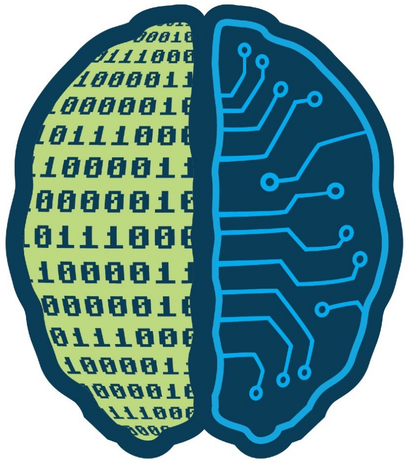


parallella

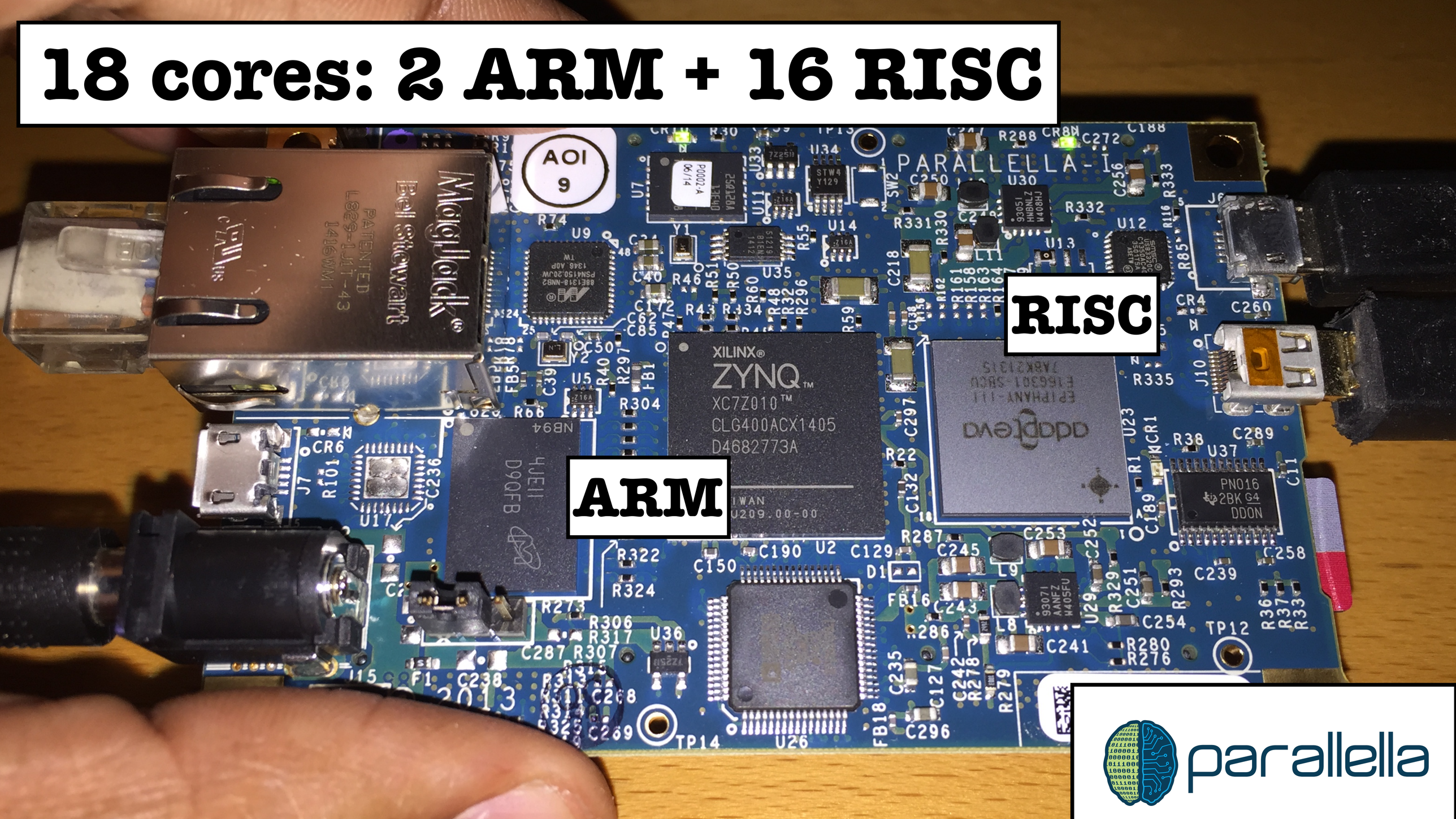
Supercomputing & Ruby

Confoo.CA Montreal, QB, Canada February 24-26, 2016 RayHightower.com

Our Journey…

- Why Parallelism?
- Concurrency vs Parallelism
- Parallella vs MacBook Pro
- More Cool Hardware
- Q & A

18 cores: 2 ARM + 16 RISC



WindyCityRails

WindyCityThings

RayHightower.com

WisdomGroup

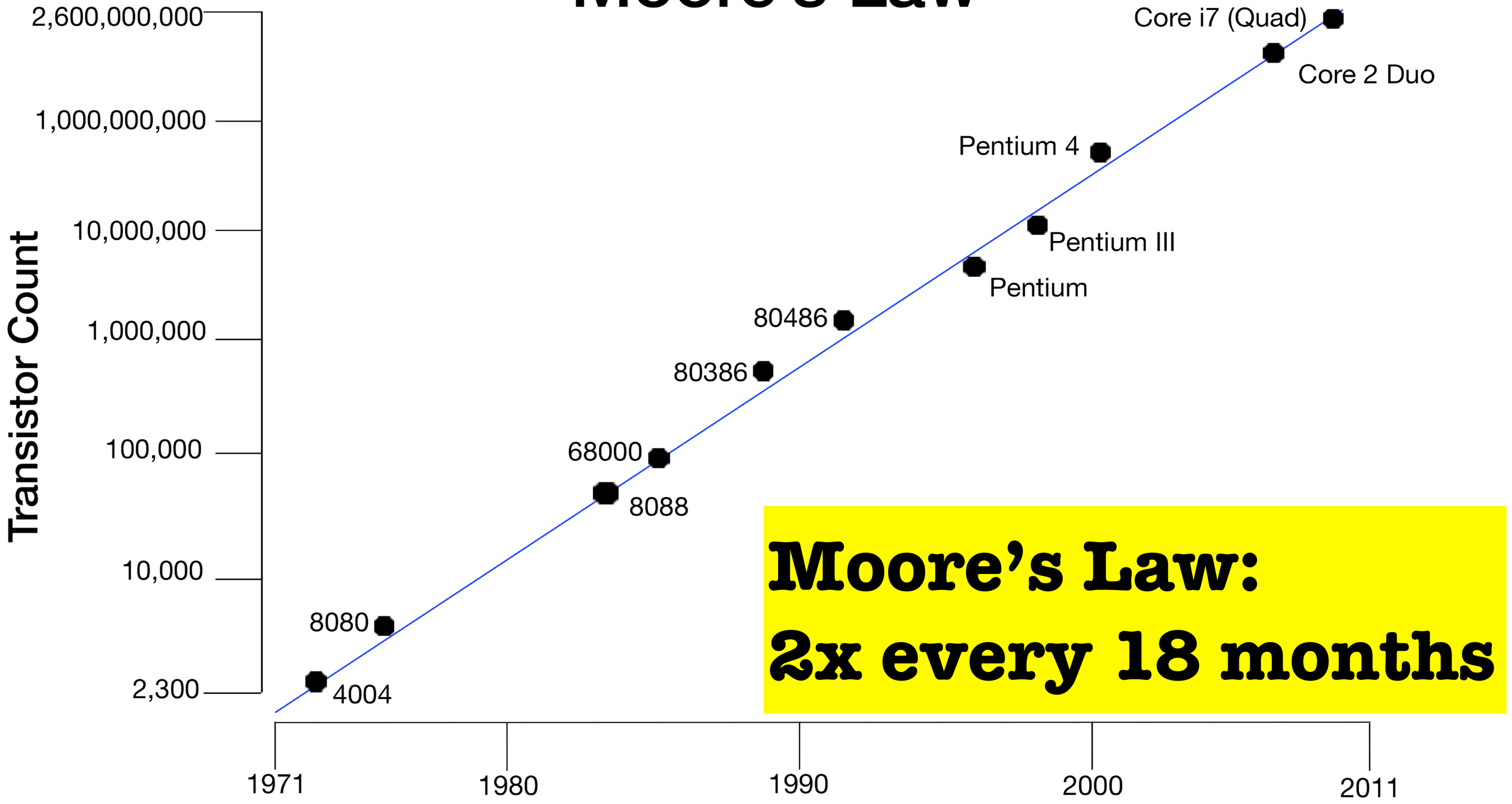
CHICAGO ruby

Why?

Faster is better.

Faster is better.

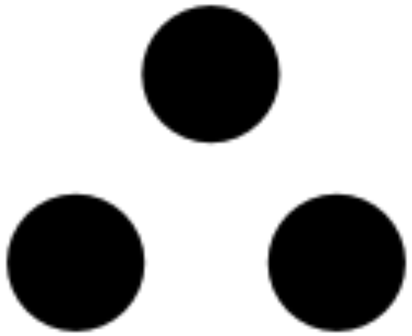
Moore's Law



Moore's Law:
2x every 18 months

Moore's Law:
2x every 18 months

http://www.washingtonpost.com/blogs/innovations/wp/2015/04/14/10-images-that-explain-the-incredible-power-of-moores-law/



Parallelism

Concurrency is not Parallelism.

-Rob Pike, Go

https://www.youtube.com/watch?v=cN_DpYBzKso&list=PLOnWKC1gI_OPU8SDIBnCLHsgzNLSbnPJQ&index=3

Concurrency

At least two threads are making progress.

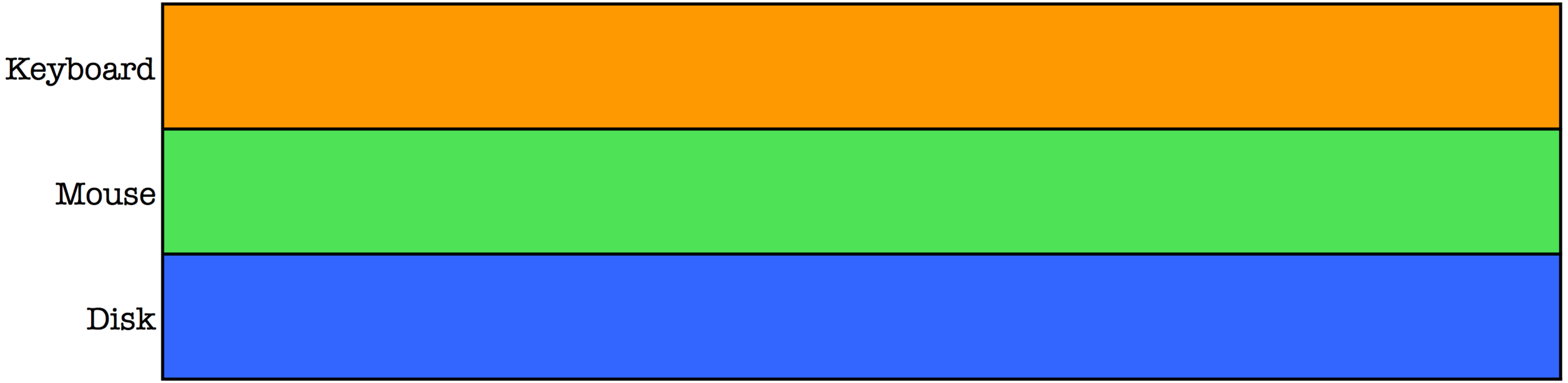
vs.

