

E4

COMPUTER
ENGINEERING

I've got the Power!

Performance comparison between state of the art x86_64 and OpenPOWER servers for High Energy Physics and related considerations

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HPC & ENTERPRISE SOLUTIONS

E4® Computer Engineering SpA was founded in 2002

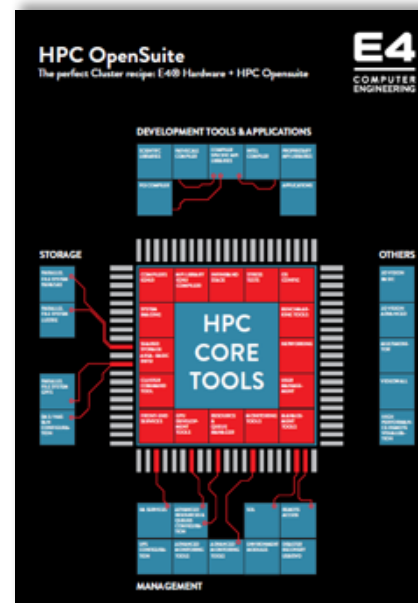


We are specialized in the **manufacturing of high performance IT systems** of medium and high range. Our products aim to meet both **industrial and scientific research requirements** with range fit for many environments, from universities to computing centers.

Thanks to the established experience acquired through the years, E4 is a valued technology's supplier acknowledged and appreciated by **many worldwide organizations**.

HPC Team

- Operating since 2005
- E4 HPC custom suite
- Unique technical skills in Italy
- E4 on SPEC website
- Intel Cluster Ready certified
- SGI fully trained and qualified



Enterprise Team

- Born in 2010 - Operating since 2011
- New certified servers and storages
- Focus on «Business Continuity»
- E4 VSTONE (first italian complete virtualization solution)



E4 VSTONE
 STRUCTURED VIRTUALIZATION SOLUTION



More than 15M euros of installed HW

Requirements

High density computational nodes
Big data storage

Application

High-energy physics research

Hardware installed

- > 20PB high performance storage
- > 5PB direct attached storage
- > 3.500 server dual socket (~ 40k computing cores)

Several GPU systems
NBD intervention times

The slide features the INFN logo at the top left. The background is dark with a large, vibrant visualization of a particle collision, showing a central point from which numerous lines radiate outwards, representing particle tracks. The lines are colored in shades of blue, green, and yellow. In the top right corner, there is a circular inset showing a similar but more detailed view of a collision event.

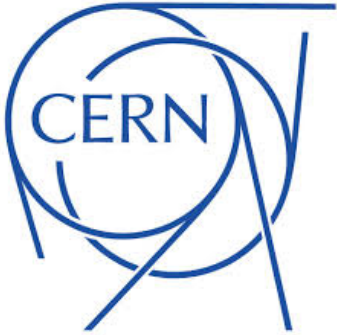
INFN
Istituto Nazionale
di Fisica Nucleare

Riconoscimento di eccellenza nella collaborazione industriale per
gli esperimenti ATLAS e CMS al Large Hadron Collider del CERN in
occasione della scoperta del Bosone di Higgs.

E4 Computer Engineering S.p.A.
Scandiano (RE)

Fornitura di processori per il trigger di alto livello
e per i sistemi di calcolo T1/T2 degli esperimenti
ATLAS e CMS.

At the bottom right, there are two logos: the CMS logo on the left and the ATLAS EXPERIMENT logo on the right. The CMS logo consists of the letters 'CMS' in a stylized font. The ATLAS logo features the word 'ATLAS' in a bold, sans-serif font with 'EXPERIMENT' written below it, accompanied by a small graphic of a particle detector.



More than 20M euros of installed HW

Requirements

High density computational nodes
Big data storage

Application

High-energy physics research

Solution

8.000+ dual socket mainboards (54.000+ cores)
50.000+ enterprise class hard disks (120PB Storage)

A black rectangular graphic with white and orange text. It features the E4 logo in the top right corner, a stylized illustration of a frying pan with food items (a hard drive, a bell, and a flame) in the center, and the CERN logo in the bottom right corner. The text reads: "E4 SERVING UP HIGH ENERGY PHYSICS", "Take 7,200 SERVERS with 108,000 tasty CORES", "Add 89 PB of STORAGE made of 42,900 crispy HDDs", "Season with ITALIAN PASSION", "... AND THE KITCHEN IS STILL OPEN...", "COOKING UP FAST COMPUTING", and "6 YEARS / ANS CERN".

