Modern Day GNU/Linux:

We are not programming in 1969 (or even 1984) anymore

by
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and
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and
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Project Cauã

SysArmy.com

Meetup

#MEETARMY + #ADMINBIRRAS

CHARLAS

INFRAESTRUCTURA DE INTERNET EN ARGENTINA

DNS, ESA COSA QUE SIEMPRE ANDA... HASTA QUE NO

MAKING OPEN HARDWARE

JUEVES 10 DE NOVIEMBRE, 19HS, MULESOFT ARGENTINA

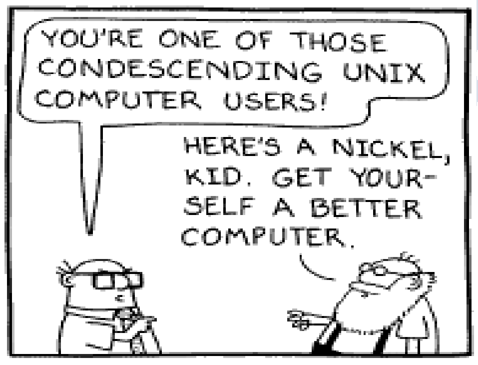
MEETUP.COM/SYSARMY

They Are Actually *Friendly!*

Do Not Sweat IT!
(Information Technology)!

Who Am I?

- *Half* Electrical Engineer, *Half* Business, *Half* Computer Software
- In the computer industry since *1969*
  - Mainframes 5 years
  - Unix since 1980
  - Linux since 1994



- Companies (mostly large): Aetna Life and Casualty, Bell Labs, Digital Equipment Corporation, SGI, IBM, Linaro
- ***Programmer***, Systems Administrator, Systems Engineer, Product Manager, Technical Marketing Manager, ***University Educator***, Author, Businessperson, Consultant
- Taught OS design and compiler design
- *Extremely* large systems to *extremely* small ones
- Pragmatic
- Vendor *and* an “open source” customer

Who Am I?
Linux

- May 1994 – funded Linus Torvalds at DECUS
  - Obtained Alpha for Linus to do port
    - CISC/RISC
    - 32/64 bit
  - Assembled DEC engineering team
- 1995 – Assumed ED role for Linux International
  - LMI – defended Linux Trademark
  - LPI – created SysAdmin certification program
  - LSB – Linux Standard Base
- Promote Linux Worldwide

Who Needs Performance?

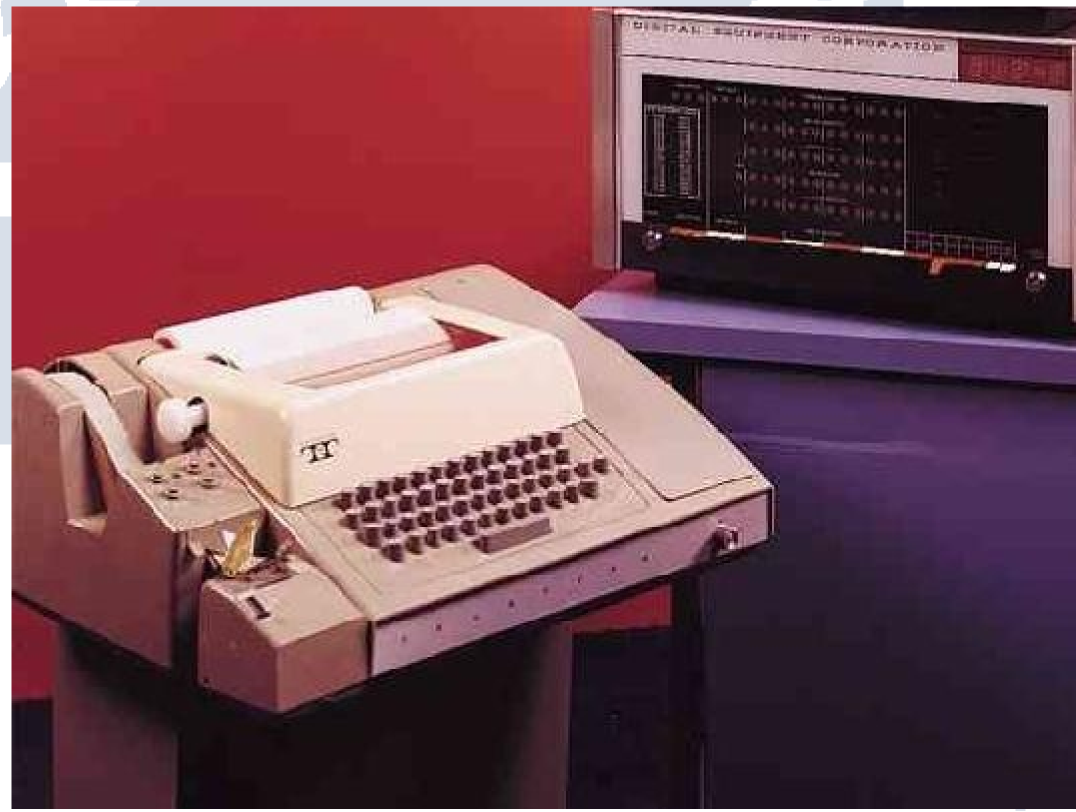
- “CPUs are fast enough”
- “JAVA is the only language people need”
- “Nobody codes in assembler language any more”
- “Virtual machines make architecture knowledge obsolete”

