RASPBERRY PI COMPUTE

Les Pounder gets exclusive access to the latest board from the Raspberry Pi Foundation.

On 7 April the Raspberry Pi Foundation announced a new device to join the family. But it was not what we were expecting: many thought that there would be an upgrade to the hardware, with more RAM and processing power and an extra USB port, maybe. But instead we got something very different and totally unforeseen.

The Compute Module is a full Raspberry Pi model A shrunk down into a printed circuit board (PCB) the size of a laptop SODIMM (small outline dual-inline memory module). The goal of the module is to put the technology of the Pi at the heart of commercial and serious hobbyist 'internet of things' projects via a smaller module that can be added to a PCB designed by the end user. The original Raspberry Pi form factor, while meeting the needs of the end user, has been adapted to serve the needs of various projects across the globe. It's perfect for makers and hobbyists, but the original Raspberry Pi form factor is not as flexible as a smaller, more modular device and this is where the Compute Module comes into its own.

> **"The original Raspberry Pi form factor is not as flexible as a smaller, more modular device."**

Linux Voice was privileged to get hold of a development board from the Raspberry Pi Foundation as well as access to James Adams, the lead for this project (who at the time was on paternity leave but still responded to our emails) to grill him about the ideas that formed this new device from the Raspberry Pi Foundation, and to find out what makes it so special.

Hi James, thanks for taking the time away from your new baby to answer a few questions about your other new baby. What was the driving force that inspired the team to create the Compute Module?

James Adams: It was a combination of factors. When I joined The Raspberry Pi Foundation in February 2013 to head up hardware design, I already had in my mind that this kind of product would be really great and allow people to leverage the Pi software and hardware into new products and form factors. Meanwhile there were also internal discussions at the Foundation about creating a smaller or more embeddable unit.

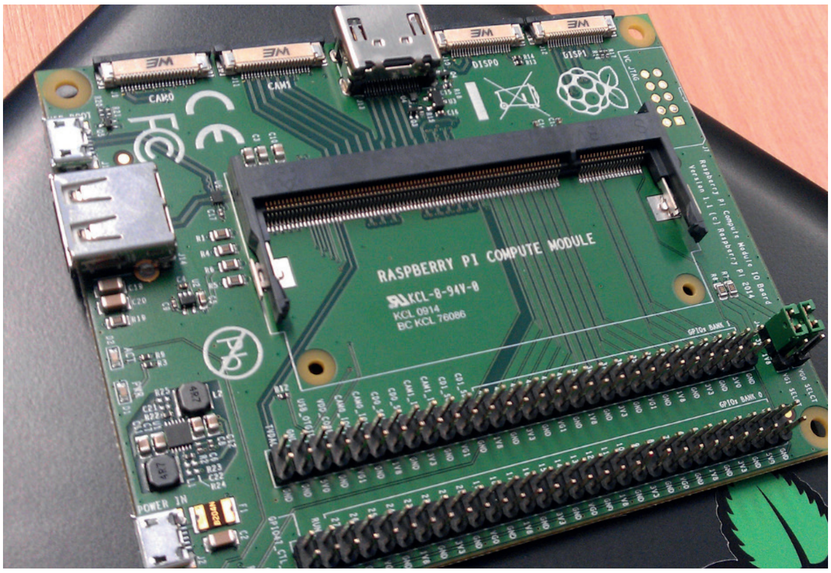
In the end we chose to go with the SODIMM module form factor and provide something that, although it requires a little expertise to use, is also extremely flexible and allows a user to leverage all of the interfaces of the BCM2835 chip. In fact we kind of see the module a bit like a chip – you have to power it correctly and wire it up the way you want, but ultimately this makes it very flexible. Less is more!

Can you explain why you chose such a radically different form factor for the Compute Module?

JA: After we had decided that we wanted to create a more embeddable Pi, it was really down to what the best connector solution and form factor for such a device would be. The SODIMM form factor (and SODIMM connector) is a widely available and cheap way of providing the 200 pins of connectivity we needed. It is also relatively small, robust, easy to use and impossible to connect the wrong way around, so is fairly foolproof.

The Compute Module came as quite a surprise to the community, with many anticipating an increase in the Raspberry Pi specs. Was this ever on the cards?

JA: We see the current Raspberry Pi as a long-term product. Rather than chase the bleeding edge, we're trying to provide a mature and feature-rich hardware platform and software stack at the $25 and $35 price points (and $30 for the CM). This means sticking with the current hardware and SoC [system on a chip]. While we continue to keep our eye on what is out there we don't have any plans currently for a spec bump.



