

# Intel Next Unit of Computing (NUC)

## The Mouse That Roars

Over the last decade, small motherboard form factors such as Mini-ITX, Nano-ITX, and Pico-ITX have proved ideal for digital signage, kiosks, and other embedded applications. Users' homebrew systems have played roles in networking, encryption/decryption, home automation, and home theater devices.

More recently, as the media streaming market heated up, we began to see small A/V appliances based on Intel Atom processors and sometimes Nvidia ION graphics. The goal was to shrink physical dimensions and power



The eye-catching DC3217BY NUC boasts a 10Gbps Thunderbolt port along with HDMI. Inside is the D33217CK "Campers Lake" motherboard.

### Giving Pi A Raspberry

Owing to its compact size, Intel's NUC invites comparison with an even tinier PC platform: the Raspberry Pi ([www.raspberrypi.org](http://www.raspberrypi.org)). That said, in many respects the two are as different as apples and, well, raspberries.

"Intel's (4 x 4-inch) NUC architecture and form factor is unique in that it's super-small but can scale from affordable solutions with basic compute functions based on our Atom processor, to high-performing, compute-intensive solutions based on our Core i7," explains Intel Client Boards Division Marketing Director John Deatherage.

In contrast, thus far the 3.4 x 2.2-inch Raspberry Pi board comes with only one processor option: an ARM11-based, Broadcom SoC (system on a chip). It has no official case like the NUC, but its power consumption (approximately 2.5 to 3.5W, depending on model) is as low as its cost (\$25 to \$35).

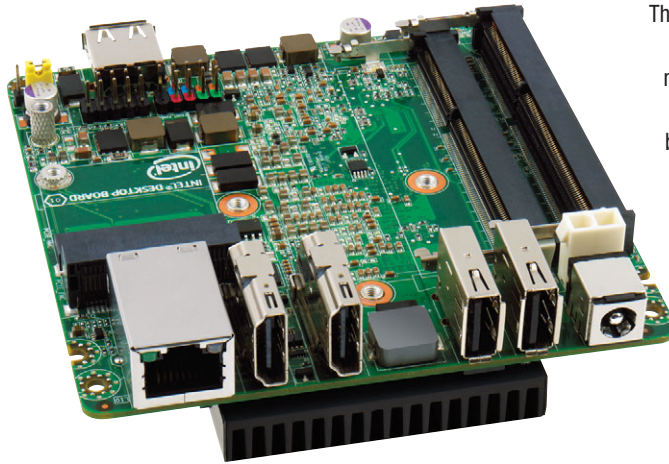
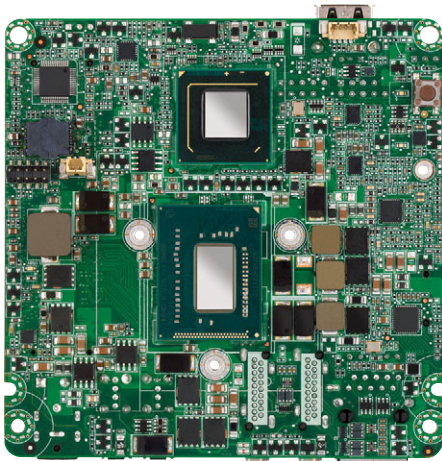
Both NUC and Raspberry Pi have built-in graphics, and can play 1080p HD video and audio over HDMI. But don't get too excited about the latter's level of computing performance;

current Raspberry Pi models' memory is 256 or 512MB, and it's not upgradeable. NUC supports up to 16GB.

Also, Raspberry Pi's SoC has a clock speed of 700MHz, as opposed to the 1.1 or 1.8GHz of current Intel NUC models. Its non-profit manufacturer says, "Overall real world performance is something like a 300MHz Pentium II (a desktop chip from 1997), only with much, much swankier graphics." What's more, Raspberry Pi relies on SD Card or USB 2.0 flash drive storage, while NUC enjoys support for potentially much faster mSATA SSDs.

While both NUC and Raspberry Pi can run suitable distributions of Linux, the Pi doesn't currently support Windows—not even the ARM-based Windows RT. However, an Android version for the Raspberry is reportedly under development.

Finally, the NUC and Raspberry Pi address very different market segments. NUC is aimed at home and business users, whereas Raspberry Pi is targeted toward the education and hobbyist markets.



