

INTRODUCING THE ODROID-C1

A POWERFUL RASPBERRY PI REPLACEMENT

by Ruppi Kim and Kevin Kim

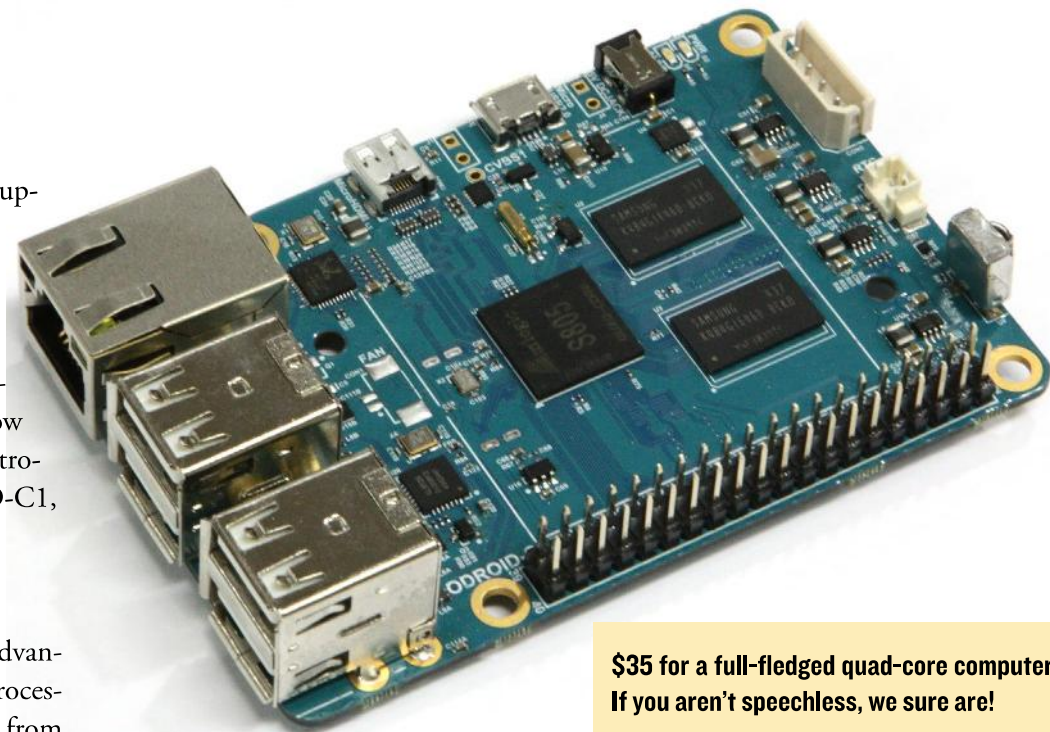
Have you been waiting to upgrade your Raspberry Pi computer, or are looking for a second computer for family, work or college use? Hardkernel's family of ultra-low-cost, powerful ARM devices is now even more affordable with the introduction of the powerful ODROID-C1, available for only \$35.

Features

The ODROID-C1 has many advantages over the Raspberry Pi. The processor is an S805 1.5GHz Quad-core from Amlogic with 1GByte DDR3 RAM, Gigabit Ethernet and IR-receiver. The size of this computer is still only 85 x 56 mm with a weight of 40g, and offers silent operation, 2~3W average power usage, and instant portability, since it fits in a shirt pocket.

One powerful feature of the ODROID-C1 is the row of GPIO (general purpose input/output) pins along the edge of the device. These pins are a physical interface between the board and the outside world. The 40-pin interface header includes SPI, I2C, UART, ADC and GPIO function.

An SD 3.01 standard compatible UHS-1 Micro-SD card, as well as the faster eMMC module, can be ordered with the ODROID-C1, and arrives with the popular Ubuntu operating system already installed. Insert the SD card into the slot, connect a monitor, a keyboard, a mouse, Ethernet and power cable, and that's all you need to do to use the ODROID-C1! Browse the web, play games, run office programs, edit



\$35 for a full-fledged quad-core computer
If you aren't speechless, we sure are!

photos, develop software, and watch videos right away.