Parallelism

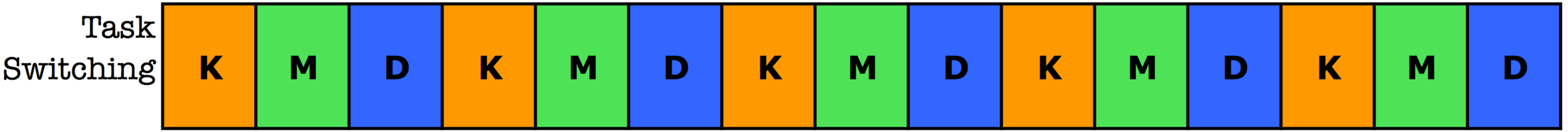
At least two threads are executing simultaneously.

Oracle Multithreaded Programming Guide
http://docs.oracle.com/cd/E19455-01/806-5257/6je9h032b/index.html

Parallelism



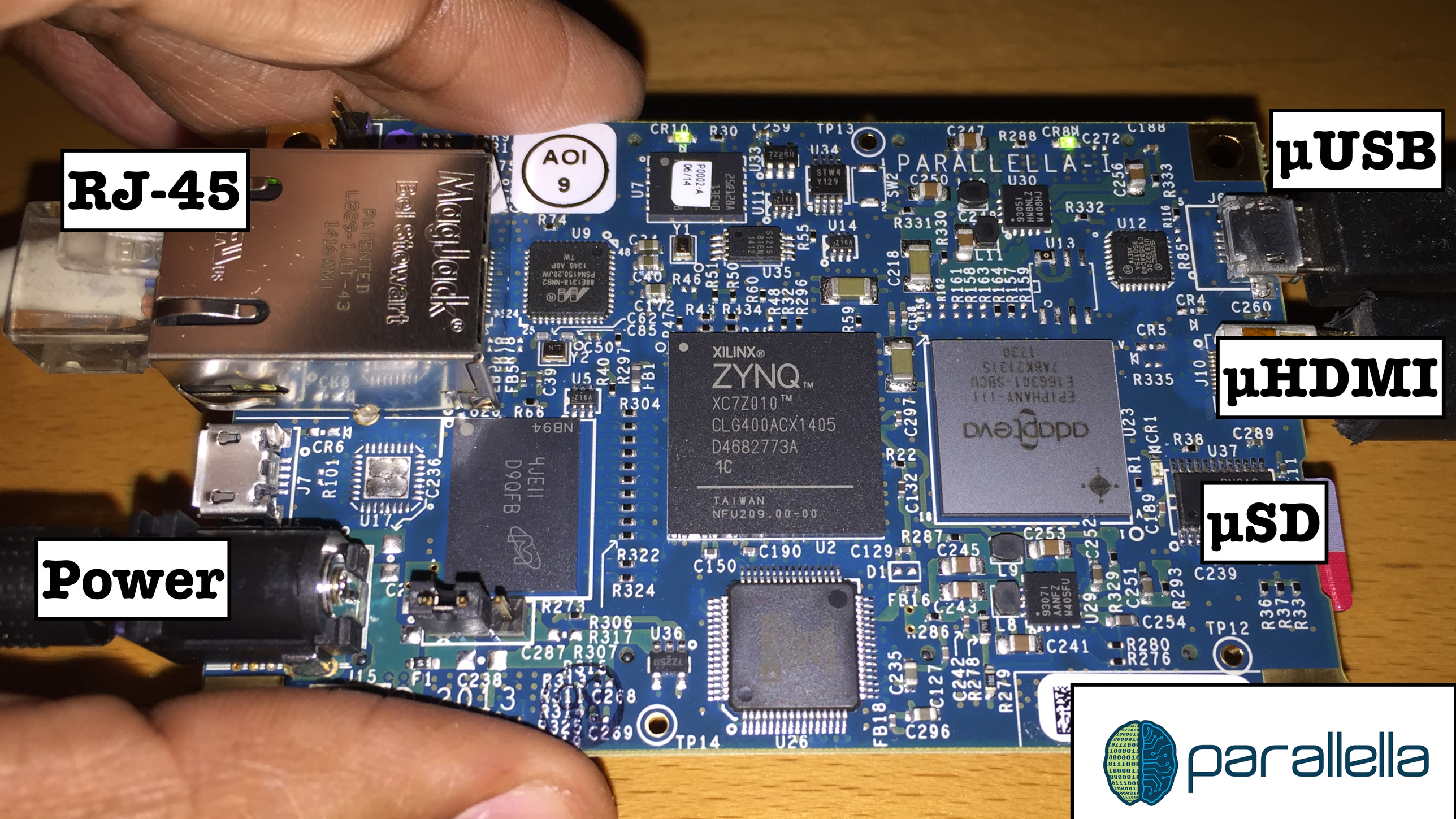
Concurrency

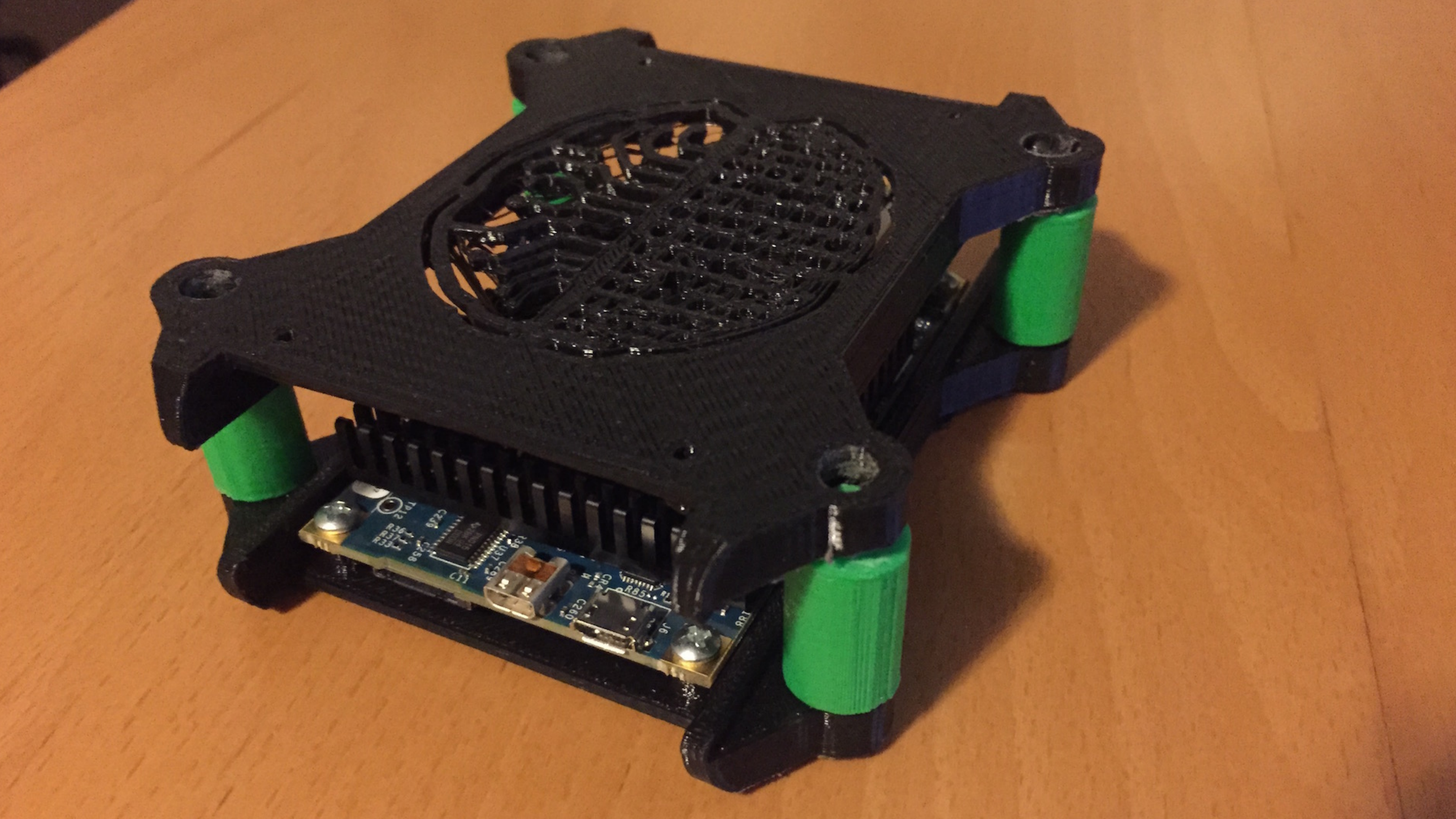


Time =====>

If one ox could not do the job they did not try to grow a bigger ox, but used two oxen. When we need greater computer power, the answer is not to get a bigger computer, but to build systems of computers and operate them in parallel.

-Grace Hopper


RJ-45
µUSB
µHDMI
µSD
Power
PARALLELLA-I
XILINX
ZYNQ
XC7Z010
CLG400ACX1405
D4682773A
1C
TAIWAN
NFU209.00-00
parallella



Parallella case and cluster

Raymond T.

www.thingiverse.com/thing:892684

Apps | WindyCityRails | RubyCaribe | Ruby | iOS | Biz | Tools | DevComm | Theory | RTHv | Admin

MakerBot Thingiverse | DASHBOARD | EXPLORE | CREATE | Enter a search term | SIGN IN / JOIN

Parallella case and cluster files

by suzannejmatthews, published Jun 22, 2015

Like 13

Collect 12

Comment 0

I Made One 1

Remix It 0

Share

Download This Thing!