**E4 SERVING UP
HIGH ENERGY PHYSICS**

Take 7,200 SERVERS
with 108,000 tasty **CORES**

Add 89 PB of STORAGE
made of 42,900 crispy **HDDs**

Season with ITALIAN PASSION

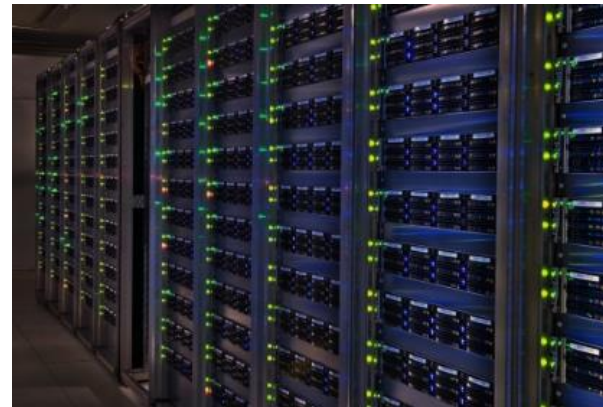
... AND THE KITCHEN IS STILL OPEN...

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ENGINEERING

COOKING UP FAST COMPUTING

6
YEARS / ANS CERN

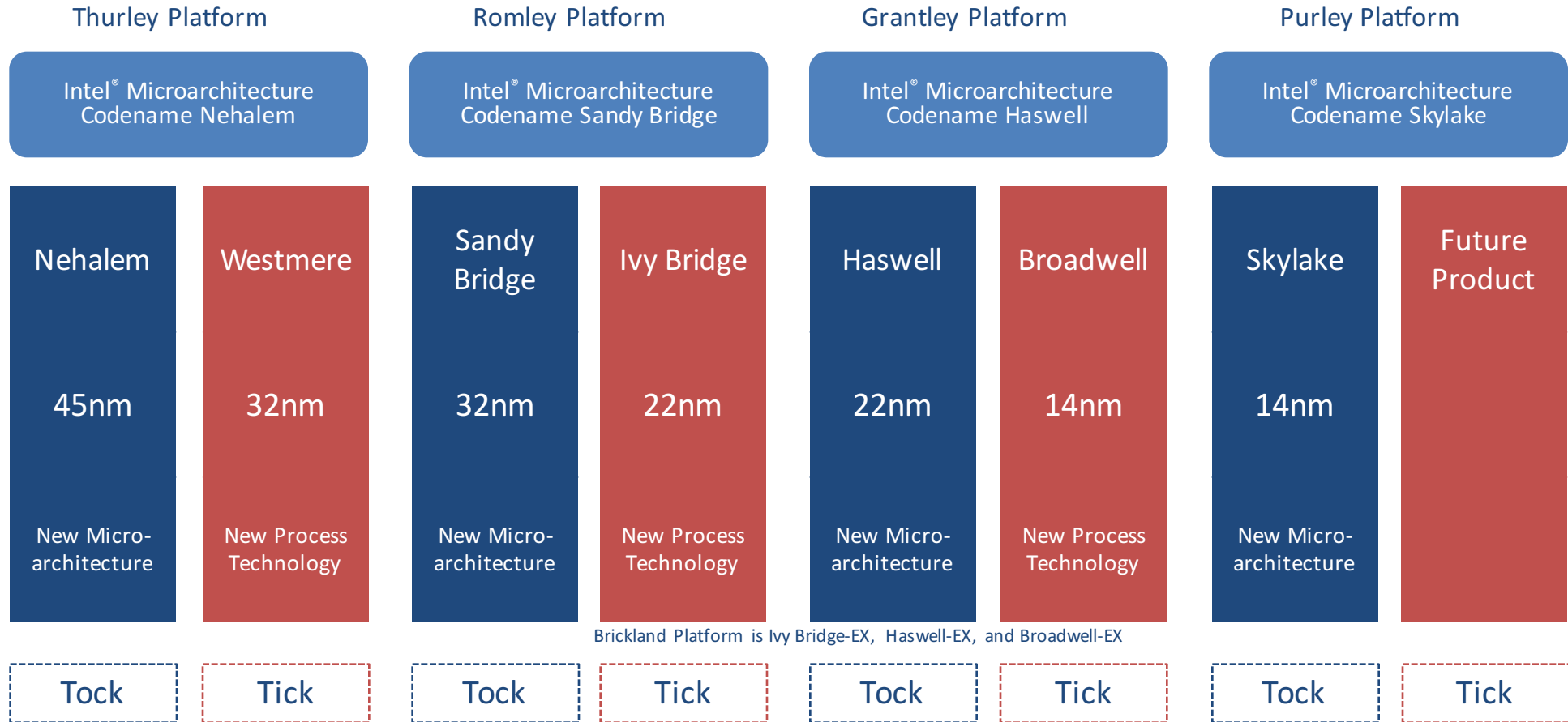
updated to 2014



E4® systems @ CERN

Tick-Tock Development Model:

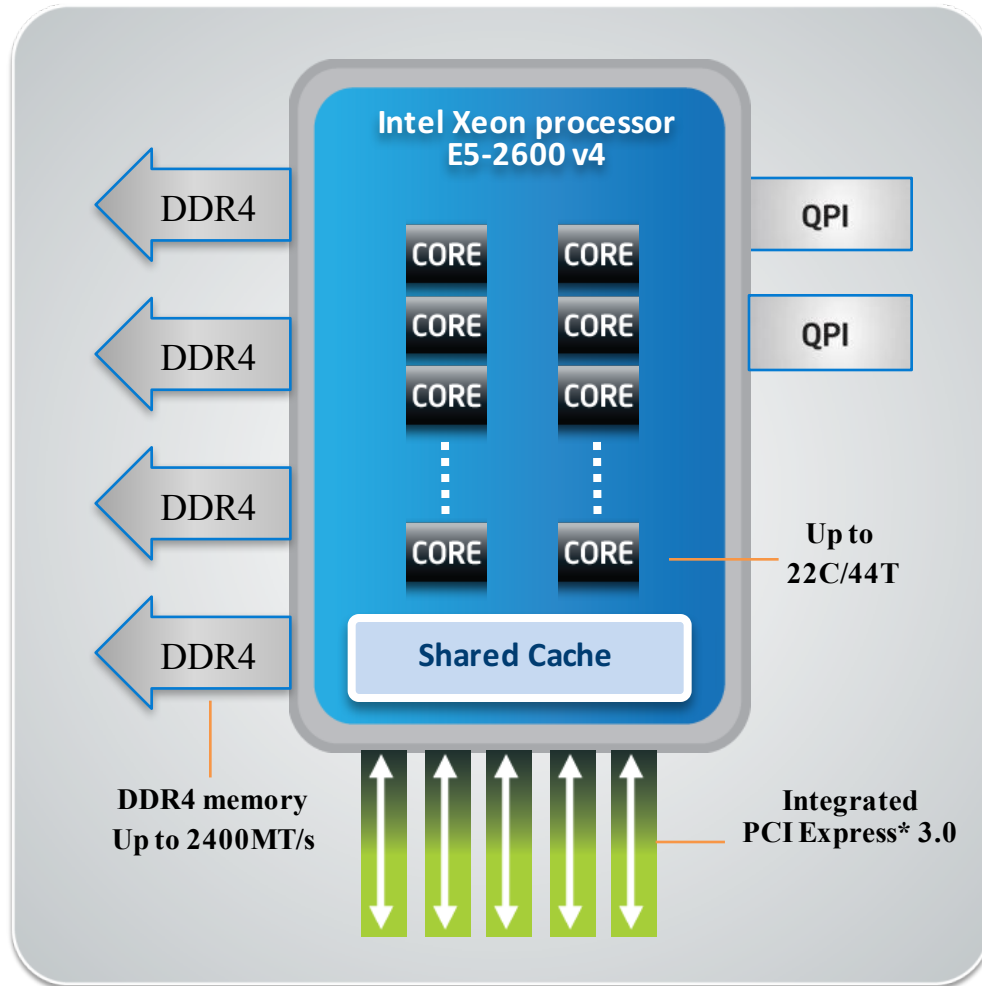
Sustained Microprocessor Leadership HPC & ENTERPRISE SOLUTIONS



Innovation delivers new microarchitecture with Skylake

INTEL® XEON® PROCESSOR E5-2600 V4 PRODUCT FAMILY

HPC & ENTERPRISE SOLUTIONS



HIGHLIGHTS:

- Broadwell-EP processor based on 14nm process technology.
- Haswell-EP microarchitecture with new instructions including AVX2 and FMA.
- Up to 22C/44T DDR4 support increased memory speed at 2400MT/s.
- Compatible with Intel® C610 series chipset.