Work and play

The ODROID-C1 is suitable for anyone from professional software engineers building Kinect-drive robotics projects to kids learning to program with the Scratch language. Run the latest Ubuntu 14.04 or Android KitKat operating systems for programming, learning, gaming, media center, web server, office/college work, hardware IO platform and many other applications. The powerful 1.5Ghz quad-core processor, low cost, energy efficient features and massive software library make the ODROID-C1 the perfect modern computer for work or play.

A Tour of the Board

Let's start with a quick tour of what you're looking at when you take it out of the box. It's similar to your typical PC

with various added features.

A. Processor

At the heart of the ODROID-C1 contains Amlogic S805 system on a chip, which is built on the quad-core ARM Cortex-A5 ARMv7 architecture and quad-core Mali-450 MP2 GPU.

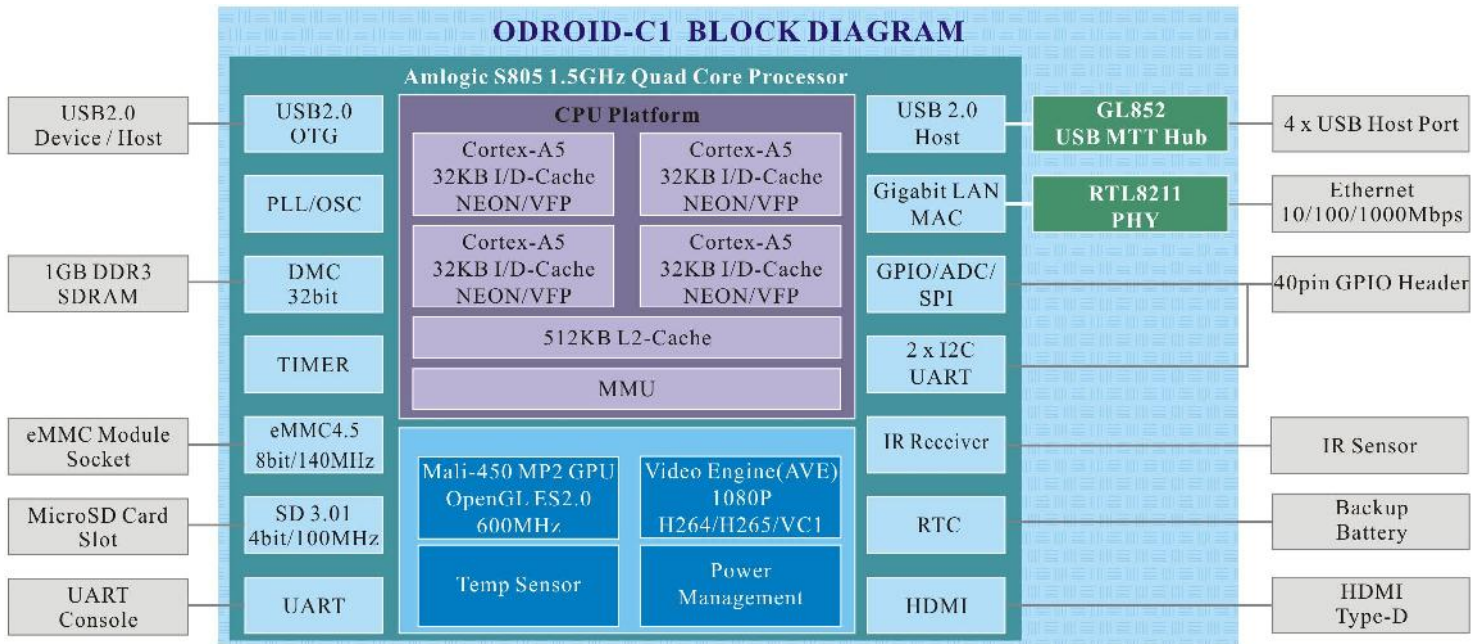
B. Memory (RAM)

The 1GB memory contains 2pcs of 512MB DDR3 SDRAM. The 800Mhz clocking delivers 1600Mhz of 32bit data traffic via DDR technology.