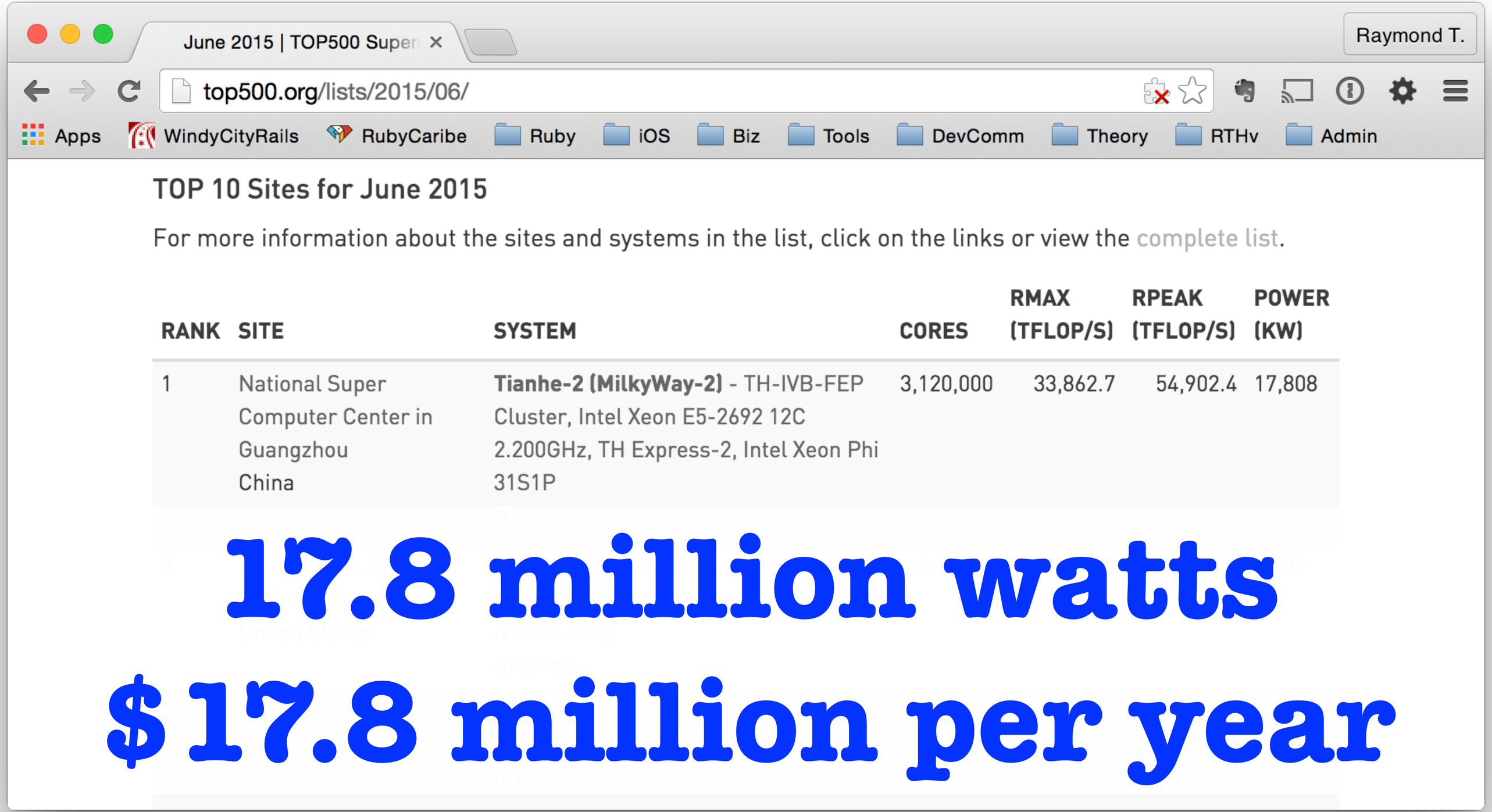

LX
Terminal
Firefox
parallella
[LXTerminal]
[Massively Paral...
22:11

Watts & Dollars

TOP 10 Sites for June 2015

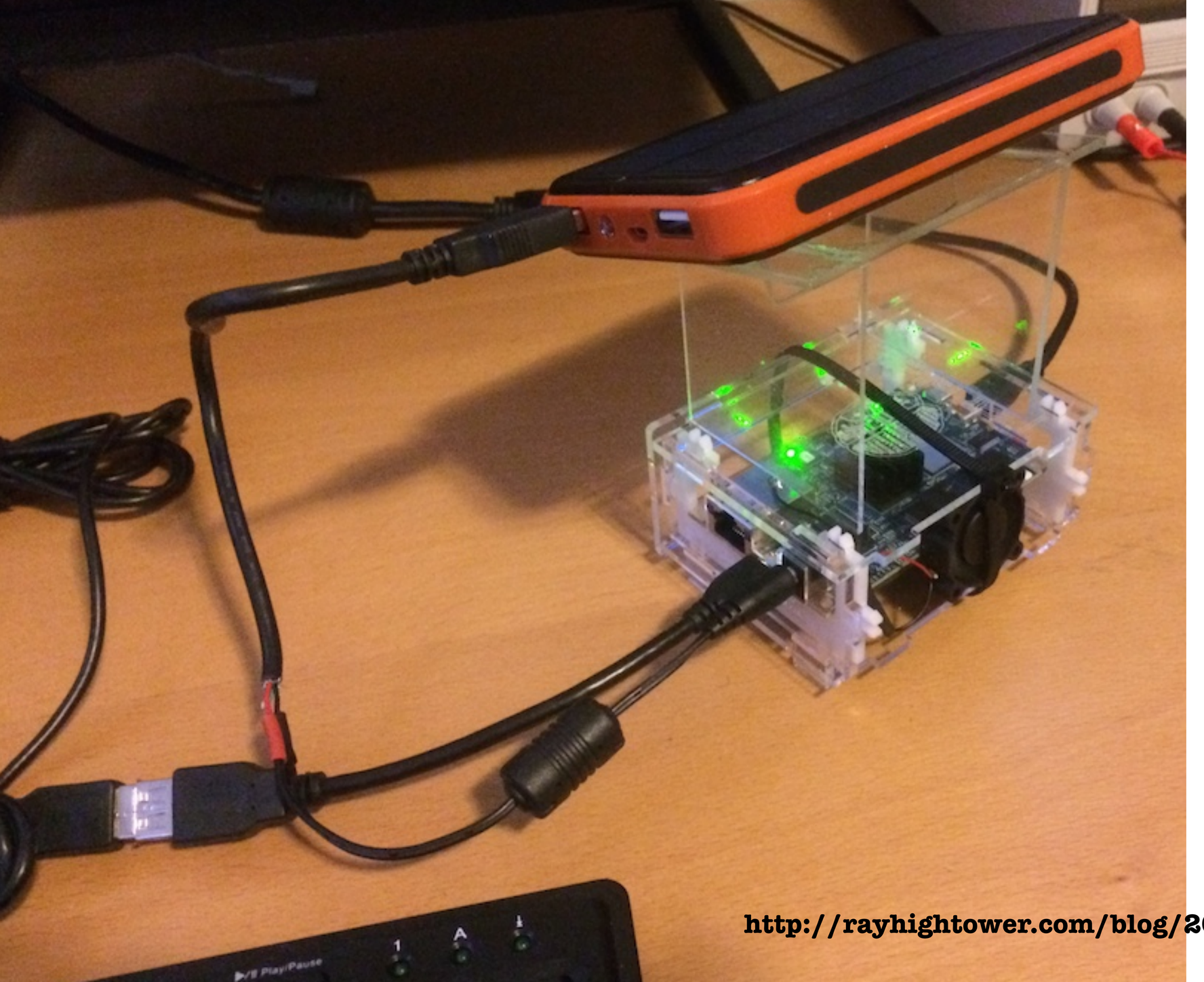
For more information about the sites and systems in the list, click on the links or view the complete list.

RANK	SITE	SYSTEM	CORES	RMAX (TFLOP/S)	RPEAK (TFLOP/S)	POWER (KW)
1	National Super Computer Center in Guangzhou China	**Tianhe-2 (MilkyWay-2)** - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P NUDT	3,120,000	33,862.7	54,902.4	17,808
2	DOE/SC/Oak Ridge National Laboratory United States	**Titan** - Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x Cray Inc.	560,640	17,590.0	27,112.5	8,209
3	DOE/NNSA/LLNL United States	**Sequoia** - BlueGene/Q, Power BQC 16C 1.60 GHz, Custom IBM	1,572,864	17,173.2	20,132.7	7,890


June 2015 | TOP500 Super
Raymond T.
top500.org/lists/2015/06/
Apps
WindyCityRails
RubyCaribe
Ruby
iOS
Biz
Tools
DevComm
Theory
RTHv
Admin
TOP 10 Sites for June 2015
For more information about the sites and systems in the list, click on the links or view the complete list.
RANK
SITE
SYSTEM
CORES
RMAX (TFLOP/S)
RPEAK (TFLOP/S)
POWER (KW)
1
National Super Computer Center in Guangzhou China
Tianhe-2 (MilkyWay-2) - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P
3,120,000
33,862.7
54,902.4
17,808
17.8 million watts
$17.8 million per year

5 watts for Parallella?


http://rayhightower.com/blog/2014/09/09/solar-powered-parallella/



5 volts
1 amp
5 watts

Solar!