Performance

- “Real” problems
  - Petabytes of data, thousands of processors
- Real-time
  - REAL real-time
    - Lower those rods!
  - Linus and “soft real time”
  - Maintaining a thought path (< 3 seconds)
- Cell Phone Apps
  - Saving battery life
- Saving the environment!
  - Only 9000 servers!
- “New” (or at least newly affordable) advancements (FPGAs, DSPs)

My “Second Language”

- PDP-8 Assembler
  - 4000 12-bit words
  - Data and Instructions same length
- From a book
  - Plenty of practice



Nobody told me “assembly was difficult”

To Write Really *Great* Code...

...you need to understand machine architecture and that includes machine/assembly language

Examples From My Past

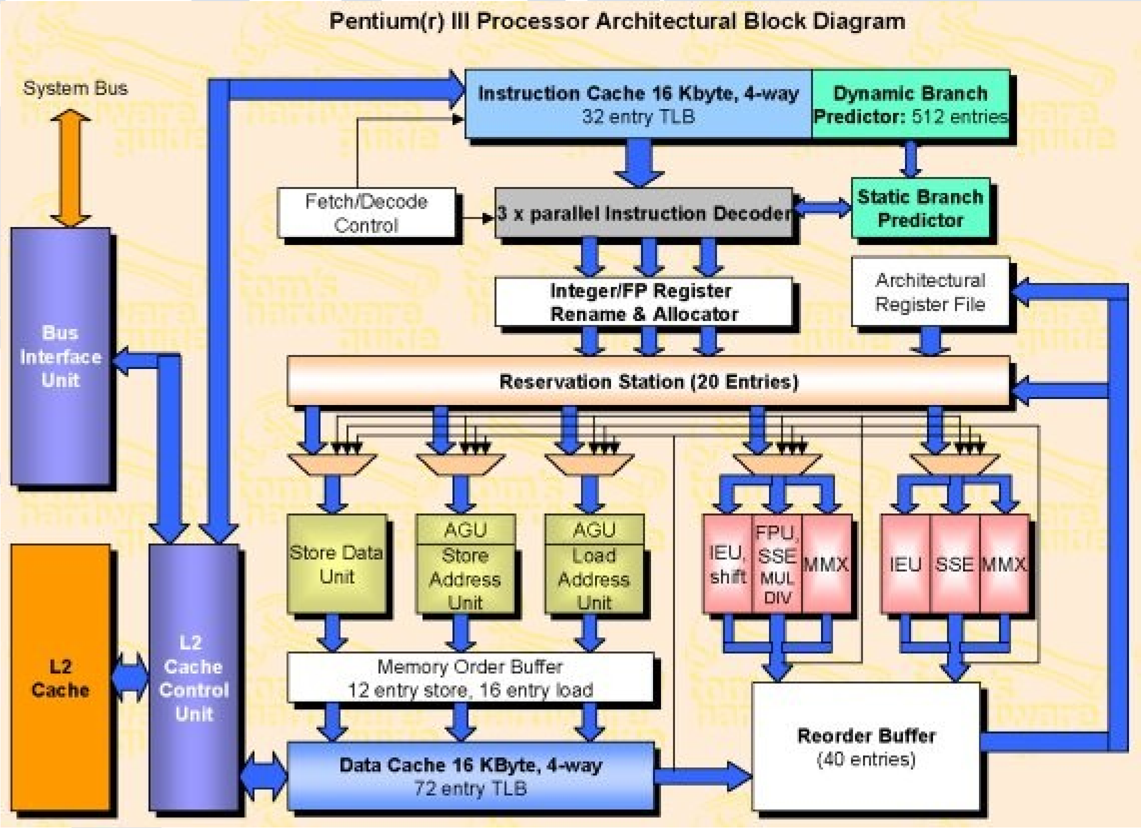
- Compiler errors (?!?)
- IBM
  - “Read Clock” - 99% of wall clock time
  - EBCDIC – the four slowest instructions
- Cache
  - Digital Unix – ½ the size, 7% faster
  - 40 times (David Mossberger-Tang)
  - 220 times – PDP-11/70 with RSTS-E
- Tapes (OMG!) - start/stop and streaming tapes