This is the D33217GKE “Golden Lake” NUC mainboard. Intel sells it separately or in a black enclosure (SKU DC3217IYE).

consumption, while simultaneously increasing performance.

Today, Intel has taken the miniature PC trend a step further with its NUC, or Next Unit of Computing. Mainboards built in Intel’s new UCFF (Ultra Compact Form Factor) are a mere 4 x 4 inches in size (Mini-ITX is 6.7 x 6.7 inches, while Nano-ITX and Pico-ITX measure 4.7 x 4.7 inches and 3.9 x 2.8 inches, respectively). However, the important distinction is that a UCFF board can harness the power of an Intel 3rd Generation “Ivy Bridge” Core i3 processor, which is in an entirely different league compared to any chip ever mounted on an ITX board.

Even better, Intel also sells NUC boards preinstalled in compact cases reminiscent of (but much smaller than) the Apple Mac Mini. Add your own memory, storage, and either Windows or Linux, and you’ve just gone NUClear.

### Mighty Mite

Convergence was the key to the bold, new NUC platform. So was Intel’s willingness to be “unrestrained by legacy form factors,” the company says. The union of CPU and GPU is one example of this convergence—every processor soldered to a UCFF board has on-die graphics built-in. Another example is the single-chip Intel QS77 Express chipset, which consists of an eponymously named PCH (Platform Controller Hub).

“A few processor generations ago, we would not have been able to do this design since we were on a three chip solution, for example,” says Intel Client Boards Division Marketing Director John Deatherage. “The integration of subsystems has helped to reduce component footprint and allowed us to achieve these innovations.”

The Intel processor in the initial run of NUC products is the Core i3 3217-U. It’s an Ivy Bridge chip running two Hyper-Threaded cores at 1.8GHz. The four virtual cores share 3MB of Intel Smart Cache.

Despite the Core i3’s low 17W TDP (thermal design power) rating, the confines of the small NUC case induced Intel to actively cool the processor with a fan. Fortunately, the company has had some recent experience with speedy silicon in tight quarters.

“The NUC had similar design challenges as the Ultrabook in terms of thermal and power consumption within any given z-height requirements,” Deatherage notes. “Because of the engineering efforts we had with Ultrabook, we were able to develop the NUC design with limited issues.”

The result is a space-saving, energy-efficient PC that’s nevertheless powerful enough to run Windows 8. As the “Intel NUC SKUs & Specifications” chart in this article indicates, available features include HDMI, USB, Gigabit Ethernet, and even Thunderbolt. Slots on the board support mini PCIe expansion

cards and dual SO-DIMM DDR3 memory modules.

“With such a small form factor,” Deatherage adds, “we were also able to take advantage of developing with a 10-layer PCB using High Density Interconnect (HDI) technology without driving up costs too high.”

As for the black aluminum and plastic NUC cases, their top panels are color-coded by model (see chart for details). Each case features a standard VESA mount, so you can attach a NUC to the back of a flat-panel display if you like. There’s also a provision for a Kensington lock for security.

Intel fits each case with a pre-assembled Wi-Fi/Bluetooth antenna, but you’ll need to add those capabilities on your own via half-length PCIe Mini Card. You’ll want to reserve the full-length PCIe Mini Card slot for an mSATA SSD storage drive.

### Uses

With hardware accelerated H.264/AVC and other video formats, NUC is ready for 1080p HD playback. It also supports lesser HD sound formats (AC-3 Dolby Digital, Dolby Digital Plus, and DTS-HD), as well as LPCM (192 kHz/24-bit, 8-channel).

“For consumer and DIY usage, Intel’s NUC is a great fit as a home theater PC (HTPC) or as a conversion kit for a smart TV,” says Deatherage. Intel also points out the portability of a NUC: You could

take it to a friend's house or on a business trip, and bring its streaming media capabilities with you.

"On the corporate side," Deatherage says, "in addition to digital signage, the NUC is also being evaluated for in-car infotainment, video surveillance cameras, point-of-sales terminals, K-12 school labs, thin clients, and medical monitoring equipment." For utility's sake, NUC can run dual displays, or one display and one monitor.

### Beyond The Core

The NUC architecture and form factor aren't limited solely to Core i3s, however. The platform can support the lower-power Intel Atom processor, for example.

"Initially we have chosen to take Celeron, Core i3, and Core i5 NUC SKUs to market," Deatherage says, "but look for Intel to build out a complete roadmap over the next several quarters."