http://rayhightower.com/blog/2014/09/09/solar-powered-parallella/

RISC

Reduced Instruction Set Computer

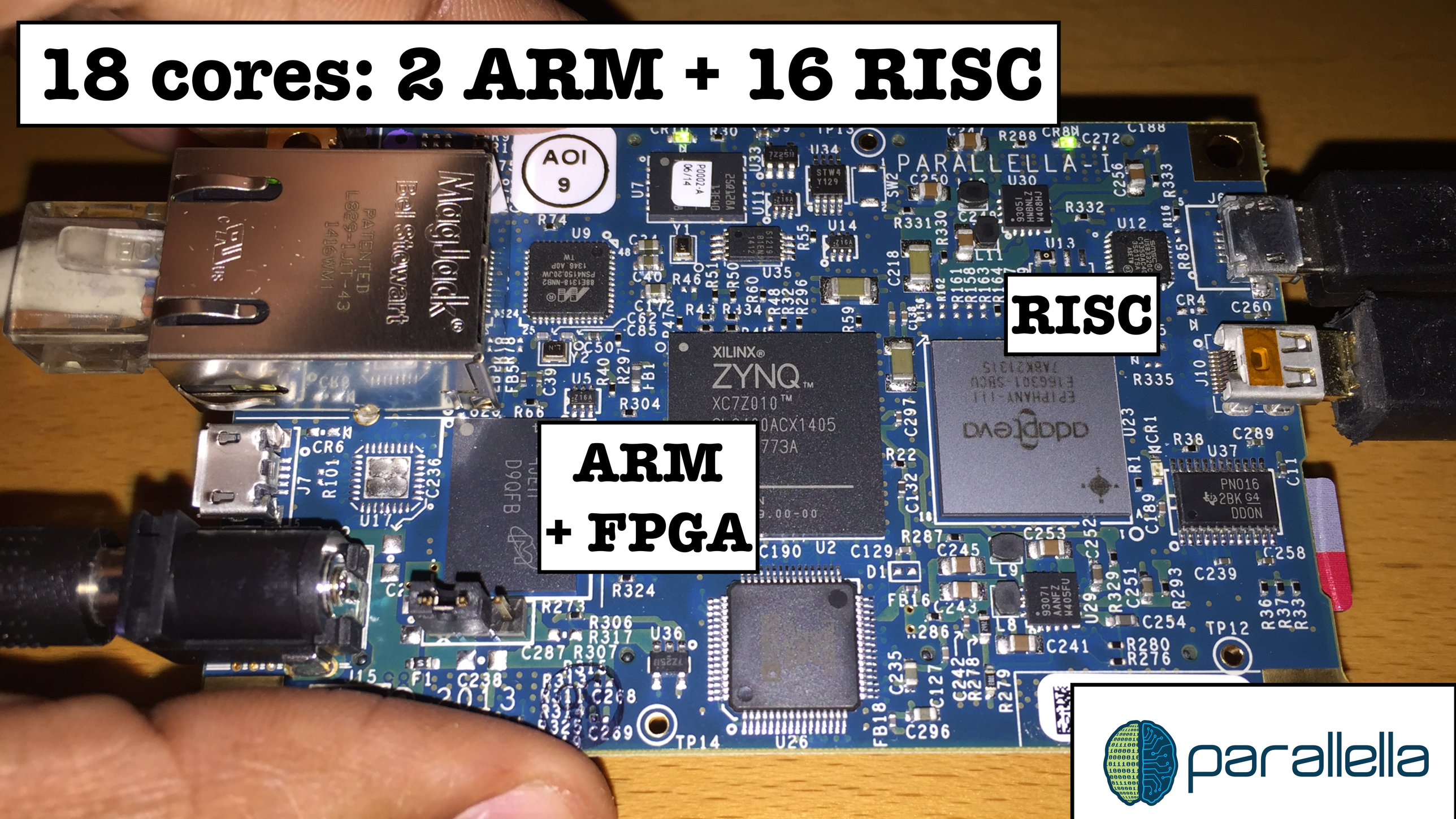
ARM

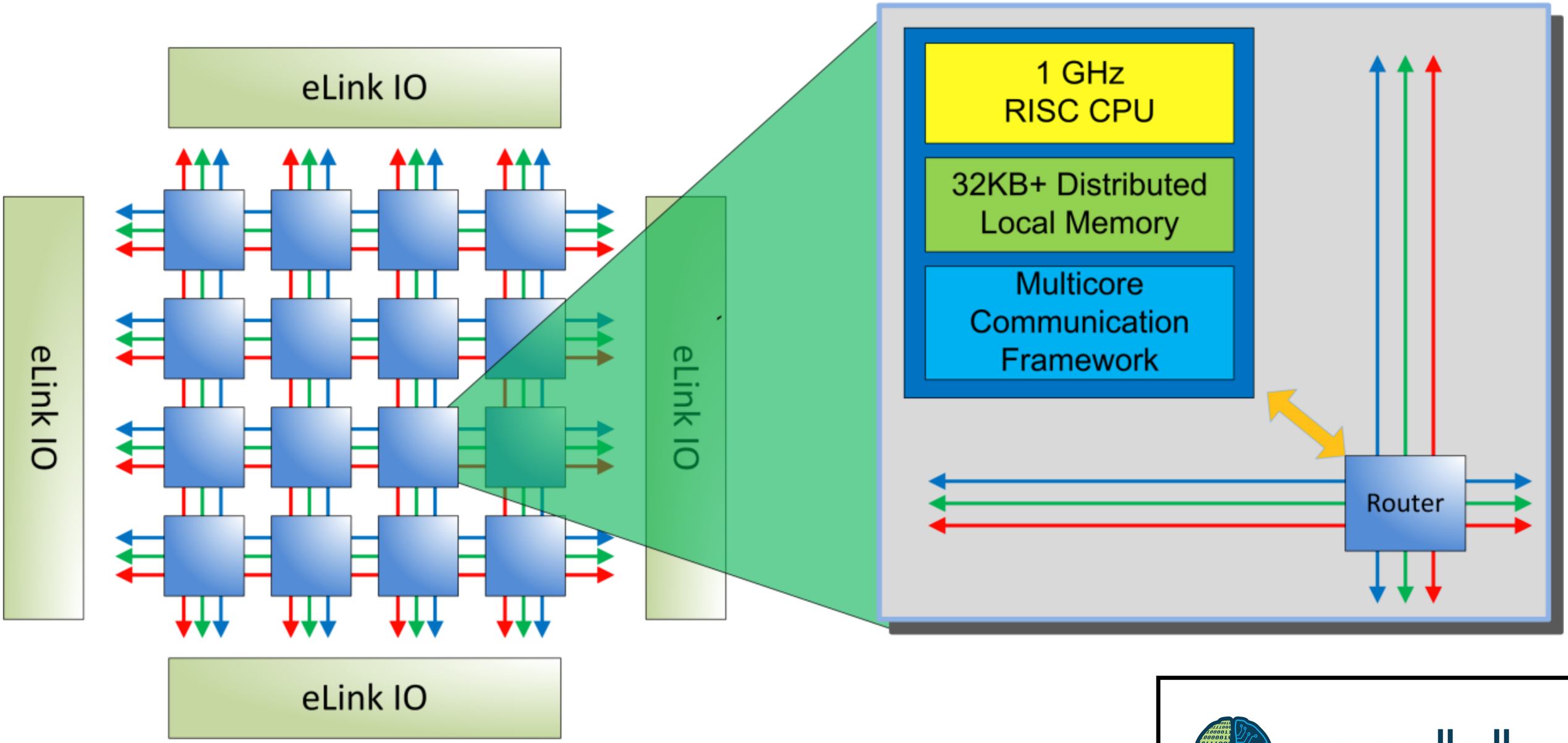
Advanced
(or Acorn)
RISC
Machine

FPGA

Field
Programmable
Gate
Array

18 cores: 2 ARM + 16 RISC




eLink IO
eLink IO
eLink IO
eLink IO
1 GHz
RISC CPU
32KB+ Distributed
Local Memory
Multicore
Communication
Framework
Router

parallella

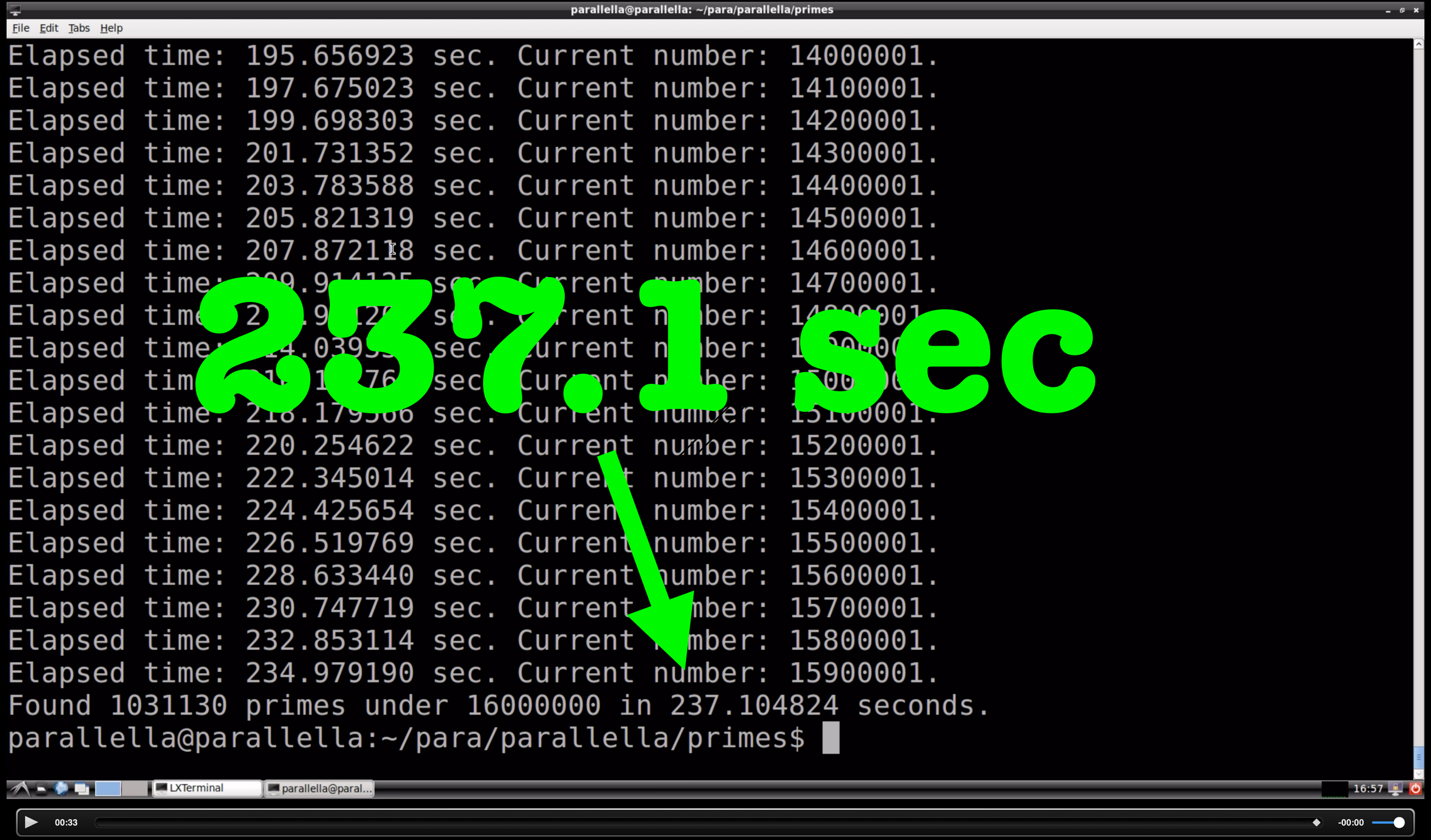
Find all primes up to 16,000,000. Serial on Parallella.

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <time.h>

#define DEFAULT_MAX_TESTS 16000000

inline int isprime(unsigned long number)
{
  unsigned long i;
  unsigned long s = sqrt(number);
  for(i=3;i<=s;i+=2)
  {
    if(number % i == 0)
      return 0;
  }
  return 1;
}
```