PLATFORM STORAGE EXTENSIONS:

- Asynchronous DRAM Refresh (ADR)
- PCIe Non-Transparent Bridge (NTB)
- Intel® QuickData Technology (CBDMA) & RAID-5 acceleration engine
- PCIe Dual-Cast

All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice.

Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. Click http://www.intel.com/products/processor_number for details

OpenPOWER – OP205



OP205
A MOST POWERFUL CHOICE



HIGHLIGHTS

- High performance Linux server
- Dual IBM POWER8 processor modules
- Dual NVIDIA GPU accelerators
- Incorporates Mellanox Scalable HPC
- Solutions with NVIDIA technology
- CAPI technology
- Supports up to 1 TB of 1333/1066 MHz DDR3L memory
- Flexible and modular I/O
- Up to 8 threads
- Max 230GBps per socket

FEATURES	OP205
Form Factor	2U
Dimensions	D x W x H (mm) 730 x 442.5 x 86
CPU	2-socket, 8-core or 10-core IBM POWER8 processor/ Up to 190 W TDP per processor
GPU	Up to 2x NVIDIA K80 GPU accelerators
Memory	Up to eight memory riser modules; Up to 32 x RDIMM slots; 4 GB, 8 GB, 16 GB, and 32 GB 1333/1066 MHz DDR3 module ; 32 GB to 1024 GB capacity
I/O	1 x USB 2.0 port (front); 1 x USB 3.0 port (rear); RJ45 port (dedicated for IPMI); 9-pin serial port; 15-pin VGA port
Power Supply	2 x 1300W 80 PLUS Platinum hot-swap redundant power supplies (non-redundant if GPU card is installed)
Storage	2 x storage bays for 2.5-inch SATA-III hard disk drive, hot-swappable, RAID 0, 1, 10 software implementation
Expansion Slot	One x16 PCIe Gen3 LP slot (CAPI enabled); Two x16 PCIe Gen3 FHFL riser cards (CAPI enabled); Two x8 PCIe Gen3 LP slot
System Management	IPMI 2.0 compliant ; AST 2400 CHIPSET
Storage Controller	SATA-III 6.0Gb/s ports (Marvell 88SE9235)

POWER8 Processor

Technology

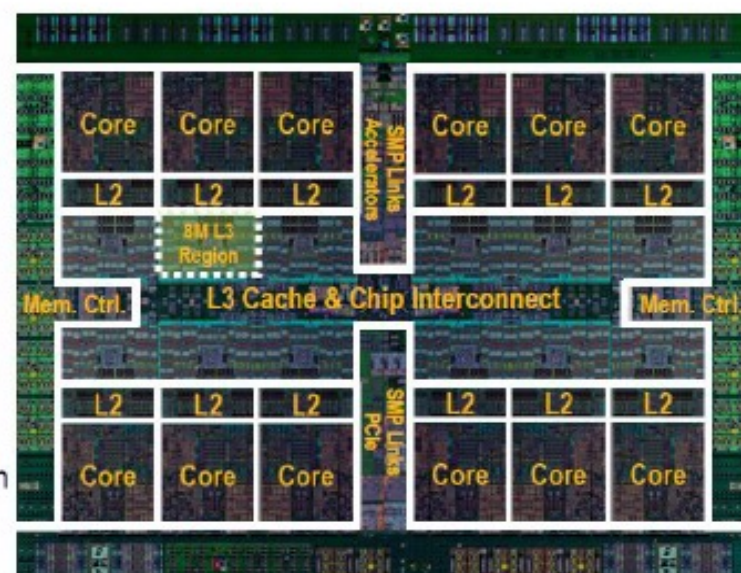
- 22nm SOI, eDRAM, 15 ML 650mm²

Cores

- 12 cores (SMT8)

Accelerators

- Crypto & memory expansion
- Transactional Memory
- VMM assist
- Data Move / VM Mobility



Energy Management

- On-chip Power Management Micro-controller
- Integrated Per-core VRM
- Critical Path Monitors

Caches

- 512 KB SRAM L2 / core
- 96 MB eDRAM shared L3
- Up to 128 MB eDRAM L4 (off-chip)