Today

- College Students learning
  - “Microsoft Office and Oracle” instead of “Office Systems and Databases”
  - JAVA and “IT/TI” instead of Assembly and Operating Systems
  - Virtual machines instead of “real iron”
- High school students
  - Games and HTML

How Most High School Students See Computers

How Computers Really Look



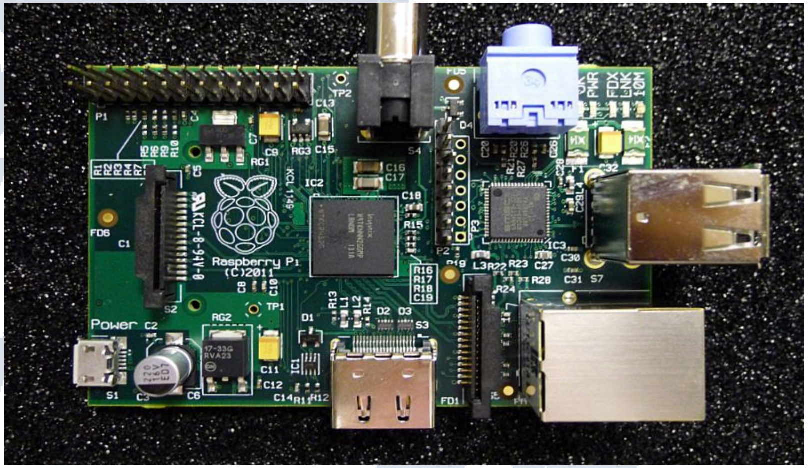
Real Life Effects of "Dumb Down"

"Incoming freshmen know less than they knew 20 years ago" - Raspberry Pi Foundation

The Raspberry Pi was created to help fix this problem.