```
 8 inline int isprime(unsigned long number)
 9 {
10   unsigned long i;
11   unsigned long s = sqrt(number);
12   for(i=3;i<=s;i+=2)
13   {
14     if(number % i == 0)
15       return 0;
16   }
17   return 1;
18 }
```

File Edit Tabs Help

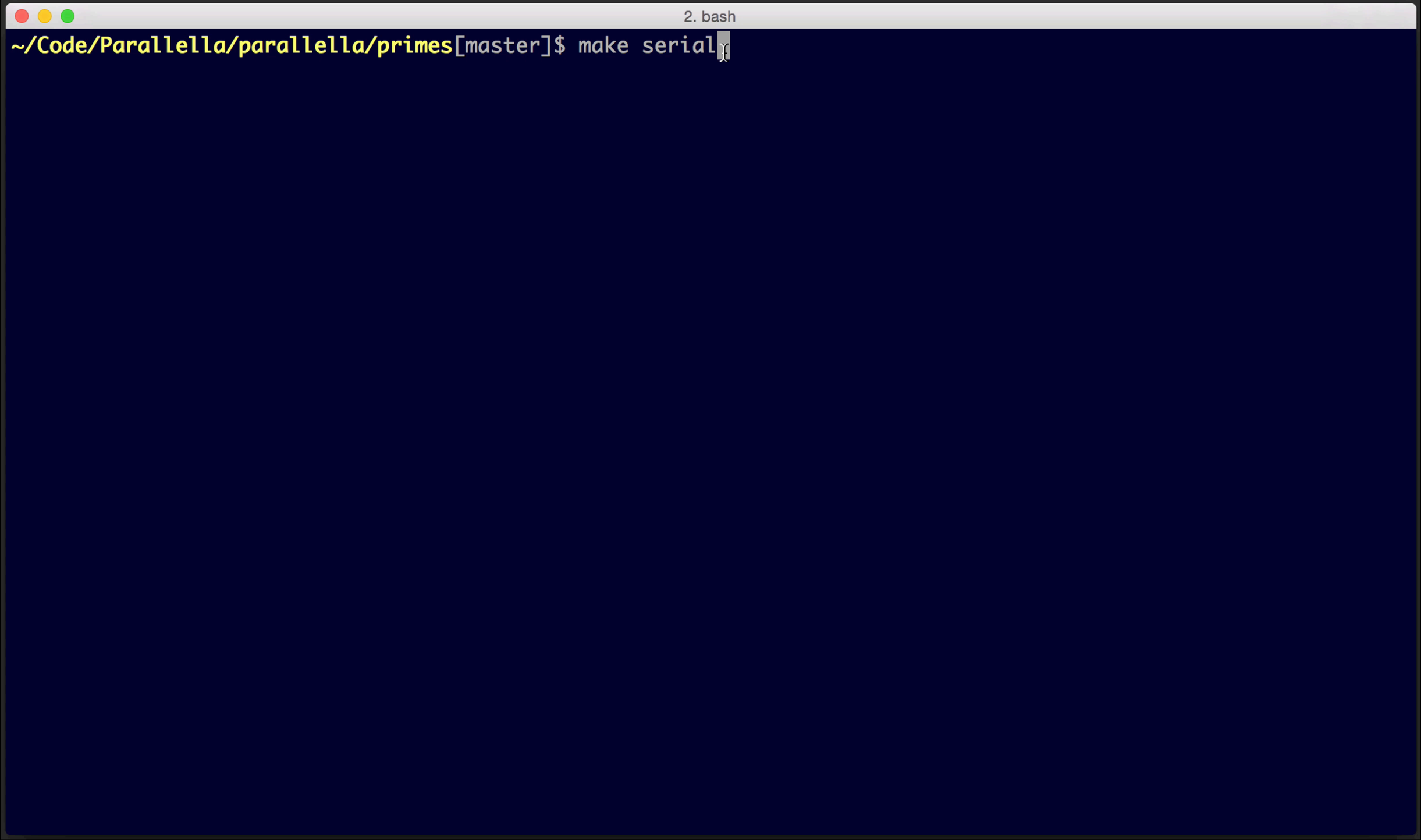
```
parallella@parallella:~/para/parallella/primes$ ./primes
```

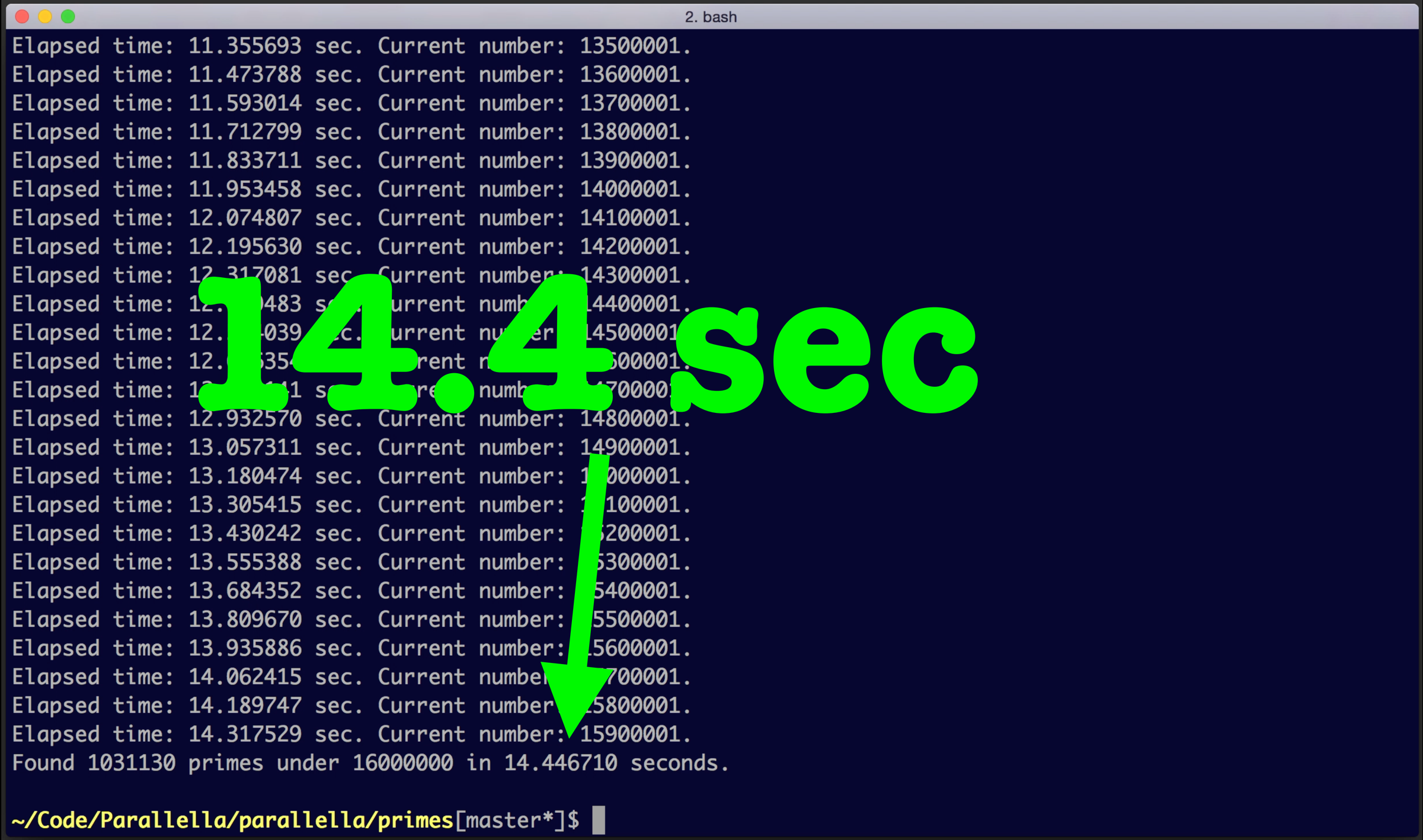

parallella@parallella: ~/para/parallella/primes
File Edit Tabs Help
Elapsed time: 195.656923 sec. Current number: 14000001.
Elapsed time: 197.675023 sec. Current number: 14100001.
Elapsed time: 199.698303 sec. Current number: 14200001.
Elapsed time: 201.731352 sec. Current number: 14300001.
Elapsed time: 203.783588 sec. Current number: 14400001.
Elapsed time: 205.821319 sec. Current number: 14500001.
Elapsed time: 207.872118 sec. Current number: 14600001.
Elapsed time: 209.914135 sec. Current number: 14700001.
Elapsed time: 211.976 sec. Current number: 14800001.
Elapsed time: 214.039 sec. Current number: 14900001.
Elapsed time: 216.1 sec. Current number: 15000001.
Elapsed time: 218.179566 sec. Current number: 15100001.
Elapsed time: 220.254622 sec. Current number: 15200001.
Elapsed time: 222.345014 sec. Current number: 15300001.
Elapsed time: 224.425654 sec. Current number: 15400001.
Elapsed time: 226.519769 sec. Current number: 15500001.
Elapsed time: 228.633440 sec. Current number: 15600001.
Elapsed time: 230.747719 sec. Current number: 15700001.
Elapsed time: 232.853114 sec. Current number: 15800001.
Elapsed time: 234.979190 sec. Current number: 15900001.
Found 1031130 primes under 16000000 in 237.104824 seconds.
parallella@parallella:~/para/parallella/primes$
237.1sec
LXTerminal
parallella@paral...
16:57
00:33
-00:00

Find all primes up to 16,000,000. Serial on Mac OS X.

Same serial code, written in C.

Build it on OS X.


2. bash
~/Code/Parallella/parallella/primes[master]$ make serial

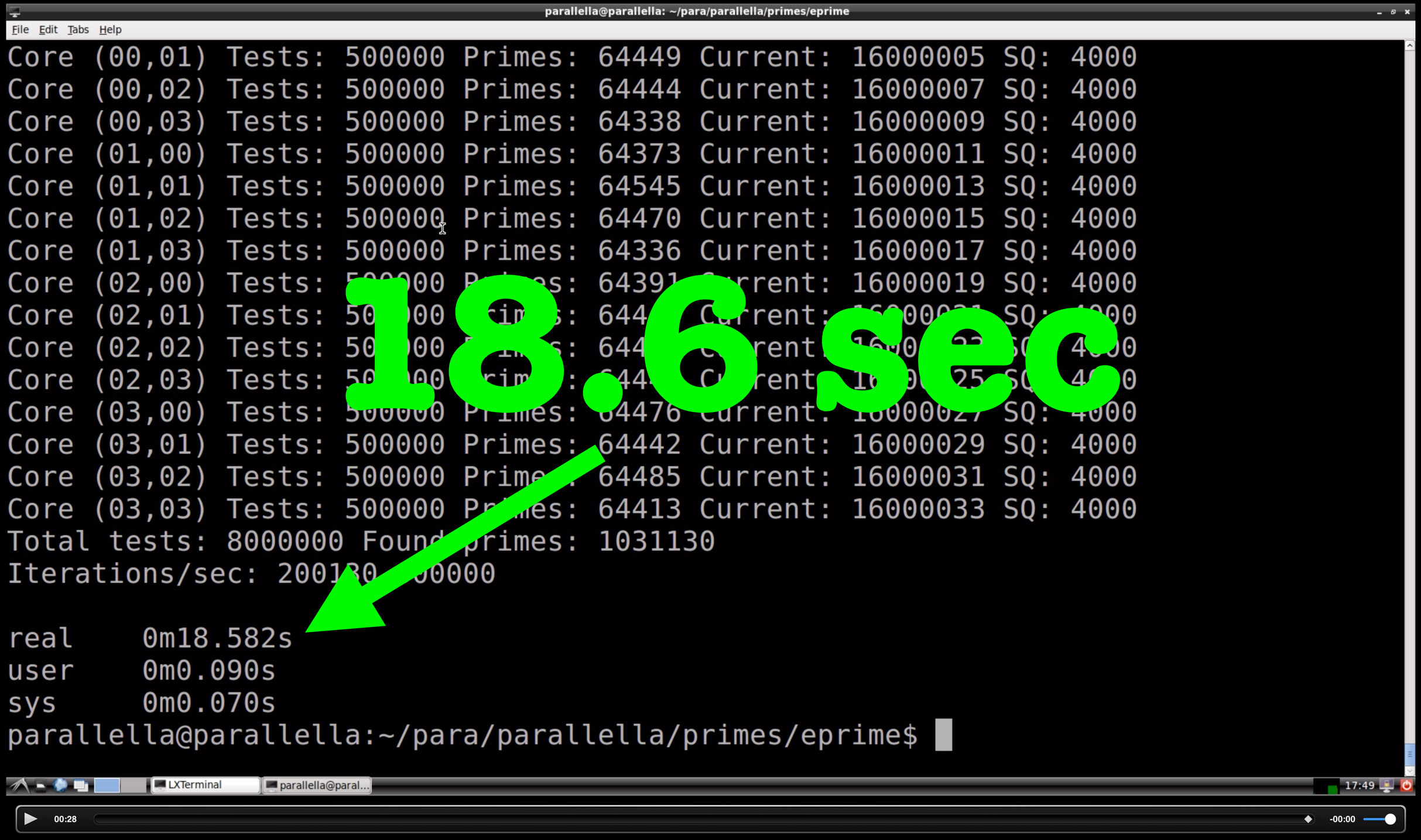

2. bash
Elapsed time: 11.355693 sec. Current number: 13500001.
Elapsed time: 11.473788 sec. Current number: 13600001.
Elapsed time: 11.593014 sec. Current number: 13700001.
Elapsed time: 11.712799 sec. Current number: 13800001.
Elapsed time: 11.833711 sec. Current number: 13900001.
Elapsed time: 11.953458 sec. Current number: 14000001.
Elapsed time: 12.074807 sec. Current number: 14100001.
Elapsed time: 12.195630 sec. Current number: 14200001.
14.4sec
Elapsed time: 12.932570 sec. Current number: 14800001.
Elapsed time: 13.057311 sec. Current number: 14900001.
Found 1031130 primes under 16000000 in 14.446710 seconds.
~/Code/Parallella/parallella/primes[master*]$

Find all primes
up to 16,000,000.
Parallel on Parallella.

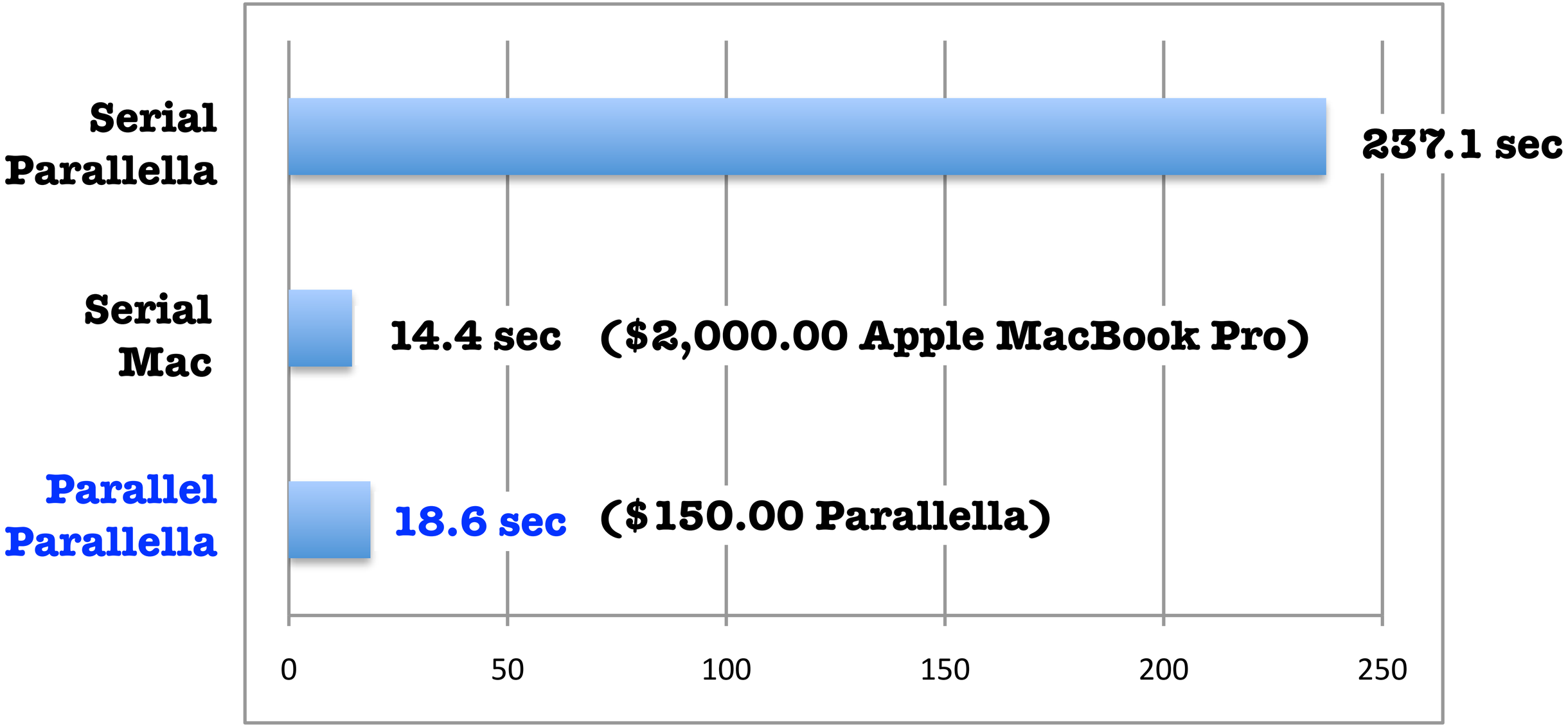
```
27 #include <e-hal.h>
28
29 // Default max number of prime tests per core
30 // Used if a limit it not provided in argv[1]
31 #define DEFAULT_MAX_TESTS 500000
32
33 int main(int argc, char *argv[])
34 {
35   unsigned row, col, coreid, i, j;
36   e_platform_t platform;
37   e_epiphany_t dev;
38
```

File Edit Tabs Help