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The first Celeron NUC kit, the DCCP847DYE, is a low-cost solution (\$167) based on the DCP847SKE "Ski Lake" motherboard. It runs a 32nm Celeron 847 with a clock speed of 1.1GHz.

In light of the rise of tablets and smartphones at the expense of the desktop PC market, and the concomitant announcement from Intel that it's phasing out its production of ATX motherboards, Deatherage says that NUC is part

of Intel's plans to revive interest in desktop computing.

"The excitement around NUC in multiple market segments is clear evidence that desktop PCs are still a vibrant and desirable product for consumers and corporate users alike," Deatherage says. "Look for Intel to continue to innovate around super-small PCs and all-in-one form factors, both targeted to fuel desktop PC growth." ■

| Intel NUC SKUs & Specifications |  |  |  |  |  |
|---------------------------------|--|--|--|--|--|
|                                 | DC3217IYE  | D33217GKE<br>"Golden Lake"   | DC3217BY   | D33217CK<br>"Campers Lake"   | DCCP847DYE                                   |
| Includes                        | Case, black, VESA mount; D33217GKE board   | Bare motherboard   | Case, black/maroon, VESA mount; D33217CK board   | Bare motherboard   | Case, black/gray, VESA mount; DCP847SK board |
| MSRP                            | \$285  | \$263  | \$315  | \$294  | \$167  |
| Dimensions (inches, HxWxD)      | 4.59 x 4.41 x 1.55   | 4 x 4  | 4.59 x 4.41 x 1.55   | 4 x 4  | 4.59 x 4.41 x 1.55                           |
| CPU                             | 3rd Gen Core i3 3217-U*  | 3rd Gen Core i3 3217-U*  | 3rd Gen Core i3 3217-U*  | 3rd Gen Core i3 3217-U*  | Celeron 847**                                |
| Chipset                         | Intel QS77 Express   | Intel QS77 Express   | Intel QS77 Express   | Intel QS77 Express   | Intel QS77 Express                           |
| RAM maximum                     | 16GB***  | 16GB***  | 16GB***  | 16GB***  | 16GB****                                     |
| Graphics                        | Intel HD Graphics 4000   | Intel HD Graphics 4000   | Intel HD Graphics 4000   | Intel HD Graphics 4000   | Integrated                                   |
| Audio                           | Intel HD Audio 8-channel   | Intel HD Audio 8-channel   | Intel HD Audio 8-channel   | Intel HD Audio 8-channel   | Intel HD Audio 8-channel                     |
| A/V Connectors                  | 2 x HDMI 1.4a  | 2 x HDMI 1.4a  | Thunderbolt 10Gbps (DisplayPort 1.1a), HDMI 1.4a   | Thunderbolt 10Gbps (DisplayPort 1.1a), HDMI 1.4a   | 2 x HDMI 1.4a                                |
| Expansion slots                 | Mini-PCIe full-length w/ mSATA support; mini-PCIe half-length w/ dual USB 2.0 ports routed | Mini-PCIe full-length w/ mSATA support; mini-PCIe half-length w/ dual USB 2.0 ports routed | Mini-PCIe full-length w/ mSATA support; mini-PCIe half-length w/ dual USB 2.0 ports routed | Mini-PCIe full-length w/ mSATA support; mini-PCIe half-length w/ dual USB 2.0 ports routed | Mini-PCIe full-length; mini-PCIe half-length |
| Other Connectors                | 3 x USB 2.0, 1Gbps Ethernet  | 3 x USB 2.0, 1Gbps Ethernet  | 3 x USB 2.0  | 3 x USB 2.0  | 5 x USB 2.0, 1Gbps Ethernet                  |
| Power                           | 65W (19V)  | 65W (19V)  | 65W (19V)  | 65W (19V)  | 12V  |
| Warranty                        | 3 years  | 3 years  | 1.5 years  | 1.5 years  | 3 years                                      |

\* 1.8GHz, dual-core w/ Hyper-Threading, 3MB Smart Cache, 17W TDP.  
 \*\* 1.1GHz, dual-core, 2MB cache, 17W TDP.  
 \*\*\* 2 x 8GB DDR3 SO-DIMM, 1066/1333/1600Mhz, 1.35/1.5V.  
 \*\*\*\* 2 x 8GB DDR3 SO-DIMM, 1066/1333Mhz, 1.35/1.5V.