C. Micro Secure Digital (MicroSD) Card slot

There are two different methods of storage for the operating system. One is by using a MicroSD Card and another is using an eMMC module, which is normally used for external storage for smartphones and digital cameras. The ODROID-C1 can utilize the newer

ODROID-C1 BLOCK DIAGRAM



A block diagram showing the architecture of the ODROID-C1

shared with typical PCs. You can also add a micro-USB to HOST connector if you need an additional USB host port. Note that this port cannot be used for power input.

L. General Purpose Input and Output (GPIO) ports

These 40-pin GPIO port can be used as GPIO/I2C/SPI/UART/ADC for electronics and robotics.

M. Serial terminal port

Connecting to a PC gives access to the Linux console. You can see the log of

the boot, or to log in to the C1 to change the video or network settings. Note that this serial UART uses a 3.3 volt interface. We recommend the USB-UART module kit from Hardkernel.

N. RTC (Real Time Clock) backup battery connector

If you want to add a RTC functions for logging or keeping time when offline, just connect a backup battery. All of the RTC circuits are included on the ODROID-C1 by default.

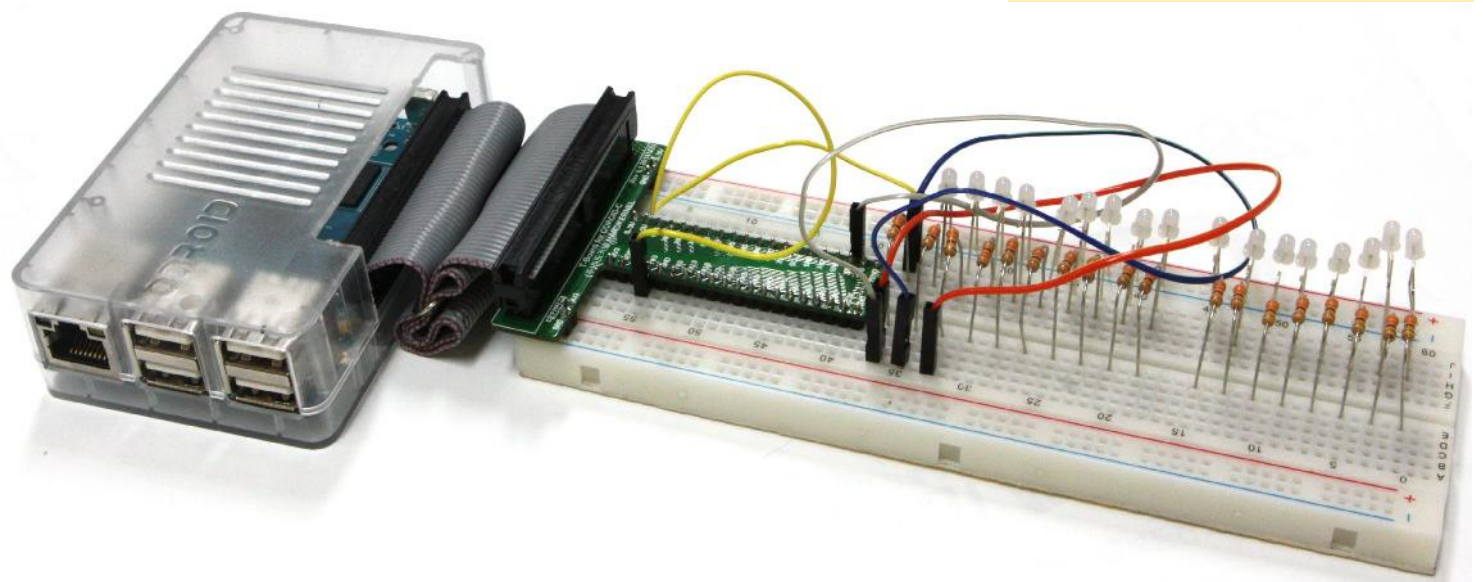
The 40 GPIO pins on an ODROID-C1 are a great way to interface with physical devices like buttons and LEDs using a lightweight Linux controller. If

you're a C/C++ or Python developer, there's a useful library called WiringPi that handles interfacing with the pins. We've already ported the WiringPi v2 library to the ODROID-C1.