```
parallella@parallella:~/para/parallella/primes/eprime$ time ./run.sh
```


parallella@parallella: ~/para/parallella/primes/eprime
File Edit Tabs Help
Core (00,01) Tests: 500000 Primes: 64449 Current: 16000005 SQ: 4000
Core (00,02) Tests: 500000 Primes: 64444 Current: 16000007 SQ: 4000
Core (00,03) Tests: 500000 Primes: 64338 Current: 16000009 SQ: 4000
Core (01,00) Tests: 500000 Primes: 64373 Current: 16000011 SQ: 4000
Core (01,01) Tests: 500000 Primes: 64545 Current: 16000013 SQ: 4000
Core (01,02) Tests: 500000 Primes: 64470 Current: 16000015 SQ: 4000
Core (01,03) Tests: 500000 Primes: 64336 Current: 16000017 SQ: 4000
Core (02,00) Tests:
Core (02,01) Tests:
Core (02,02) Tests:
Core (02,03) Tests:
Core (03,00) Tests:
Core (03,01) Tests: 500000 Primes: 64442 Current: 16000029 SQ: 4000
Core (03,02) Tests: 500000 Prime
Core (03,03) Tests: 500000 P
Total tests: 8000000 Found
Iterations/sec:
18.6sec
real 0m18.582s
user 0m0.090s
sys 0m0.070s
parallella@parallella:~/para/parallella/primes/eprime$
LXTerminal
parallella@paral...
17:49
00:28
-00:00

Summary: Finding Primes

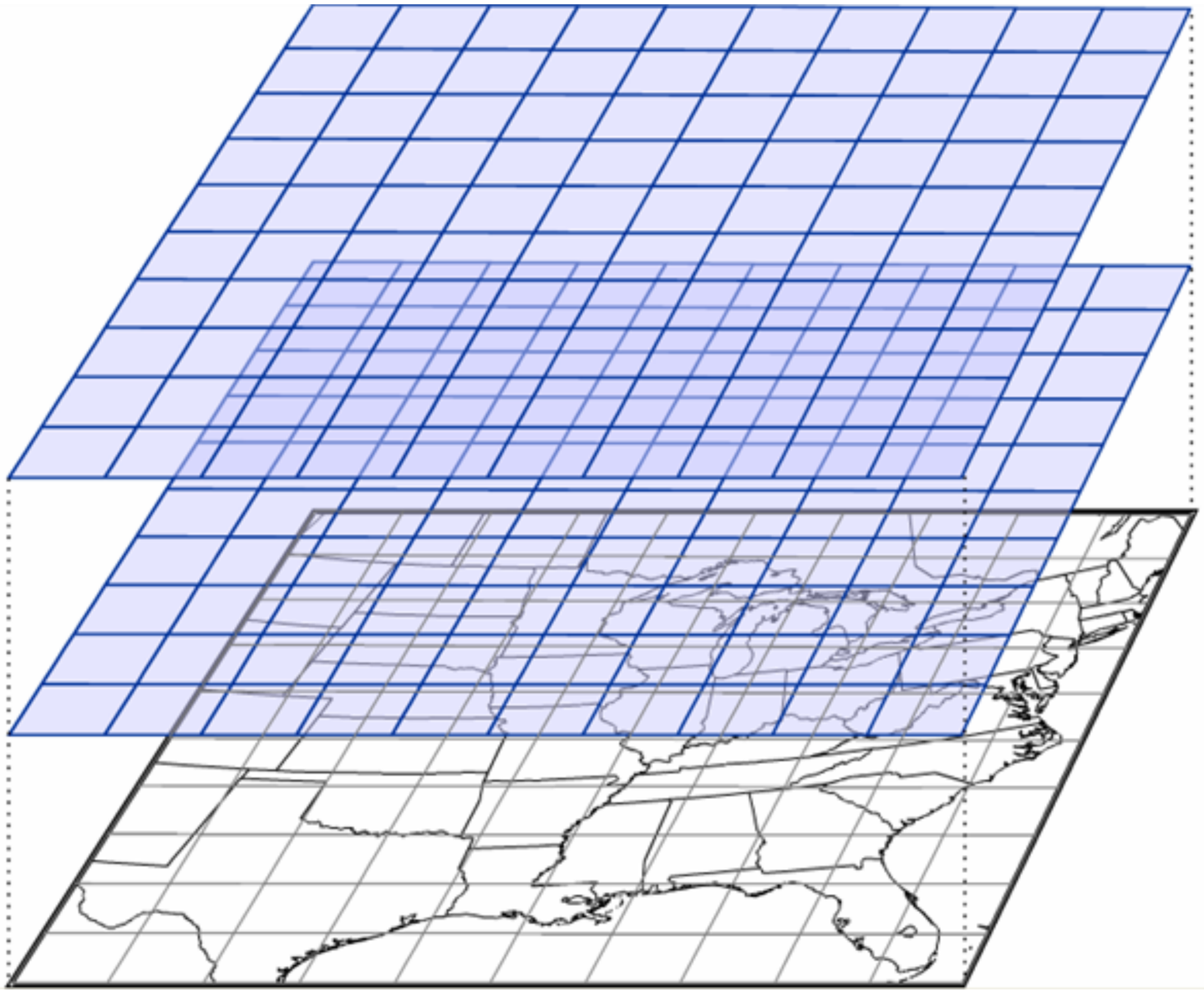


Embarrassingly parallel problem.

Mandelbrot Set


LX
Terminal
Firefox
parallella
19:27

Why?



Weather Prediction

Grid spacing influences accuracy.

https://www.e-education.psu.edu/worldofweather/node/2029

Where can Ruby (or Python, Node.js, Erlang, etc.) fit?

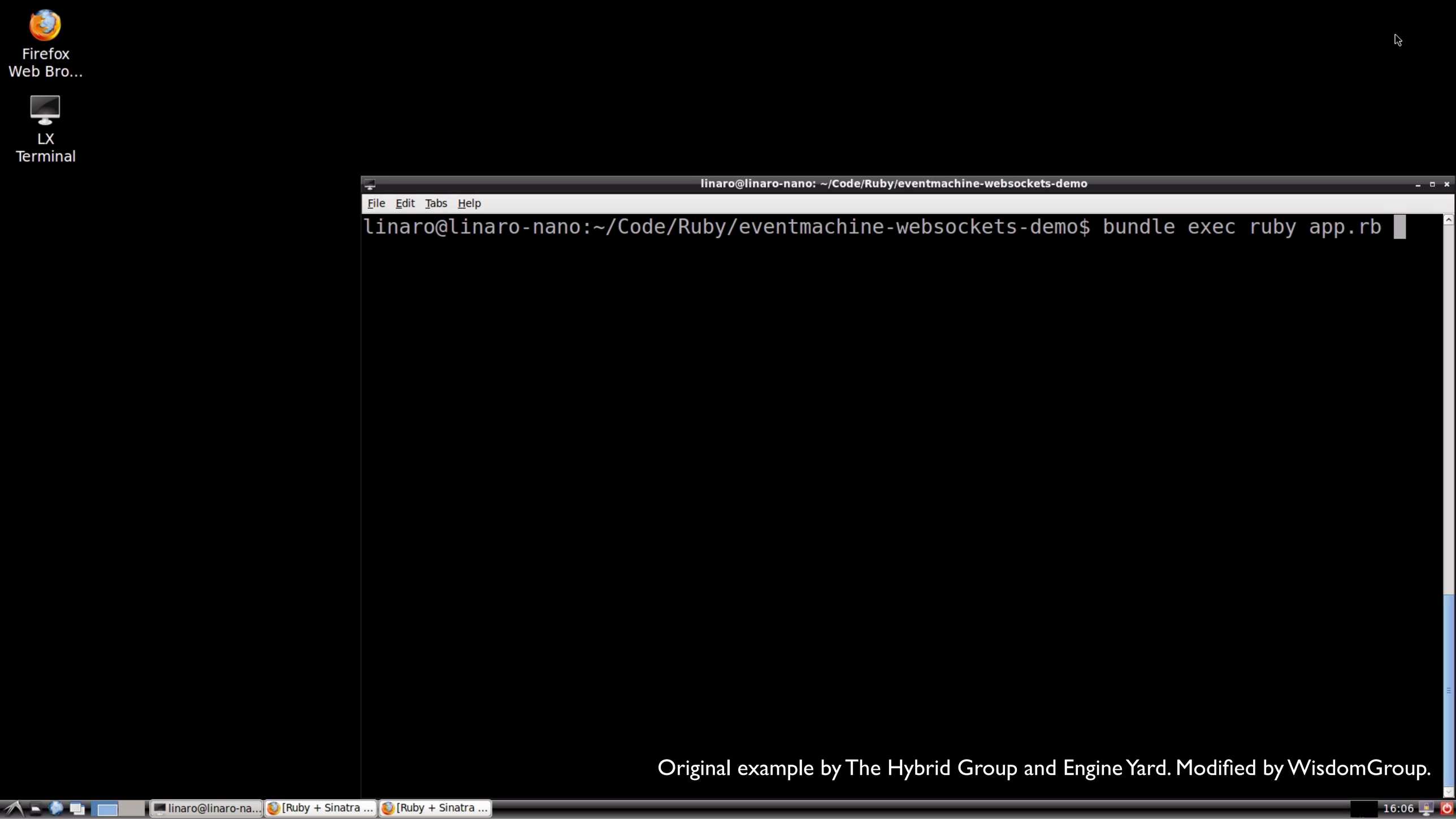
Ruby

+

Sinatra

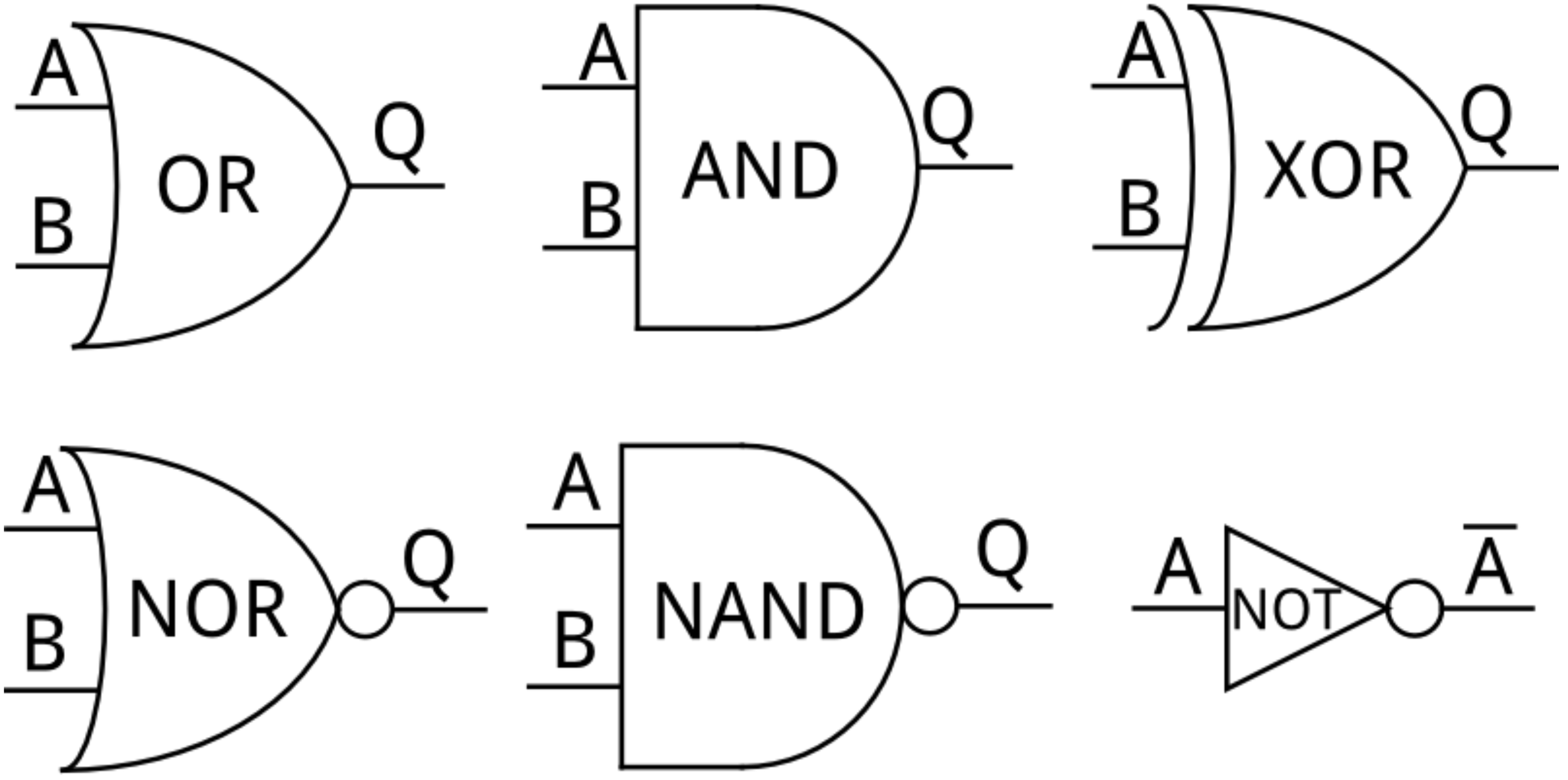
+

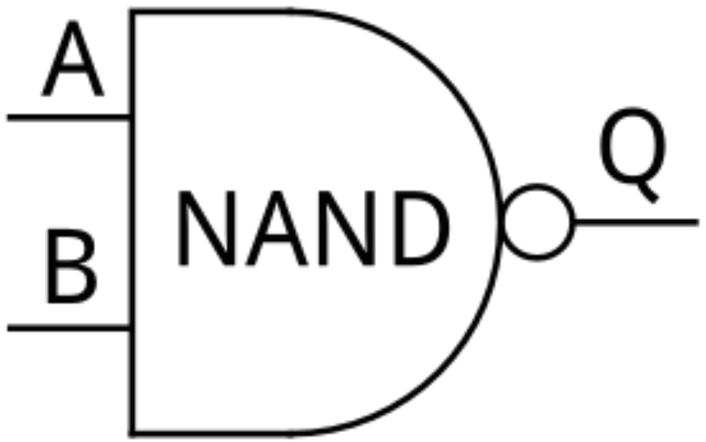
WebSockets


Firefox Web Bro...
LX Terminal
linaro@linaro-nano: ~/Code/Ruby/eventmachine-websockets-demo
File Edit Tabs Help
linaro@linaro-nano:~/Code/Ruby/eventmachine-websockets-demo$ bundle exec ruby app.rb
Original example by The Hybrid Group and Engine Yard. Modified by WisdomGroup.