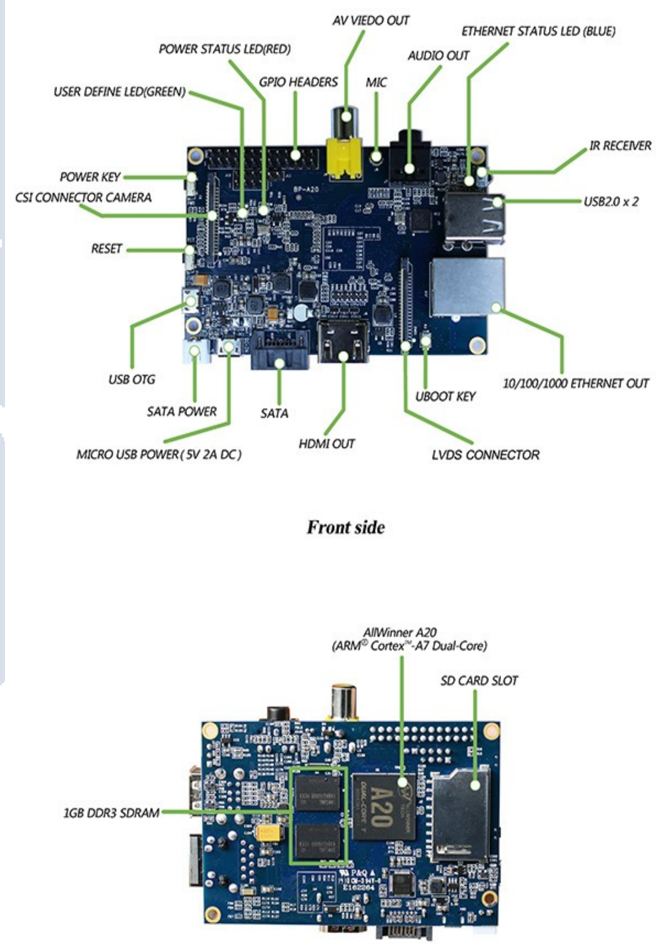
Raspberry Pi – 35 USD

- Single Core ARM – 700Mhz
- ½ Gbyte Memory
- 3D GPU
  - Hardware video decode
- USB 2.0
  - 10/100 Ethernet
- HDMI
  - Analog AV also
- GPIO Pins
- 3W



Banana Pi – 50 USD

- Dual Core ARM – 1000 Mhz
- Gbyte RAM
- 3D GPU - Hardware video decode
- USB 2.0
  - 10/100/1000 Ethernet
- HDMI
  - Analog AV also
- GPIO Pins
- SATA
- IR receiver/transmitter
- 3W – better power management



Front side

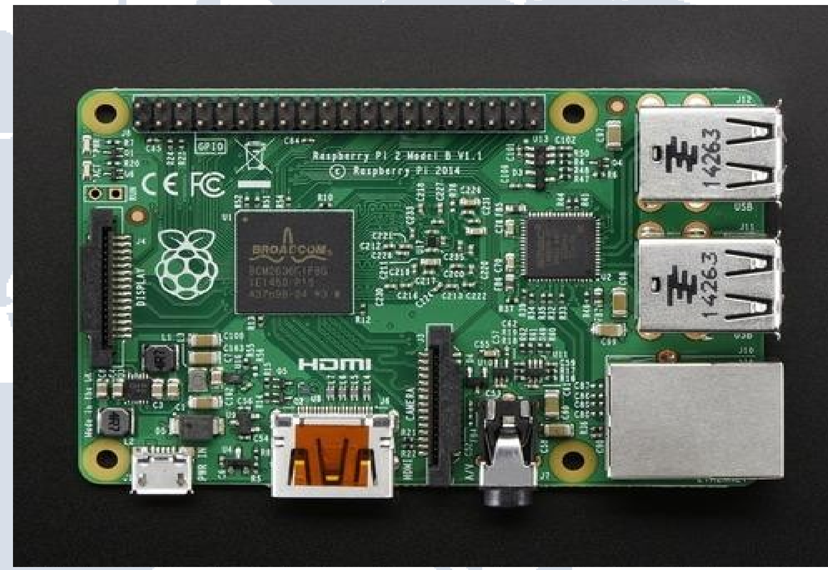
Back side

New Raspberry Pi 2 Model B 35 USD!