Memory

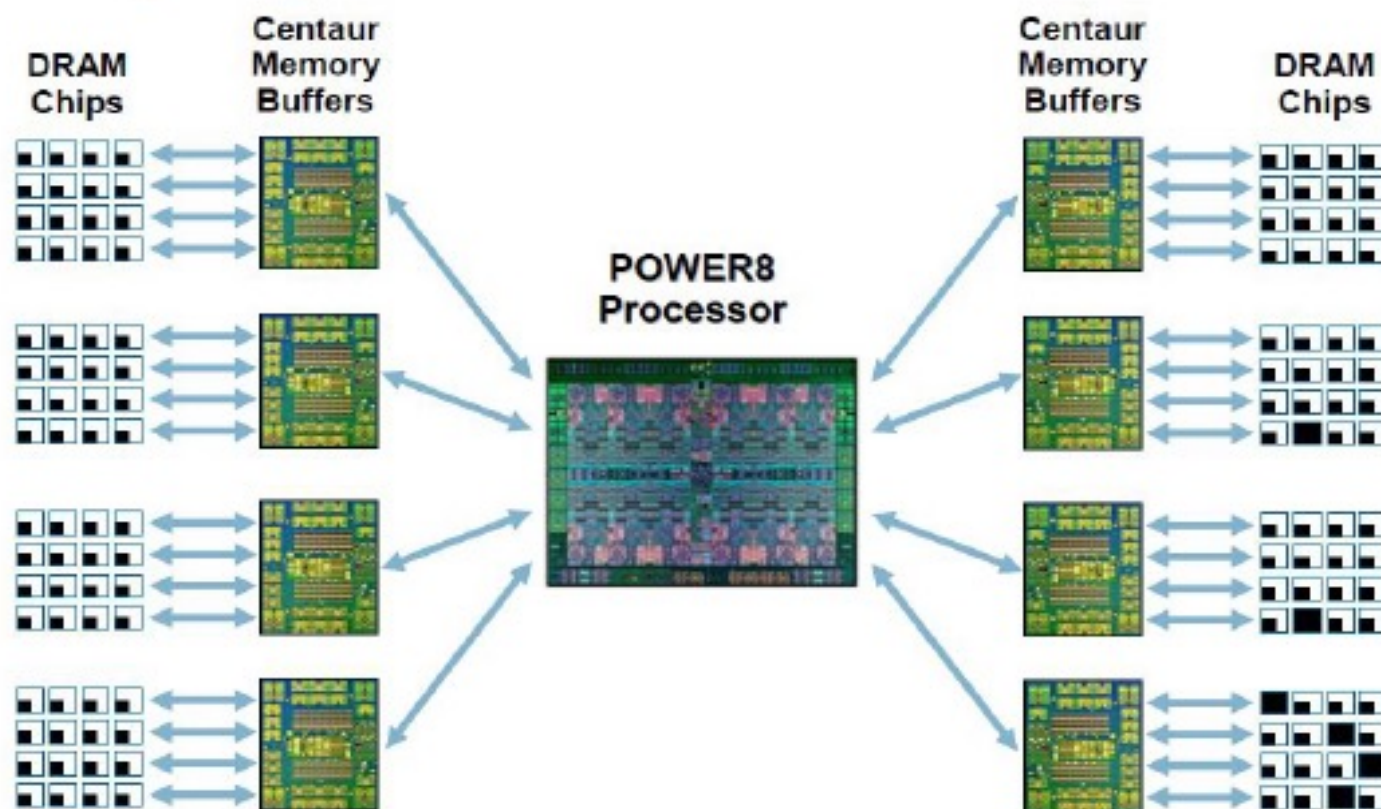
- Up to 230 GB/s sustained bandwidth

Bus Interfaces

- Durable open memory attach interface
- Integrated PCIe Gen3
- SMP Interconnect
- CAPI (Coherent Accelerator Processor Interface)



Memory Organization



- **Up to 8 high speed channels, each running up to 9.6 Gb/s for up to 230 GB/s sustained**
- **Up to 32 total DDR ports yielding 410 GB/s peak at the DRAM**
- **Up to 1 TB memory capacity per fully configured processor socket**



