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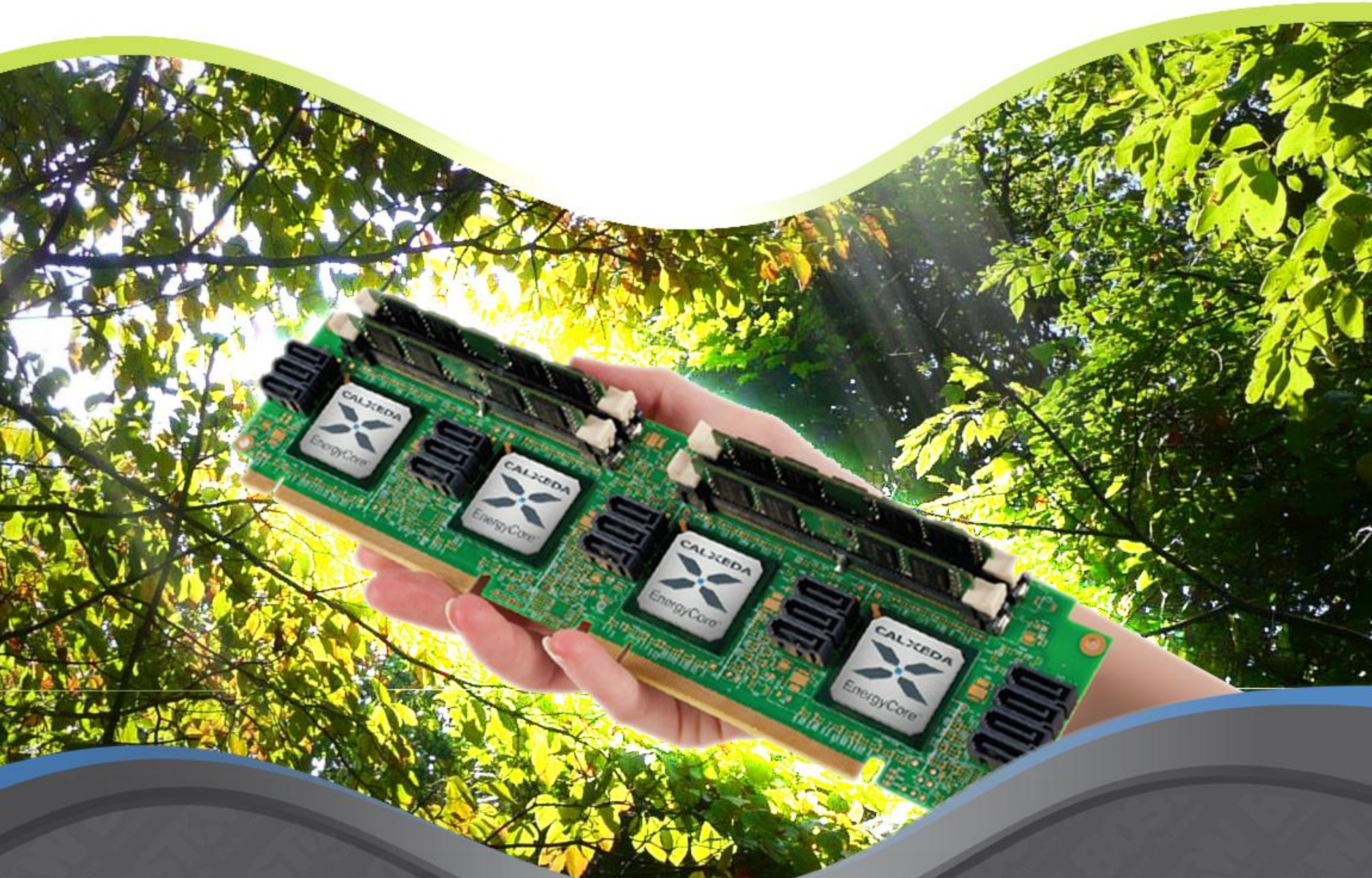

Revolutionising the data centre with application-specific servers based on ARM® processors

By Boston Limited

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About Boston Limited

With over 20 years of trading within the distribution and OEM marketplace, Boston Limited continues to lead the way in providing the latest high performance power optimised technologies into the HPC, ISP, military, VFX, enterprise and broadcast markets with our multi-award winning server, storage, workstation and clustered solutions.

Our experience in the assembly, testing and validation of high-performance bespoke solutions combined with our ability to provide client specific branding, documentation, packaging and global on-site maintenance packages, allows us to provide a genuine range of value added services to our partners.

Headquartered in the UK, Boston is based in the USA, Germany and India to support its growing global operations. For more information, visit our website at www.boston.co.uk

Introduction

Web giants such as Google and Facebook are inching towards the Arctic Circle, building their latest data centres in countries such as Finland and Sweden to cope with the exponential demand for their Internet services. What was forbidden terrain for agriculture and manufacturing is now home to power hungry server farms that not only need sustainable sources of energy, but an extremely cold climate to chill servers.