- ARMv7 Quad Core

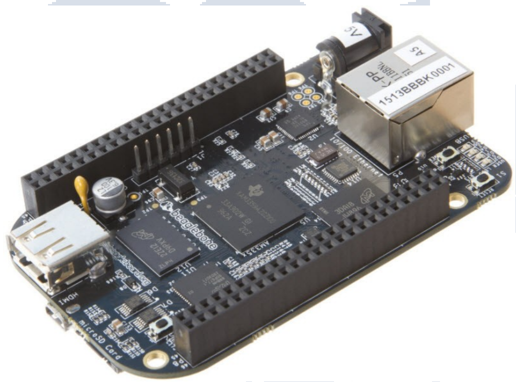
(85% improvement single-core performance, up to 7.5x parallel performance improvement)

- 1GByte RAM
- HDMI
- Audio out
- Gbit ETHERNET
- Micro SD card
- Physical as RPI B+



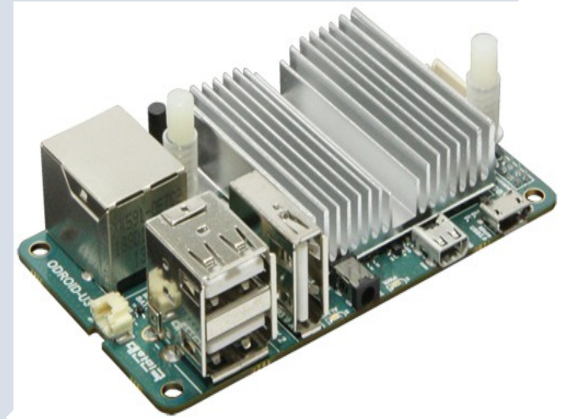
Remember GNU/Linux does a lot in parallel....