Please note that pins #37, 38 and 40 are not compatible with the Raspberry Pi B+ 40-pin header. Those pins are dedicated to analog input functions.

To see the ODROID-C1 in action, visit YouTube at <http://bit.ly/1wFDwrg> and <http://bit.ly/1Grw2Hq>.

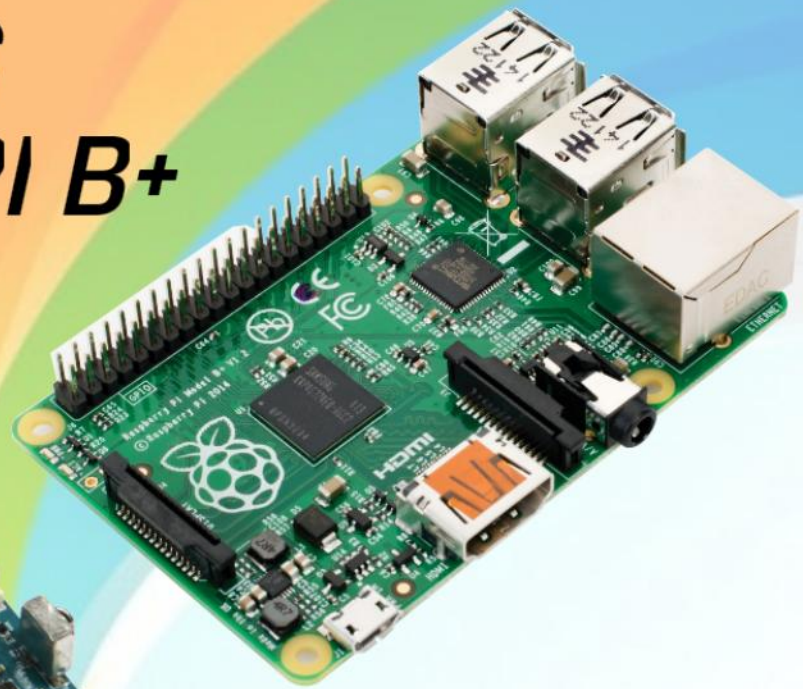
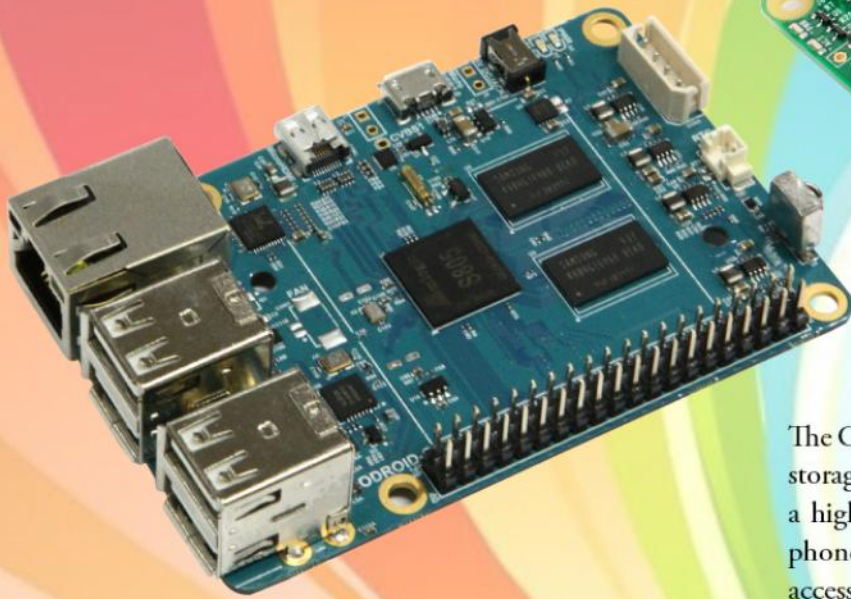
ODROID-C1 prototyping example