When Facebook announced that it was building a data centre in Lulea, Sweden which is less than 100km south of the Arctic Circle, the Guardian reported that 'each of Facebook's US data centres is estimated to use the same amount of electricity as 30,000 US homes. Energy consumption of warehouses run by companies such as Facebook, Google and Amazon, is among the fastest growing sources of global electricity demand. In the US, which hosts approximately 40 per cent of the world's data centre servers, their electricity consumption increased by nearly 40 per cent during the economic downturn of 2007-2010.'

The scale of Facebook's and Google's operations necessitated an extreme solution to the same problems faced by any company running a server farm – i.e. efficient power and cooling.

If you're not quite ready to relocate way up north, is there an alternative solution?

Power-hungry processors

The crux of the power and cooling problem in servers lies in the fact that many of them use processors that are based on the x86 architecture. One of the biggest concerns with x86 servers is the ever increasing power consumption, with the latest generation Intel Xeon E5-2600 series processor averaging a 95W TDP and the fastest models peaking at 150W, the CPU is considered a significant pain-point. This is for the simple reason that processor architects continue to add more features and performance capabilities to each new design. However, multiple studies, from the likes of Microsoft and McKinsey, have consistently shown that most server CPUs typically only run at around 10 per cent capacity in daily use.

This means that data centre administrators are currently wasting huge amounts of their limited fiscal and power budget on processing transactions that aren't being handled efficiently.

Over the last few years, numerous IT companies have proposed virtualisation as a potential solution to this problem. This is based on the idea that you can increase efficiency by running more than one application on a single server.

Rather than going this route, Boston Limited propose that: "Instead of deploying general-purpose servers based on energy-inefficient x86 processors that will barely run at a fraction of their capacity, why not consider deploying servers that have been specifically designed to run a single application in the most efficient manner possible?"

Once the problem was framed this way, Boston knew that true innovation was needed to significantly reduce power consumption and heat dissipation in its new range of servers, it would have to: (1) use an alternative processor architecture to the x86; (2) design the servers so that they run a single application at maximum efficiency.

CISC vs. RISC

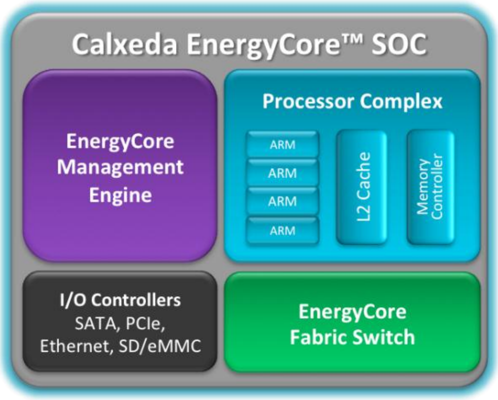
One of the handicaps of the x86 instruction set is that despite its 34 years of evolution, it is still inherently an inelegant CISC (Complex Instruction Set Computing) architecture. As such, it is very capable of running a wide variety of applications but is not particularly efficient at specific tasks.

In contrast, a processor based around the RISC (Reduced Instruction Set Computing) architecture, a design philosophy that emphasises simpler instructions over complex instructions, enables much greater processing efficiency.

Boston have chosen ARM® as a technology partner for its new range of servers because it is the market leader in RISC processors. ARM® is already a household name thanks to the success it has had with its power efficient processors that can be found in a huge variety of devices such as smartphones, tablets, media players, digital cameras, GPS navigation systems and games consoles.

The ARMv processor architecture is such a good fit for Boston's new server range because it is characterized by extremely low power consumption and heat dissipation. These advantages are amply demonstrated in the widespread use of ARMv processors in the handheld device segment. Handhelds use batteries that only carry a finite amount of power and their small form factor precludes any active cooling technology.

The Calxeda EnergyCore



Boston has also partnered with Calxeda, a young, dynamic silicon design house in Austin, Texas. While ARM has shown ARMv's suitability to a wide range of devices, Calxeda's contribution to the project has been to enhance these abilities and tailor the ARMv processor architecture specifically for the server market.

Calxeda's first ARM-based server solution is as System on a Chip (SoC) that it named EnergyCore™.

Despite their increasing level of integration, conventional x86 processors are still essentially just CPUs. A SoC differs from a conventional CPU because its single package design enables it to run its own operating system and applications. It includes everything you need to build a complete working server.

In the case of the Calxeda EnergyCore, the SoC incorporates four ARM Cortex A9 processor cores, two levels of cache memory, a floating point unit, a 32-bit memory controller, network connectivity, a SATA drive controller and an I/O bus. All that is required is the addition of external memory to have a fully functional server node.

Meet the Boston Viridis

Bespoke RISC processor in hand, Boston combined hardware, software and system design expertise to build a server that is far more energy efficient than a general-purpose, x86-based server. Called the Boston Viridis, the server uses an array of RISC architecture processors to run an application at the same level as a traditional x86 server at a fraction of the power.