More and more people are building the Raspberry Pi model A and B boards into products, so the Foundation knew that there was demand for the Compute Module.

The Compute's target markets are professional/commercial users. Do you have any ideas for potential use cases?

JA: We can see so many use cases for the CM that it's hard to know where to begin. The Raspberry Pi (and hence Compute Module) is a cheap and low-power way to add network connectivity and compute and imaging horsepower to many types of product. Its Linux software stack is also actively developed and now very stable. We expect to see a lot of 'Internet Of Things' type applications. The other thing the BCM2835 [the chip at the heart of the Pi] does extremely well is video encode/decode and 3D graphics. We see this being useful in digital signage applications, video recording and imaging applications and media players.

The Raspberry Pi Foundation's focus has always been on education, so how does the Compute Module fit into this?

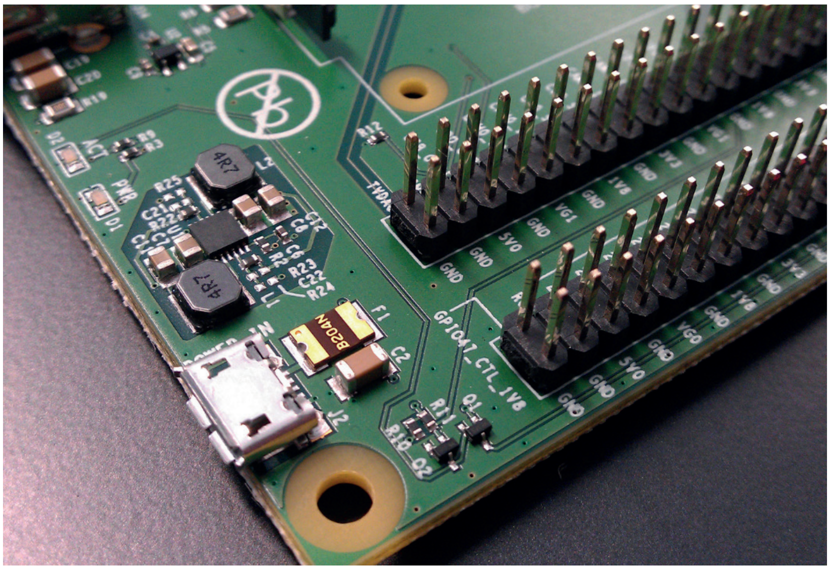
JA: The core focus of the Foundation is and always will be educating kids in computing, and the revenue stream generated by the Compute Module goes straight back into the Foundation to further these

Potential use cases

With new hardware comes lots of opportunities to hack and learn and the Compute Module is no exception. It has familiar hardware and software capabilities for Raspberry Pi-based hacking, so many of the tutorials and guides already available for the Raspberry Pi can be easily ported to work with it.

We asked a group of hackers and makers what they would do with the new Compute module. Tim Gibbon, of RossLUG in east Lancashire, suggested gigital signage: "We see digital signage in schools and shopping centres, and it is now so integrated into our lives that works of fiction such as the Minority Report are easily replicated using the Raspberry Pi. The Compute module could easily be used with a custom PCB to integrate with LCD and LED matrix displays, while enabling access to the camera for openCV-powered facial recognition. Attach a 3G or Wi-Fi dongle to the board and you have an internet-enabled display.

Linux Voice contributor Jon Archer (also of RossLUG) suggests: "Now you can have a server farm in the comfort of your own home, a custom PCB that can link many Compute Modules so that they can work together. The amount of space and power taken by this setup would be negligible compared to a full server solution."



The CMIO board that accompanies the Compute Module provides a host of extra connectivity options over the standard Pi – including 120 GPIO pins.

aims. However we do understand the bigger picture, what Pi has grown into and also that nurturing the community is very important to the success of the project. This community is not only providing the required revenue stream for us to continue to meet our charitable aims, but also feeding so much back. We have so many volunteers doing everything from writing/improving the software on the Pi to running Raspberry Jams and doing their bit to educate kids in computing. Back to the CM then, we see this as filling an obvious market need and providing us with valuable revenue. It will also provide positive feedback into the Pi ecosystem in terms of third-party CM boards, driver software etc, so really it was a no-brainer for us and does fit in well with what we are trying to achieve.

"We see the Compute Module as filling a market need and providing us with revenue."

LV The Compute is only half of the package. Can you tell us about the IO board into which the Compute is attached?