Many Little Computers:
45 USD – 199 USD



BeagleBoneBlack

Hackberry 10



ODROID-U3

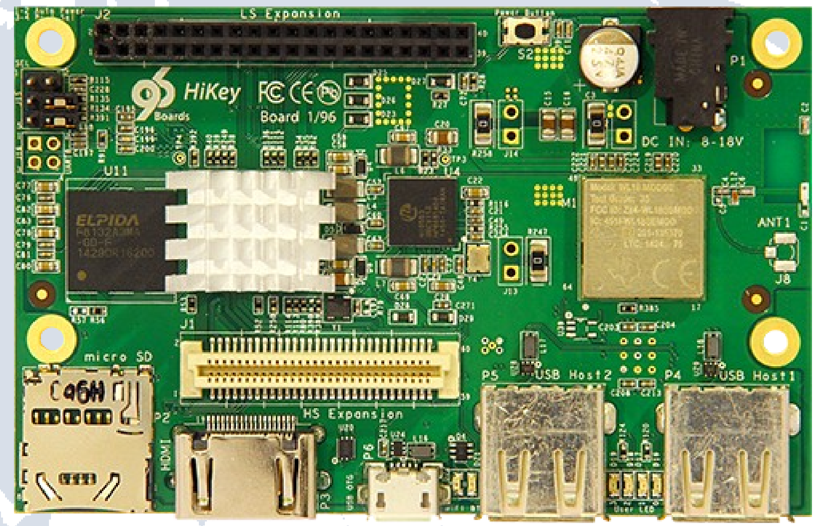
OlimoX - LIME

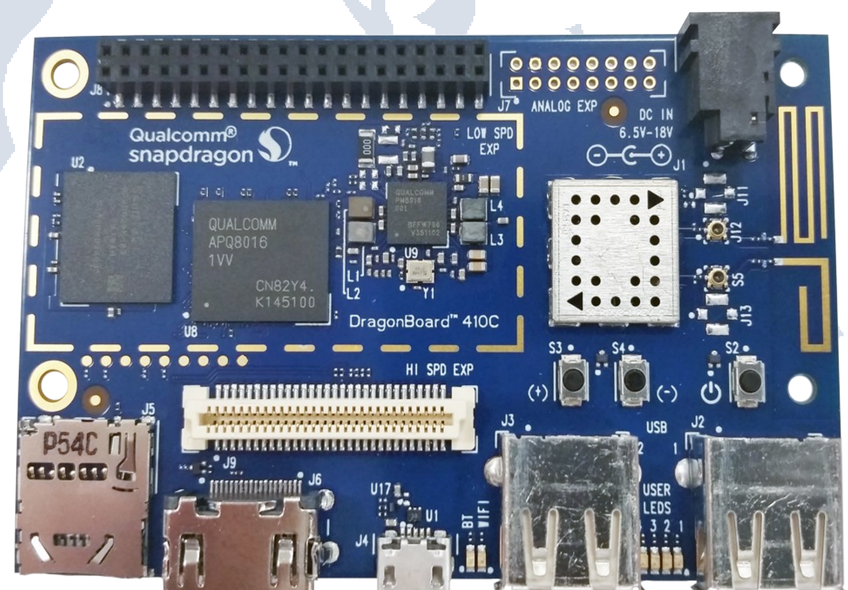
Pandaboard

Galileo

96Boards.org

- Open standard for ARM SBCs – 32 and 64 bit
  - “Consumer” <100 USD
  - “Enterprise < 300 USD
- Placement of
  - Mounting holes
  - Connectors
  - Power supplies



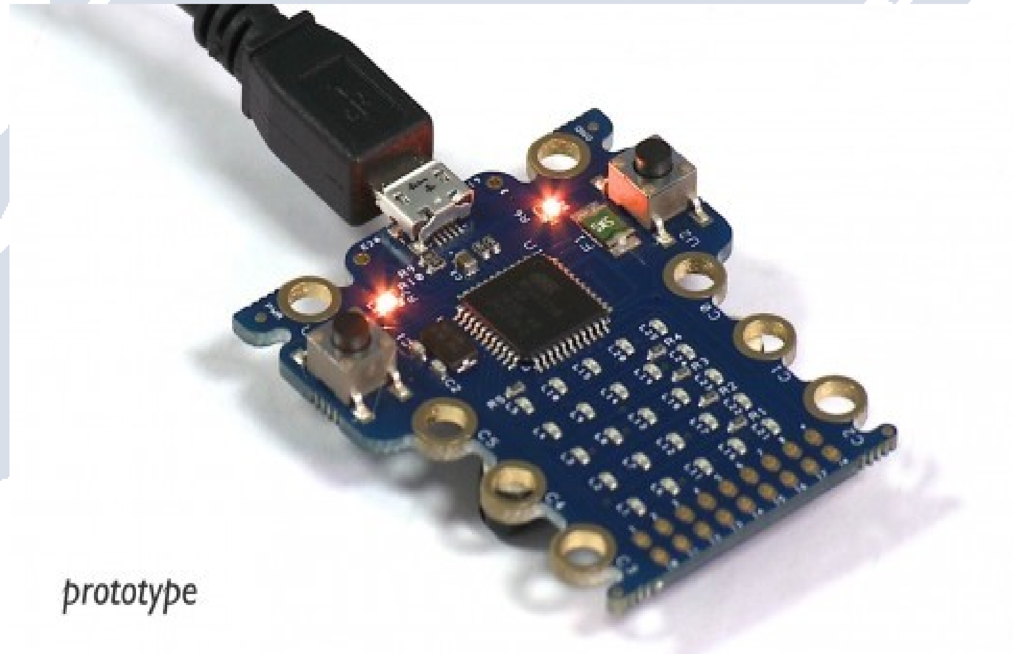


LeMaker Guitar

- Four core 32-bit ARM9 processor
- 1-2 Gbytes RAM
- HDMI
- USB 2.0 and USB 3.0
- 10/100 Mbit/sec Ethernet
- 240 pin DIMM connector
- Open Design - four motherboards....