ODROID-C1 VS RASPBERRY PI B+

OUR SECOND AFFORDABLE COMPUTER SHOWDOWN

by Ruppi Kim



The ODROID-C1 is a new Raspberry Pi B+ clone that eclipses the original in terms of performance

Both the ODROID-C1 and the Raspberry Pi B+ are Linux-friendly, cost-effective ARM single-board computers suitable for various applications and purposes. Although the ODROID-C1 is an inexpensive ARM single-board computer, it offers a quad-core ARMv7 CPU, and includes an Amlogic S805 quad-core ARM Cortex-A5 1.5GHz SoC, Mali-450 MP2 GPU, four USB 2.0 host ports, one 10/100/1000Mbit Ethernet port, a 1080p video output via micro-HDMI, 1GB of DDR3 system memory, eMMC and micro-SD sockets for solid state storage, and support for Debian Wheezy, Ubuntu Linux and Android operating systems.

Hardware comparison

Compared to the Raspberry Pi (RPi), the C1 has 4 times the number of CPU cores, and the operating clock frequency is about 2 times faster. In addition, the RAM size is also 2 times larger and the RAM access frequency is twice as fast. The C1 also includes a Gigabit Ethernet port that allows higher throughput speeds of around 500Mbps in the real world. The C1 has 4 USB-host ports, as well as a USB-OTG port for fast connectivity with Linux gadgets.

The C1, unlike the RPi, supports a UHS-1 compatible SD Host controller which allows 2 times faster I/O performance.

The C1 goes one step further and adds an option to use eMMC storage. eMMC, which is sold separately as an accessory, is a high speed MLC flash memory like those used on modern phones and tablets, and can be removed or replaced easily. The access speed of an eMMC module is typically 2-3 times faster than SD cards. As a bonus, the built-in Real-Time Clock (RTC), Infrared (IR) receiver and Analog-To-Digital Converter (ADC) features on the ODROID-C1 offer many options for building great DIY projects.

Feature comparison of computing performance

	ODROID-C1	Raspberry Pi (Model-B+/512MB)
CPU	Amlogic S805 SoC 4 x ARM Cortex-A5 @1.5Ghz ARMv7 Architecture @28nm wafer	Broadcom BCM2835 1 x ARM11 @700Mhz ARMv6 Architecture @40nm wafer
GPU	ARM Mali-450 MP2	1 x VideoCore IV @ 250 MHz
RAM	1GB 32bit DDR3 @800Mhz	512MB 32bit LP-DDR2 @400Mhz
Flash Storage	Micro-SD UHS-1@100Mhz/SDR50 eMMC storage option	Micro-SD @50Mhz/SDR25 No eMMC storage option
USB 2.0 Host	4 Ports	4 Ports
USB 2.0 Device/OTG	1 Port for Linux USB Gadget driver	Not Available
Ethernet/LAN	10/100/1000 Mbit/s	10/100 Mbit/s
Video output	HDMI	HDMI / Composite RCA
Audio output	HDMI	HDMI / 3.5mm Jack
Camera Input	USB 720p	MIPI CSI 1080p
Real Time Clock	YES (On-board RTC)	No(unless using an add-on module)
I/O Expansion	40pin port (GPIO/UART/SPI/I2C/ADC)	40pin port (GPIO/UART/SPI/I2C)
ADC	10bit SAR 2 channels	No (unless using an add-on module)
SIZE	85 x 56mm (3.35" x 2.2")	85 x 56mm (3.35" x 2.2")
WEIGHT	40g (1.41 oz)	42g (1.48 oz)
Price	\$35	\$35

Benchmarks

We ran a simple, popular benchmark called Unix-Bench (version 5.1.3) to compare the performance of the two boards. Tests were done using several manufacturer-provided images based on a clean install, and the “apt-get update && apt-get upgrade” commands were first run to ensure that both boards was up-to-date.