JA: The Compute Module IO Board (CMIO) is designed to be both a reference design for how to wire up the compute module and also as a platform for developers to prototype up system designs with before they go to the expense of creating a custom PCB for the Compute Module. It provides the minimum possible power chain, provides an easy way to program the eMMC and then breaks all other CM interfaces out to more friendly pin headers and FFC connectors.

LV Do the extra GPIO pins on the IO board provide any extra features or special pins?

JA: The GPIOs on the BCM2835 can be set to be either 'straight' GPIO – ie software-controlled inputs or outputs – or set to one of a number of other hardware interfaces such as I2C, SPI, UART, I2S etc. What you get with these extra pins is more options for both straight GPIO and the other interfaces.

There are also a few more undocumented interfaces that will hopefully have some documentation released for them fairly soon. Two of these are parallel display (DPI) and Secondary Memory Interface (SMI). Neither of these interfaces are available on the Pi as they are wide interfaces – eg SMI uses 16 data pins and several control signals, DPI 16–24 bit data and strobes. Both interfaces are also very useful, and will allow even more options for attaching different hardware to the CM once the relevant documentation is released.

LV While it's not a pin-compatible GPIO board to the existing Pi, is it possible to connect a board, for example Pibrella, PiBorg or others using jumper cables?

JA: Absolutely. The GPIO pins on the Raspberry Pi GPIO header are a subset of those available on the BCM2835 (and therefore the CM and therefore CMIO headers). If you connect the right pins up with jumper wires theoretically it should just work. We aren't really expecting users to want to do this – if you want to use a Pibrella, why not just buy a Raspberry Pi? What we expect is for users to add their own custom circuitry with just the features they need for their application to a CMIO board; test it, and once the design is proven, spin their own custom PCB.

LV The IO board does not have any Ethernet connectivity – why not?

JA: The IO board is designed to break all of the CM interfaces out into a more prototype-friendly manner, to provide power to the module and allow (re) programming the eMMC and be as simple as possible in doing so. The Broadcom BCM2835 chip does not have native Ethernet, so neither does the CM or the CMIO Board.

On the Raspberry Pi, Ethernet is provided by a USB to Ethernet + USB Hub bridge (LAN9512), which a user can add to their CM-based product if that is what they need. We are not trying to second guess what a user might want to plug in to their development platform here, just provide the basic interfaces and let the user add what they need for their application and no more.

GPIO pins & connectivity

The original Raspberry Pi has 26 GPIO pins at your disposal, but the Compute increases the available pins to 120, of which 45 can be configured by the user. The remaining pins are a mix of exclusive pins for certain devices (USB OTG, TVDAC, Camera etc) and others are GND or 1v8 , 3v3 and 5v0. The increase in pins brings with it a much larger scope for projects and experimentation.

On either side of the HDMI port are two connectors: on the left of the HDMI they are labelled DISP0 and DISP1; and to the right CAM0 and CAM1. DISP connectors are reserved for connecting bespoke display screens, such as the forthcoming Raspberry Pi Foundation screen. The CAM connectors are for the official Raspberry Pi camera, but you cannot use the official camera as is – if you already own a Pi camera, you will need to purchase an adapter as the connector is a few mm smaller than that of the original Raspberry Pi. We spoke to CPC (one of the Raspberry Pi's distributors) about this adapter and it confirmed that it will be stocking the adapter and bundling it with Pi Cameras purchased after the release of the Compute – do check to see if yours is there if you buy one.

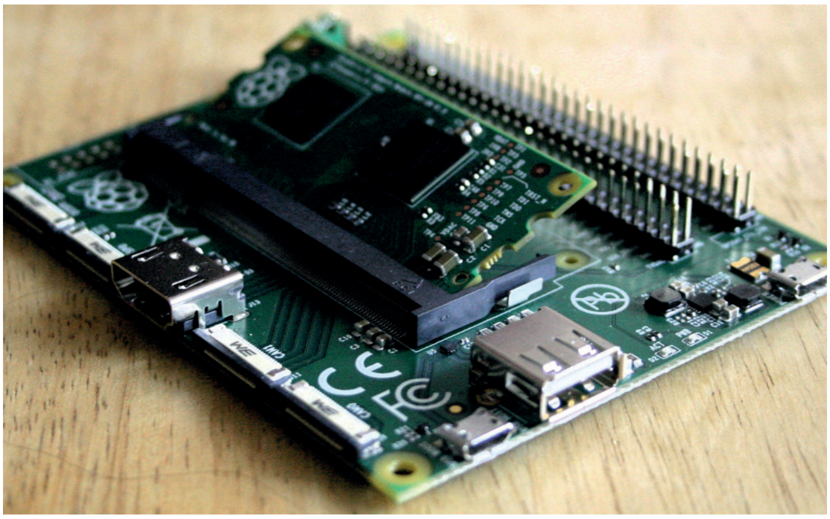
Raspberry Pi Compute Module

The possibilities of a souped-up Raspberry Pi are mouthwatering – but is it right for your project, or should you stick with the Model A or B? **Les Pounder** finds out.