OpenPower8 2CPU 8core per CPU @ 3.8GHz, 512 GB RAM

OS: CentOS 7.2.15.11 ppc64le Compiler: gcc 4.8.5

Intel(R) Xeon(R) CPU E5-2697A v4 @ 2.60GHz, 128 GB RAM

OS: CentOS 6.6 Compiler: gcc 4.4.7

- Test HEPspec @ 64 bit
- Needs to recompile hepspec and toolset

HEPSPEC is the test adopted in HEP community to addresses the common workload

<https://w3.hepik.org/benchmarks/doku.php>

<https://www.spec.org/>

HEP SPEC

444.namd
447.dealll
450.soplex
453.povray
471.omnetpp
473.astar
483.xalancbmk

```
daniele.gregori — root@opower03:/opt/E4specCPU2006v1.2 — ssh root@100.100.3.5 — 117x
Installing FROM /opt/E4specCPU2006v1.2
Installing TO /opt/E4specCPU2006v1.2

Is this correct? (Please enter 'yes' or 'no')
yes

The following toolset is expected to work on your platform. If the
automatically installed one does not work, please re-run install.sh and
exclude that toolset using the '-e' switch.

The toolset selected will not affect your benchmark scores.

ppc64le-linux                               Come se fosse Antani arch

=====
Attempting to install the ppc64le-linux toolset...

Checking the integrity of your source tree...
```