BBC's Micro-Bit
Given Away to Grade 7 (11-12 YO)

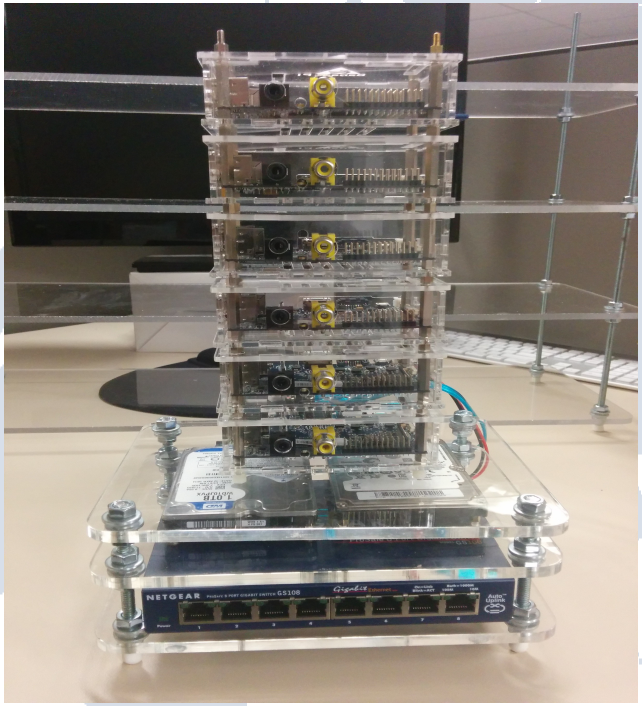
- CPU
- Micro-USB power
- 5x5 LED display
- Bluetooth LE
- Accelerometer
- Other measuring devices
    - Final specifications not ready
- “Program from their smartphones”



Why Do I Show You All This?

Because Of THIS!

- 12 ARMv7 Cores at 1 GHz each
- 6 GBytes of RAM
- 6 HDMI ports
- 6 SATA ports (currently driving two disks)
- IR on board
- 2 TB SATA disk
- 8 Port Gbit ETHERNET
- 70 Watts
- Fits in standard briefcase



Why Is This Interesting?

- Can be used to teach
  - HPC computing
  - HA computing
  - heterogeneous computing (programming and systems administration)
- Very portable, can be assembled in minutes
- Very modular
- Prototype cost: 500 USD
  - Currently using “Banana Pi”
- Production cost: < 400-1000 USD
  - Will use (6) new “LeMaker Guitar/Model D”
    - Will increase from 12 up to 96 ARMv7 cores
    - Will increase from 6 GB of RAM to 48 GB RAM

GNU/Linux: 30+ Years

- Memories have gotten larger
- CPUs have gotten faster
- CPUs are multi-core
- Algorithms have changed
- Pipelining and cache more prevalent
- Optimizations in compilers have gotten better
- Need for assembly language decreased (and often is detrimental)

Can we make the code better?

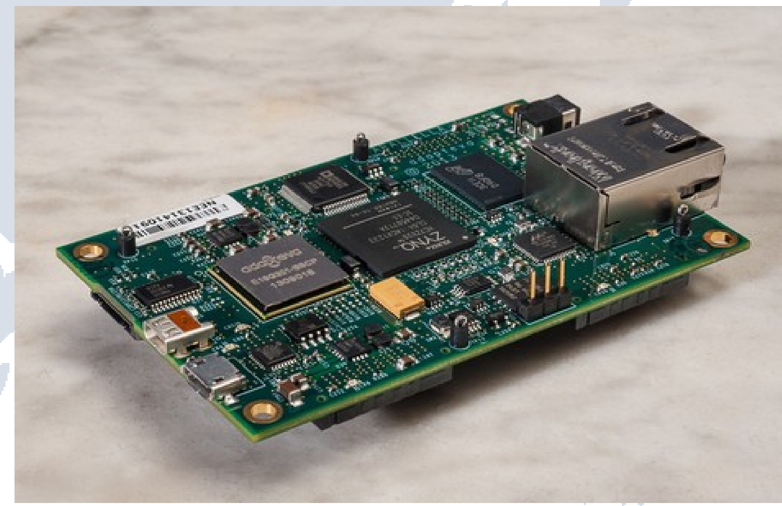
GNU/Linux: Programming For The *Future*

- “Beowulf” supercomputers
  - Non Uniform Memory Architecture (NUMA)
- GPUs – not just for graphics anymore
- Field Programmable Gate Arrays (FPGA)
- Quantum computing – noooooooooo!