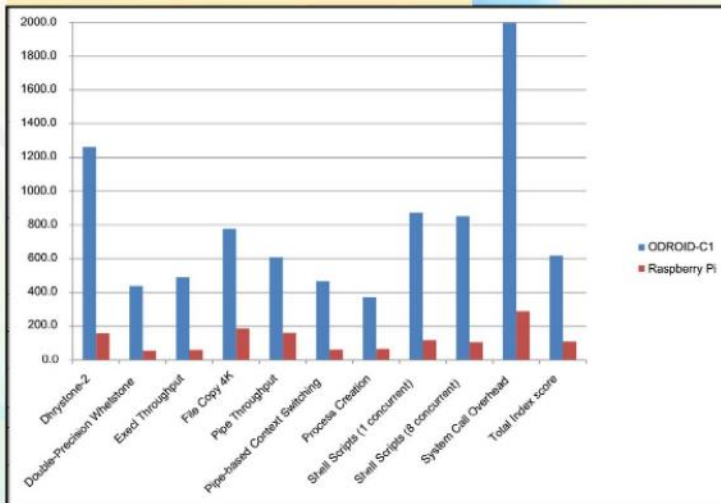
The RPi was clocked at 800Mhz using a Sandisk UHS-1 8GB SDCard running the Debian Wheezy OS. The C1 was clocked at 1.5Ghz using an 16GB eMMC with Ubuntu 14.04 OS. Both units were powered by a 5V/2A power supply and connected to the 1920x1080 HDMI output. Note that in order to utilize all four cores in the C1, the “./run -c 4” command was used.

Benchmarks (Index Score)	Raspberry Pi	ODROID-C1	Ratio
Dhrystone-2 using register variables	162.1	1262.8	7.8
Double-Precision Whetstone	56.2	439.6	7.8
Execi Throughput	61.6	489.4	7.9
File Copy 4096 bufsize 8000 maxblocks	187.9	778.4	4.1
Pipe Throughput	164.1	610.4	3.7
Pipe-based Context Switching	62.7	467.0	7.4
Process Creation	68.2	371.8	5.5
Shell Scripts (1 concurrent)	117.2	874.4	7.5
Shell Scripts (8 concurrent)	106.2	853.8	8.0
System Call Overhead	290.5	1999.7	6.9
Total Index score	109.8	622.3	5.7

Benchmark results of C1 vs Rpi

The results show that the Dhrystone-2 benchmark is about 8 times faster on the C1. File I/O benchmark is about 4 times faster because of the faster storage speed of the eMMC module. Overall performance test result show that the C1 is approximately 6 times faster than the RPi, even though the price of C1 is exactly same.

Performance comparison of C1 vs Rpi



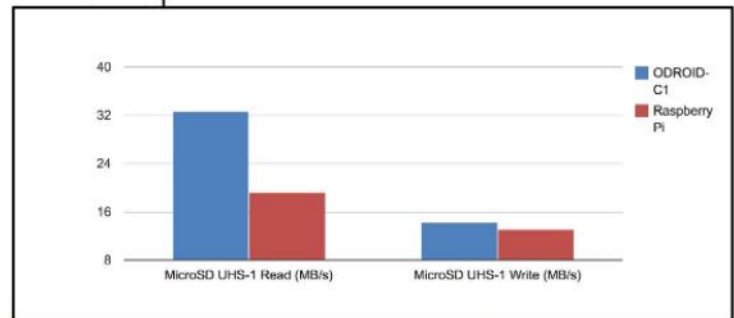
Storage I/O comparison

To obtain the results in the storage I/O comparison graph, type the following lines at a command prompt. The first command tests the write speed, and the second command tests the read speed:

```
$ dd if=/dev/zero of=test.tmp oflag=direct bs=500K count=1024
$ dd if=test.tmp of=/dev/null iflag=direct bs=500K count=1024
```

Media access performance	ODROID-C1	Raspberry Pi
eMMC Read (MB/s)	62.2	N/A
eMMC Write (MB/s)	25.1	N/A
MicroSD UHS-1 Read (MB/s)	32.5	19.2
MicroSD UHS-1 Write (MB/s)	14.2	13.1