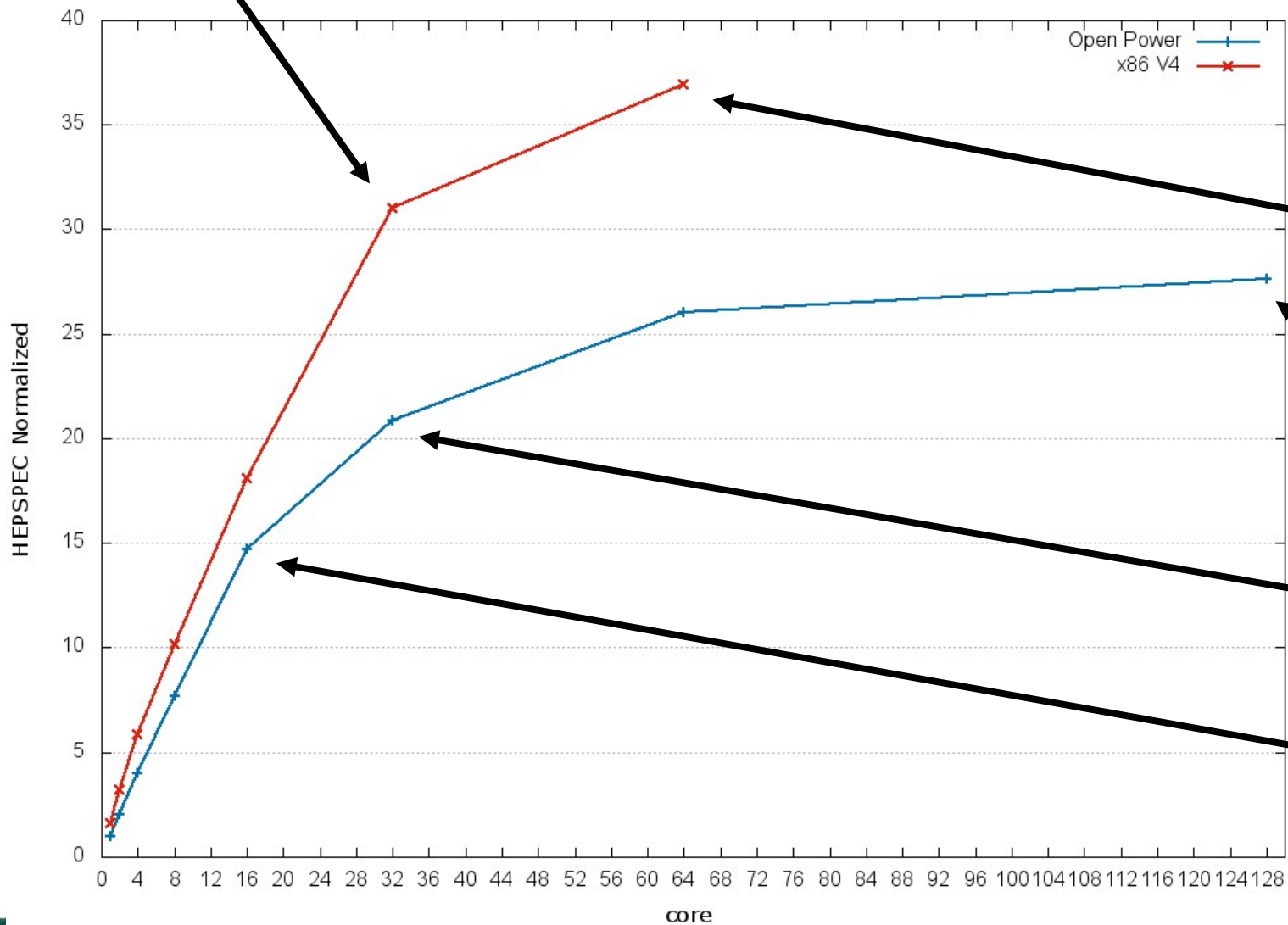
Results

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32 physical core

HEPSPEC per core: Open Power vs x86 V4 Normalized



HT on

8 Threads per core

2 Threads per core

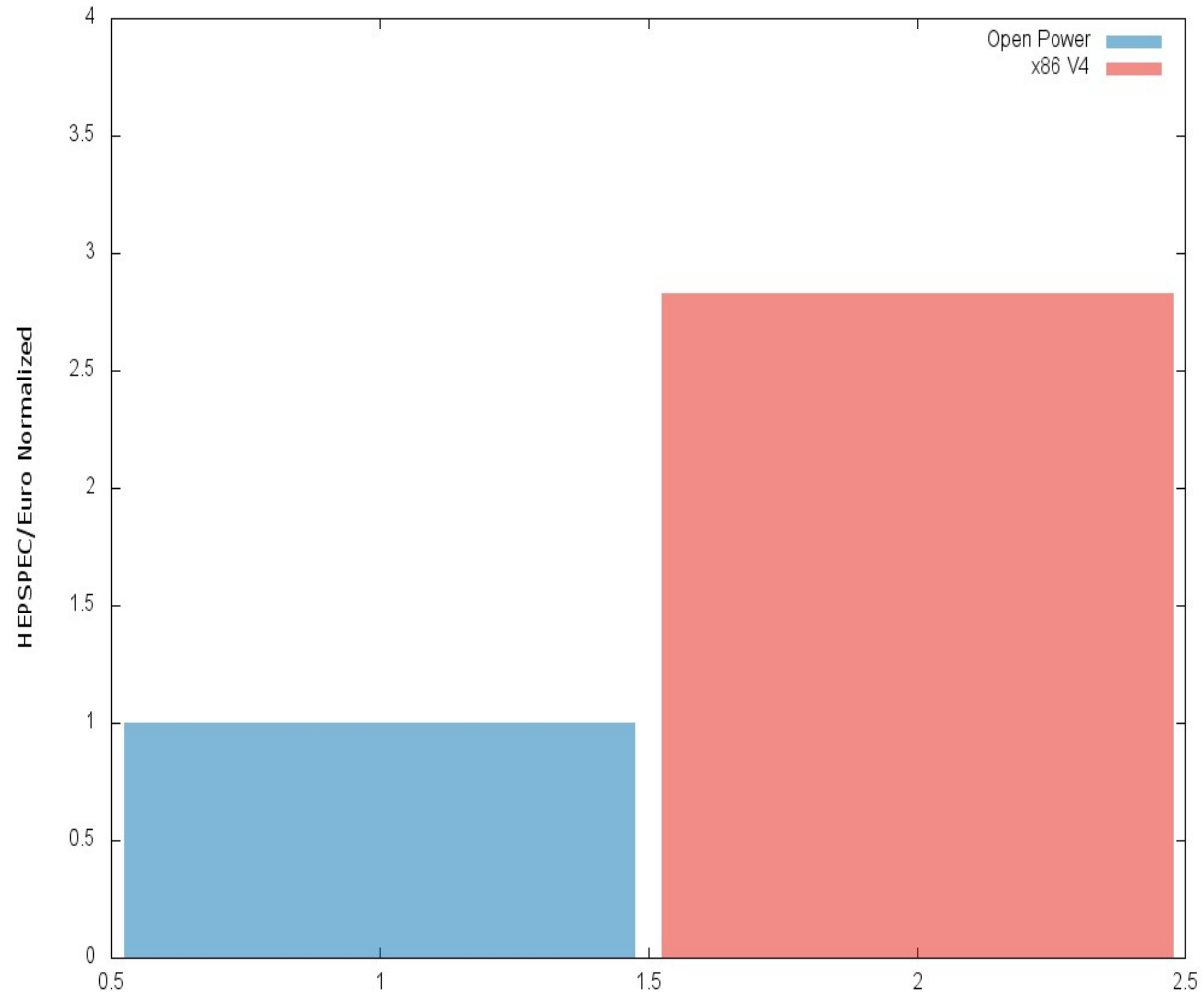