Interestingly, once the issue of power efficiency was addressed, the Viridis team became more ambitious and were able to run the application at higher speeds than the benchmark x86 server.

For the initial configurations of Viridis application-specific server, each SoC will be partnered with 4GB of main system memory. This might seem like a tiny amount compared to the dozens or hundreds of gigabytes of memory each x86 CPU in a traditional server is able to address, but in an application-specific server each EnergyCore SoC will be processing a proportionately smaller amount of work. Remember, just like a RISC-architecture CPU, an application-specific server is more efficient than a general-purpose server precisely because it divides the work into smaller, more easily processed segments.

What makes the EnergyCore SoC so efficient is that multiple SoCs and their associated memory (herein referred to as nodes) are linked together in parallel via Calxeda's Fabric Switch. This low latency I/O bus is used for both inter-node communications, and to link to I/O and networking, but also to service and manage the nodes via IPMI.

This means that any application that can be split into multiple segments to be processed in parallel could potentially benefit from running on an application-specific server using EnergyCore SoCs.

In the first generation of Boston Viridis application-specific servers, four nodes are clustered together on a single daughtercard known as an EnergyCard. Up to 12 of these quad-node EnergyCards can be installed in a 2U chassis, for a total of 48 nodes, or 192 processor cores. Thanks to the Fabric Switch I/O, as many as 4,000 nodes can be linked together, depending on the demands of your applications.

The EnergyCards themselves are installed in a passive backplane that provides an extended Fabric Switch between the cards, 12V power and external networking via four 10Gbit LAN ports. The backplane also provides fan management capabilities for the whole server and can also support EnergyDrive cards, node-less daughtercards that instead support up to four SATA drives.

What about software?

Rather than trying to be a 'jack of all trades, but master of none' like the traditional x86 server, the Boston Viridis is being developed to run specific applications. Currently, Boston and Calxeda are working closely with a number of leading independent software vendors (ISVs) to ensure that seamless support for the EnergyCore design. These ISVs include operating system specific vendors such as Ubuntu and Fedora.

The application market for the Viridis can be divided into four main segments as follows:

Applications built on portable or interpretive programming models such as PHP, Ruby or Perl.

Scale scout, parallel applications such as search indexing, MapReduce, Big Data, financial and risk modelling, data intensive and single-precession HPC.

Applications whose in-memory data domains are easily segmented into relatively small sets such as memcached.

Applications that require extremely high I/O throughout (as opposed to extremely short response times) such as media streaming, content delivery and no-SQL in-memory databases.

To ensure the best possible performance and efficiency, rather than offering bare metal servers, Boston produces a range of application-specific servers that will include an appropriate selection of Viridis hardware that is pre-installed with optimised applications equipped with any networking hardware that is required.

What are the benefits?

While it's unfortunately too early in the development cycle to publish any detailed performance benchmarks at this time, this white paper is able to share some exciting power consumption figures with you.

At a low level, it's clear that the EnergyCore SoC is the herald of a new era in power efficient computing. This is because each node (SoC plus RAM) has a typical power draw of just 5W under load and less than 0.5W when idle. This compares very favourably with traditional x86 server CPUs such as the Intel Xeon E3-1220L, which has a TDP of 20W, four times greater than an EnergyCore node. That's not even the whole picture, as this 4x drop in power consumption does not take into account that the x86 system also requires an ethernet controller and I/O hub chip, which will add a further 15W or so. This means that an EnergyCore SoC in fact draws closer to seven times less power than a traditional x86 server.

Put another way; even when running at a generous 20 per cent CPU utilisation (double what most industry sources agree on), a pair of Intel Xeon E5620 processors will still draw 90 per cent more power than a pair of EnergyCore nodes.

Compute density is also far higher with an EnergyCore-based server, leading to substantial space savings. For example, a single 2U chassis with 120 EnergyCore nodes is estimated to provide the same compute performance as twenty dual-processor x86 servers - these are some of the key workloads Boston is targeting.

From these figures, and the initial performance data published by Calxeda, it's easy to see that EnergyCore-based servers will deliver substantial savings in both energy and space - two valuable and limited commodities in any data centre. For example, when feeding these estimates into James Hamilton's TCO tool, Calxeda has estimated that an EnergyCore-based infrastructure could slash your data centre's TCO by half.

Conclusion

While traditional x86 processors will continue to play a leading role in the server market for the foreseeable future, it's becoming increasingly clear that something more radical than a die shrink is required to provide a significant drop in power draw and thus TCO.

Calxeda EnergyCore SoCs, based on the ARM processor architecture, that have been designed from the ground up for maximum power efficiency and compute density are one possible solution to this problem. As this white paper demonstrates, an array of EnergyCore nodes running in parallel specific applications can deliver substantial savings.

To find out how an application-specific server based on EnergyCore nodes could revolutionise your business contact Boston sales on +44 (0) 1727 876100 or email sales@boston.co.uk. Boston will be delighted to arrange a remote test or proof of concept demo system to be delivered to your data centre and show you how to slash your TCO.

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