If you use the eMMC storage, you can get about two to three times faster storage I/O read performance. However, an affordable microSD UHS-1 card can still achieve reasonably fast speeds thanks to the advanced SD 3.01 host controller in the S805 processor. The MicroSD card read performance on C1 is still about 1.7 times faster than RPi if you use the UHS-1



File I/O comparison of C1 vs Rpi

Ethernet I/O comparison

To replicate the results in the Ethernet comparison graph, type the following lines at a command prompt:

Server agent on the C1 and Client agent on the host PC

```
ruppi@ruppi-desktop:~$ iperf -c 192.168.2.10 -P 10
[SUM] 0.0-10.0 sec 700 MBytes 584 Mbits/sec
```

Server agent on the host PC and Client agent on the C1

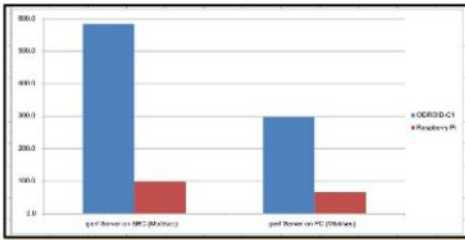
```
odroid@odroid:~# iperf -c 192.168.2.2 -P 10
[SUM] 0.0-10.1 sec 351 MBytes 292 Mbits/sec
```

Server agent on the RPi and Client agent on the host PC

```
ruppi@ruppi-desktop:~$ iperf -c 192.168.2.11 -P 10
[SUM] 0.0-10.3 sec 121 MBytes 98.6 Mbits/sec
```

Server agent on the host PC and Client agent on the RPi

```
pi@raspberrypi:~$ iperf -c 192.168.2.2 -P 10
[SUM] 0.0-10.3 sec 81.6 MBytes 66.6 Mbits/sec
```



Networking comparison of C1 vs Rpi

Thanks to the Gigabit Ethernet available on the ODROID-C1, the network performance of C1 is an impressive four to six times faster than Raspberry Pi.

Conclusion

As one can see from the testing results, the quad-core 1.5GHz ODROID-C1 can easily outperform the single-core 700MHz Raspberry Pi board, even when the Raspberry Pi is overclocked. Many test results show four to seven times more performance from the ODROID-C1 platform.

Even though both platforms are Linux-friendly computing devices, the performance to cost ratio is much higher with the ODROID-C1. If you are considering a tiny computer for general purpose computing, software development, or as a project platform, the ODROID-C1 will give you a lot more satisfaction and fun with incredible performance for a very low price.

The Hardkernel team that makes it all happen



Rob Roy in his ODROID den with a Q2 and U3



BEHIND THE SCENES

THE AMAZING STAFF OF YOUR FAVORITE TECH MAGAZINE

by Rob Roy

Now that ODROID Magazine has completed its first full year of publication, we thought that it might be a good time to introduce you to the work process of the magazine staff that brings you the latest ODROID news, tips, and hacker projects every month.

We start by reading through the article submissions from our worldwide network of contributors, who send their submissions either through email or by posting on the ODROID forums. Rob Roy and Bo edit the articles for consistency and technical accuracy, then save the final versions to Google Drive.

Once the articles are completed, the art editors Bruno, Nicole and James carefully transcribe them using Adobe InDesign, and create a custom layout for each page by placing all of the article images and screenshots alongside the text. At the same time, Bruno creates the cover each month based on the feature article, which is usually written by the team from Hardkernel.

Next, we all come up with funny pictures and captions to fill up the extra space, with some of our favorite images of robots, cats, dogs, and other silly things. We hope you like our sense of humor.

Finally, Manuel takes the magazine contents and translates them into Spanish for our worldwide audience. Another job well done!

Bo also owns the Ameridroid distributor



Nicole has a cozy office with lots of plants



Bruno with a fancy hat and bottle of tequila



James likes a natural setting for his work



Manuel is our bilingual expert in Spanish