Can we make the code *better*?

Adapteva's Parallella – 249 USD Supercomputer On A Card

- Zynq Z7020 System On a Chip:
  - Two core ARM 9 processor
  - Field Programmable Gate Array
  - Digital Signal Processing chips



- Epiphany: 16 or 64 core processor, each core having its own 32K of memory directly addressable, as well as direct access to other core's memory
- 5 W

Parallella In Detail

- Xilinx Zynq®-7000 All Programmable SoC (XC7Z010/XC7Z020)
  - Dual Core ARM A9 CPU
  - FPGA
  - DSPs
- Epiphany III (16 or 64-core CPU Accelerator)
- 1GB DDR3 SDRAM
- 128Mb Quad-SPI flash
- Ethernet 10/100/1000
- Micro HDMI connection
- Micro SD Card Slot
- Micro USB 2.0 (two)
- Dimensions are 3.4" x 2.1"

Categories Of Performance

- % Speedup
- Memory utilization
- Cache utilization
- Algorithm replacement
- Compiler Intrinsic creation
- Compiler performance improvements
- More categories?

What do we know/have today that we did not know/have 20-30 years ago?

Side Effects of Studying Performance

- Learn really cool assembly language
- Learn code analysis techniques
- Create better code overall
- Open Source Portfolio
- Possible university level course in optimization
- Research into new optimization techniques
  - Automatic detection of race conditions?

Resources

- “The Definitive Guide to GCC: 2nd Edition” by William von Hagen (Apress, 2006)
- “The Art of Debugging with GDB, DDD, and Eclipse” by Matloff and Salzmann (No Starch Press, 2008)
- “Valgrind 3.3: Advanced Debugging and Profiling for GNU/Linux applications” by Seward, Nethercote et. al. (Network Theory Ltd., 2008)

More Resources

- “ARM Assembly Language – an Introduction” by J.R. Gibson (Lulu, 2007)

And Now....Here In Argentina..

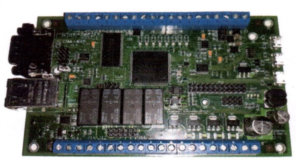
Computadora Industrial Abierta Argentina

www.proyecto-ciaa.com.ar

The CIAA Project: Argentine Open Industrial Computer

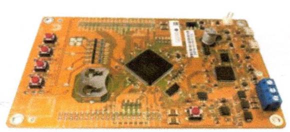
“The CIAA Project is an **open-source hardware and software initiative** driven by engineers and professors from several universities, public institutions and private companies around the country.

The main objective of this project is to incorporate added value to the electronics industry in Argentina, **providing design and implementation resources that are free *-libre-* to use for everyone**.

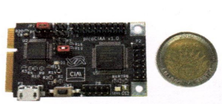


CIAA-NXP is the first hardware release of the project, based on NXP’s LPC4337 dual-core microcontroller.

Linux support!
See more:



EDU-CIAA is a low-cost educational version of the CIAA-NXP aimed to students and teachers.



picoCIAA is the smallest member of the family (mini PCI-Express format). It can provide Real-Time capabilities to existing systems.

Follow us! www.github.com/ciaa

@ProyectoCIAA

- **CIAA-Firmware** is the embedded software running on each CIAA board.
  - RTOS based on the OSEK-VDX standard.
  - C/C++ API.
  - Java and Python API.
  - Ladder (PLC-like) API.
  - Unit and functional tests.
  - www.github.com/ciaa/firmware
- **CIAA-IDE** is the Eclipse-based integrated development environment.
  - GCC ARM Embedded Toolchain.
  - GDB support.
  - OpenOCD debugger.

Supported OS

Follow us! www.github.com/ciaa

Questions, Comments, Ideas?

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