The Compute Module is a typical SODIMM-sized board that contains the Broadcom BCM2835 chip found on the original Raspberry Pi, with a few notable extras to extend its functionality – most notably 4GB of onboard eMMC flash storage and a USB OTG port, which is the only way of copying an operating system to the internal storage. To mount the internal flash storage you'll need to download a special tool from the Raspberry Pi website; installing this tool and mounting the eMMC is automatic from this point on. Now that the Compute is mounted on your computer, you can use **dd** to transfer an image across from your Linux box.

For this review we used the stock Raspbian image as this is the most mature of the available distros – please note that the NOOBS image is, at time of writing, not really for use with the Compute. After the Raspbian image was successfully installed on the Compute, we unplugged it from our test machine and set the kit up as per a normal Raspberry Pi installation.

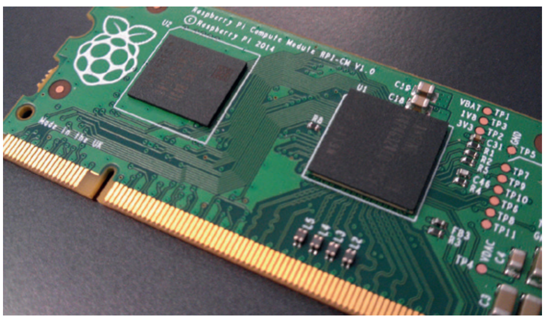
The Compute Module's boot sequence is identical to a standard Raspberry Pi, except that the Compute is much faster, owing to the on-board eMMC being directly available, rather booting from an SD card.



The Compute Module is pretty much the shrunken guts of a Model A Raspberry Pi, with some extras, and improved connectivity courtesy of the CMIO board.

Boundless possibilities

We started the LXDE desktop and ran the IDLE Python editor as root, then using the standard **Rpi.GPIO** library for Python, were able to work with pins that were not available on the Raspberry Pi. This is something really awesome: in total there are 120 GPIO pins on the board, split into two banks of 60 pins. From these 120 pins the user can adapt 45 pins to meet the needs of their project. The remaining pins are reserved for power, 1V8, 3V3 and 5V and Ground (GND). The use of I2C and SPI is also available via the GPIO in the same manner as the standard Raspberry Pi. The CMIO board uses the Broadcom pin numbering sequence rather than the more common logical board reference, but the Broadcom pin numbering is very clearly and logically laid out on the board. The Compute is a mighty beast for GPIO-based projects and this is clearly its specialist area.



4GB may not seem like a lot of storage, but the Compute Module is aimed at specialised embedded products.

The Compute module is meant to be used with expansion boards and PCBs created by the end user, and the CMIO board from the Foundation is a means to access the hardware locked inside the it. These user-created boards are yet to see the light of day, but there are a few Kickstarter projects based around the specifications of the Compute module – for example the OTTO hackable camera **www.kickstarter.com/projects/1598272670/meet-otto-the-hackable-gif-camera**.

The Compute and CMIO board provide a stable and well supported platform for serious hardware development. It is a more challenging platform to work with, given the added complexity of flashing the on board eMMC flash storage as opposed to the more common SD card method. Once this hurdle is overcome, and it quickly will be, you are greeted with the familiar Raspberry Pi experience that we know and love. This board is for serious development and the early kits will be priced for serious development, with the Foundation aiming to mass produce the boards in greater numbers and drive the cost down as soon as possible. LV

LINUX VOICE VERDICT

A great product that will build on the support and knowledge of the existing Raspberry Pi community.

★★★★☆

DATA

Web
http://raspberrypi.org
Developer
Raspberry Pi Foundation
Price
$200 - $250 for early developer kits. Price TBA for individual units.

CMIO CONNECTIONS

- 200 pin SODIMM connector for Compute Module.
- Micro USB power.
- Micro USB On The Go (OTG) for connecting to a computer.
- USB 2.0 port.
- HDMI output.
- 2 Official Raspberry Pi Camera ports.
- 2 Official Raspberry Pi Display ports.
- 120 GPIO pins, of which 45 can be used as inputs or outputs in projects.
- GPIO support for I2C, SPI, UART I2S.
- Multiple GPIO pins for 1v8, 3v3, 5v and GND.