd/
```

Terminal
(konsole)

```
File Edit Options Buffers Tools Help
Main Page
From Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/Main_Page
Main Page
From Wikipedia, the free encyclopedia
Welcome to Wikipedia.
Welcome to Wikipedia.
the first encyclopedia that anyone can edit.
5,429,453 articles in English
In the news
March 1951 cover
Planner Stories was an American pulp science fiction magazine, published by Fiction House between 1939 and 1955. It featured adventures in space and on other planets, and was initially focused on a young readership. Halcolm Beiss was editor or editor-in-chief for all of its 71 issues. It was launched at the same time as Fiction House's were successful Planet Stories. Almost every issue's cover emphasized scantily clad women in distress or alien encounters. Planet Stories did not pay royalties to its authors.
Top of page (1/1)
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total 88
drwxr-xr-x 10 root root 4096 Jul 14 12:09 ./
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drwxr-xr-x 1 root root 54 Jul 14 12:09 xauthpads
drwxr-xr-x 1 root root 1479 Jan 1 2013 xinetd/
```

Editor de texto

Desenvolvimento cruzado

- Para gerar o sistema que queremos, usaremos o seguinte processo:
 - Edição do texto do programa em C
 - Compilação, conversão do arquivo binário e carregamento no microcontrolador
- A edição pode ser feita em qualquer editor (por exemplo, `kate`)

Desenvolvimento cruzado

- A segunda parte é realizada por um Makefile, um arquivo com instruções para o programa `make`.

Bibliografia

- Microcontrolador
 - Datasheet
- Chibios/RT
 - Site: <http://www.chibios.org>
- Programação reativa
 - Miro Samek. Practical UML Statecharts in C/C++: Event-Driven Programming for Embedded Systems, 2ª edição, CRC Press, 728p, 2008.