linaro@linaro-na...
[Ruby + Sinatra ...
[Ruby + Sinatra ...
16:06

FPGA

Field
Programmable
Gate
Array


A
B
OR
Q
A
B
AND
Q
A
B
XOR
Q
A
B
NOR
Q
A
B
NAND
Q
A
NOT
$\overline{A}$



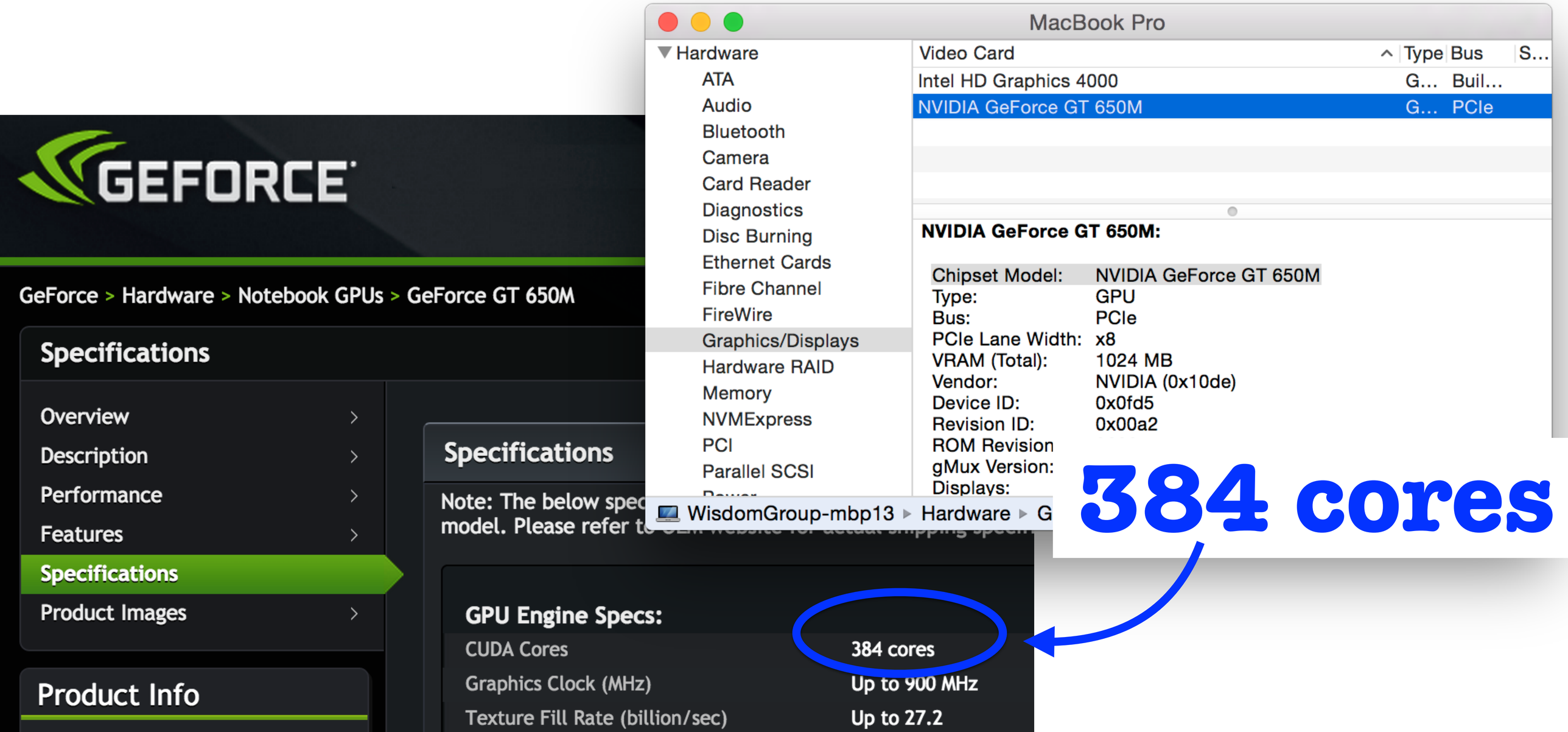
AB	Q
00	1
01	1
10	1
11	0

FPGA Uses...

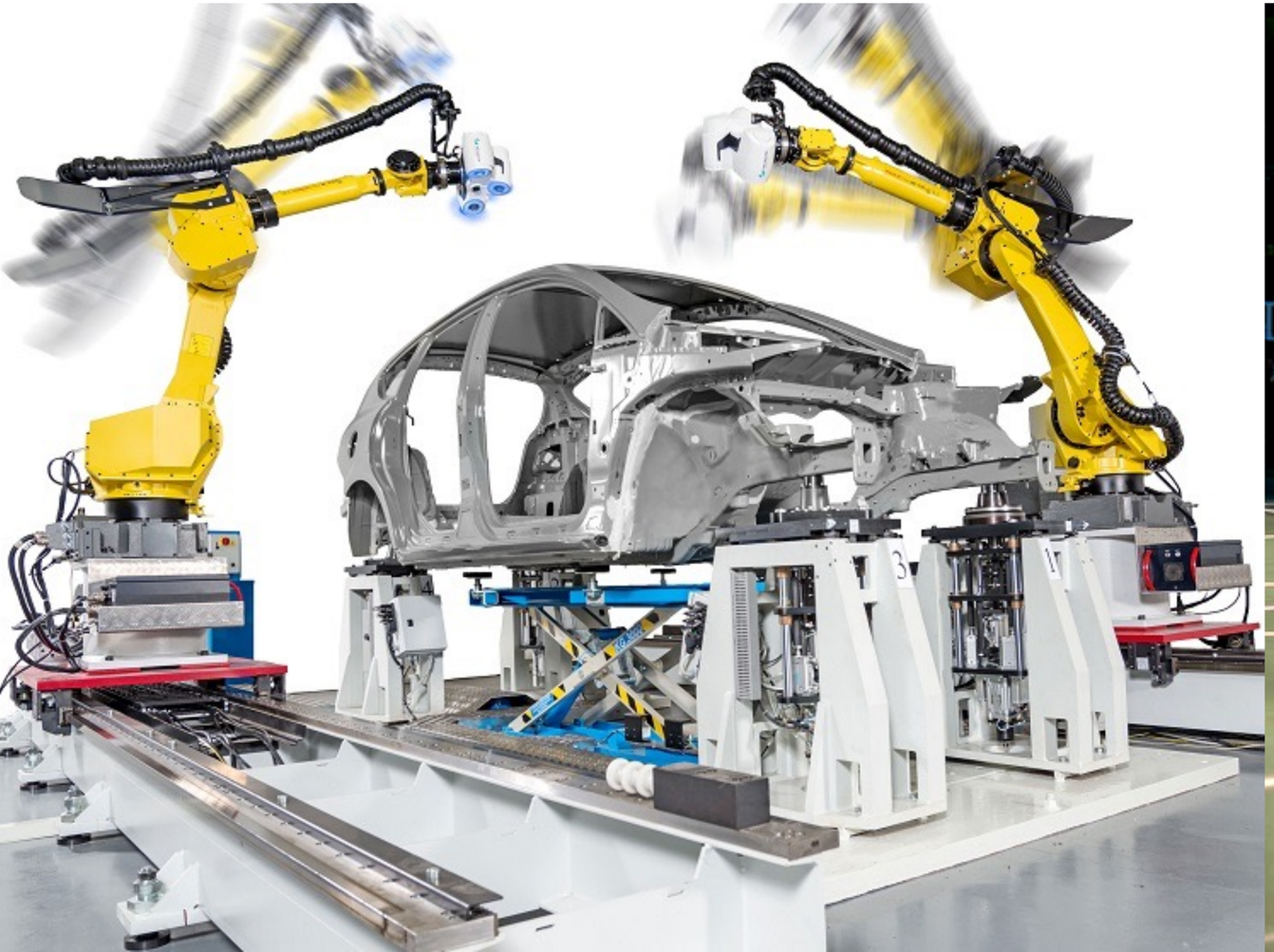
- Cable boxes
- Finance: High-freq trading
- Routers
- Health care: MRIs, CAT scanners
- Cell phone towers
- Anything with lots of connections
- HDMI interface on Parallella.

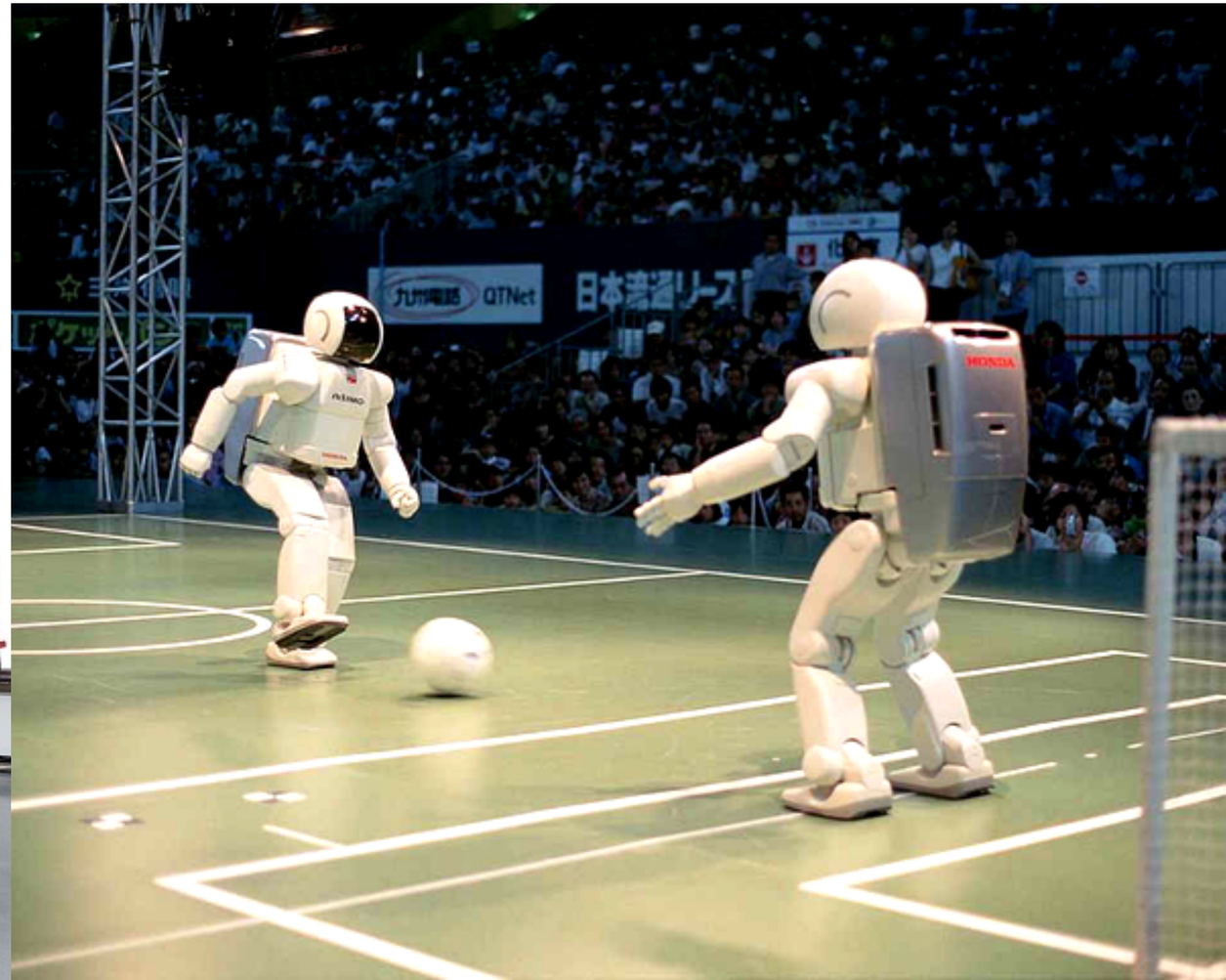
Parallella vs GPU

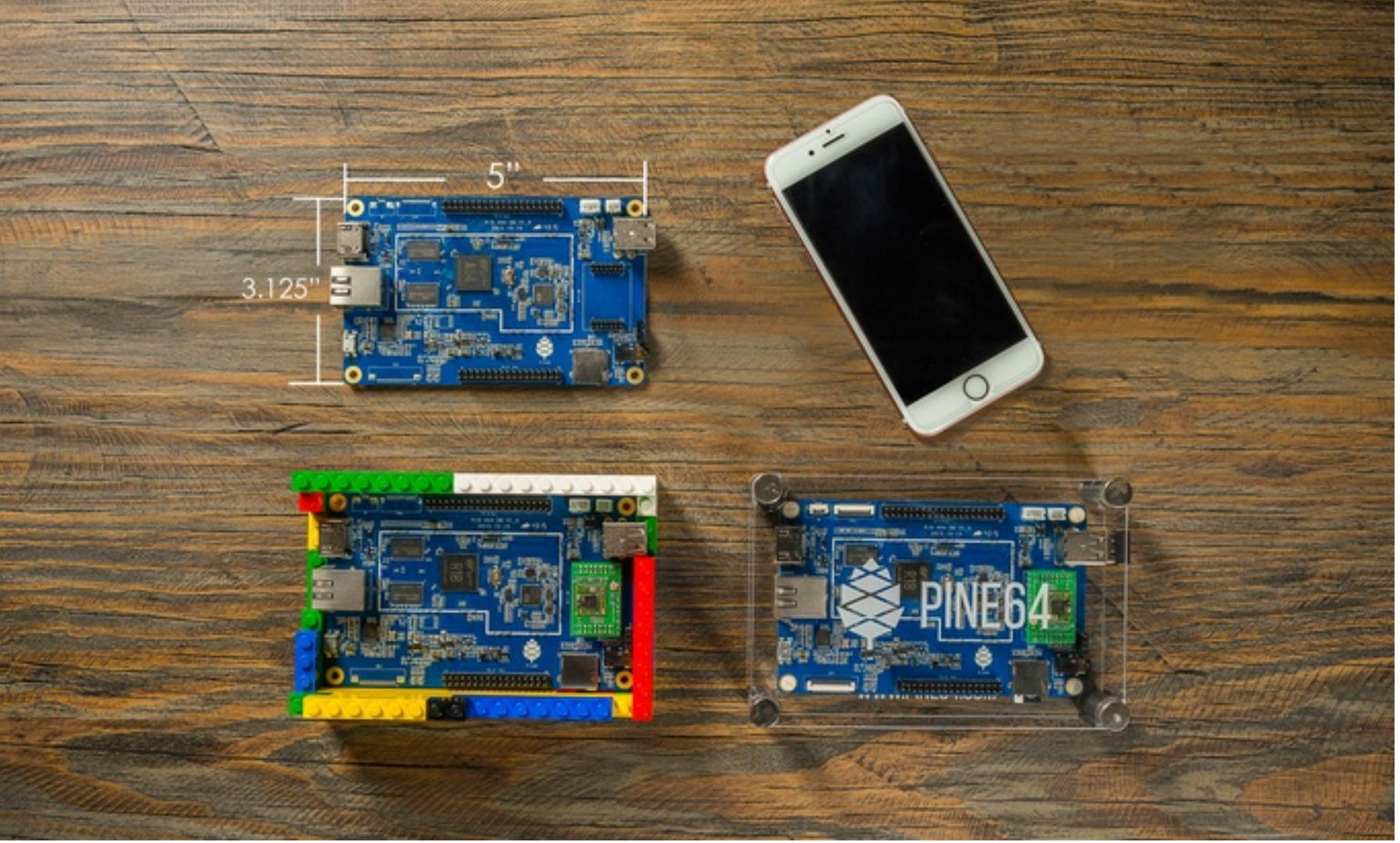
MacBook Pro Video



Specialized vs. General







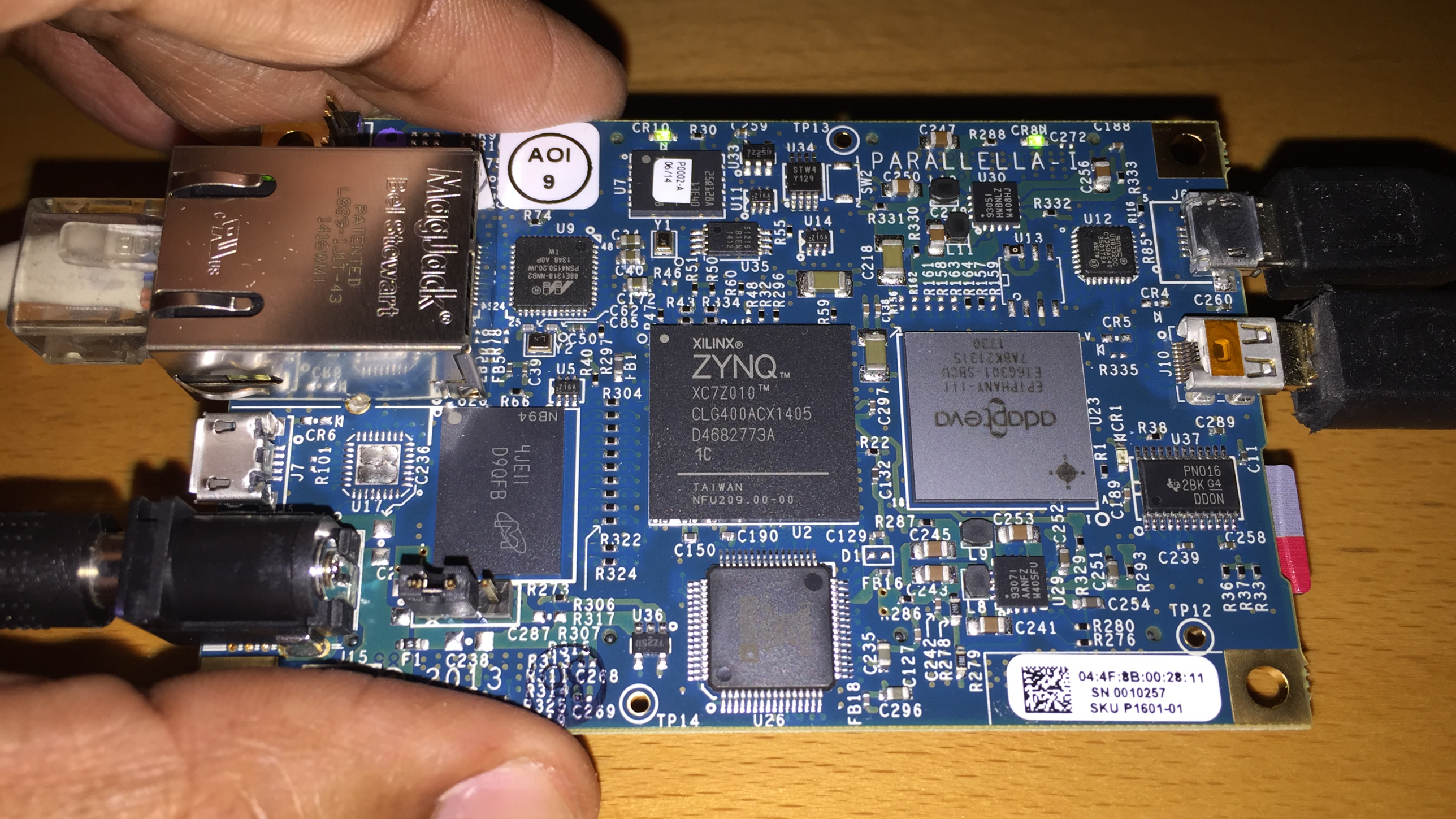
Pine A64

4 cores

64-bit

$15.00

Something new for you...


PARALLELLA-I
XILINX
ZYNQ
XC7Z010
CLG400ACX1405
D4682773A
1C
TAIWAN
NFU209.00-00
04:4F:8B:00:28:11
SN 0010257
SKU P1601-01

Merci!

WindyCityRails

WindyCityThings

RayHightower.com