16 physical core

Results HEPSEC/Euro

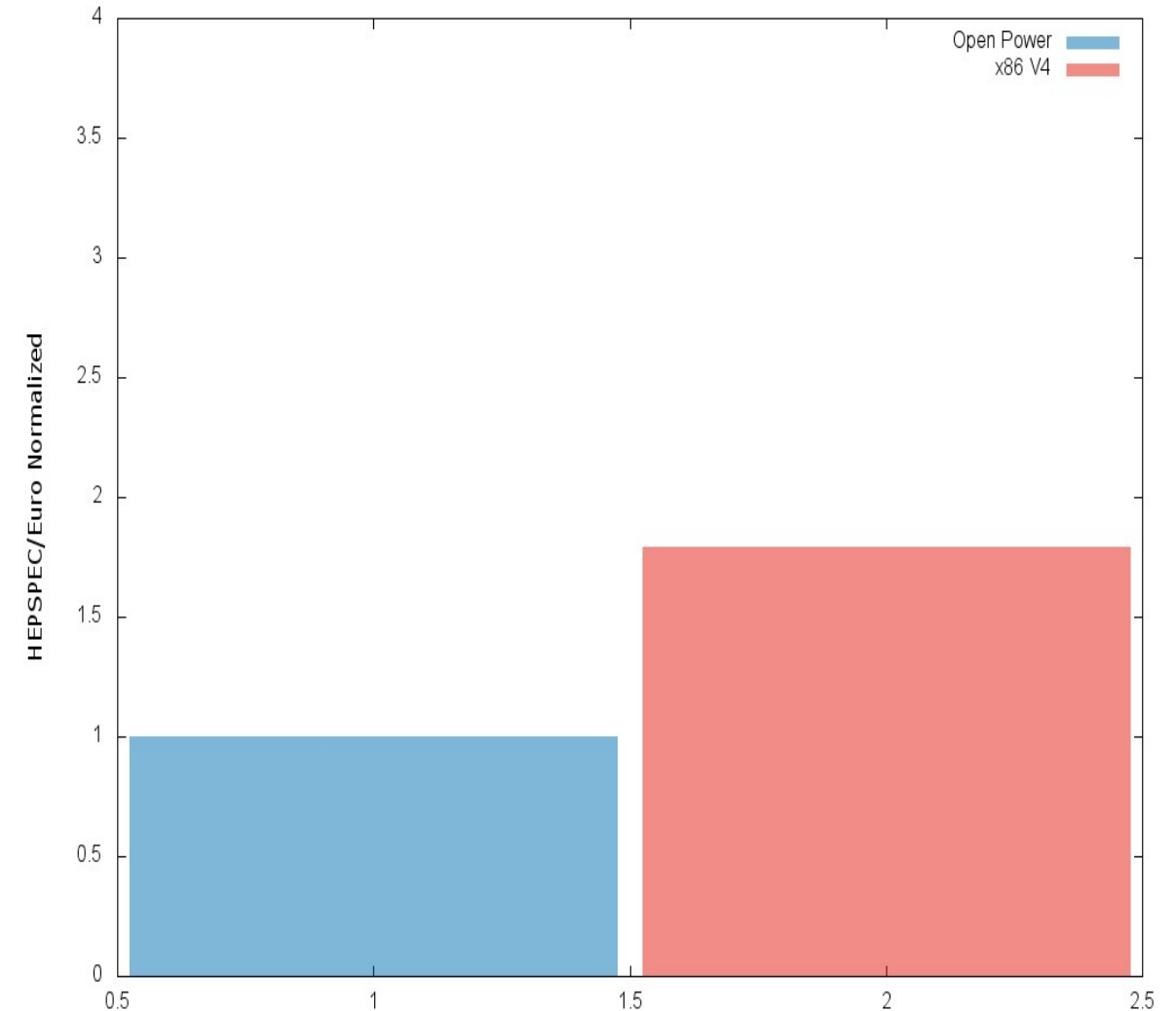
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HEPSPEC/Euro per CPU Normalized: Open Power vs x86 V4



HEPSPEC/Euro per max Threads Normalized: Open Power vs x86 V4

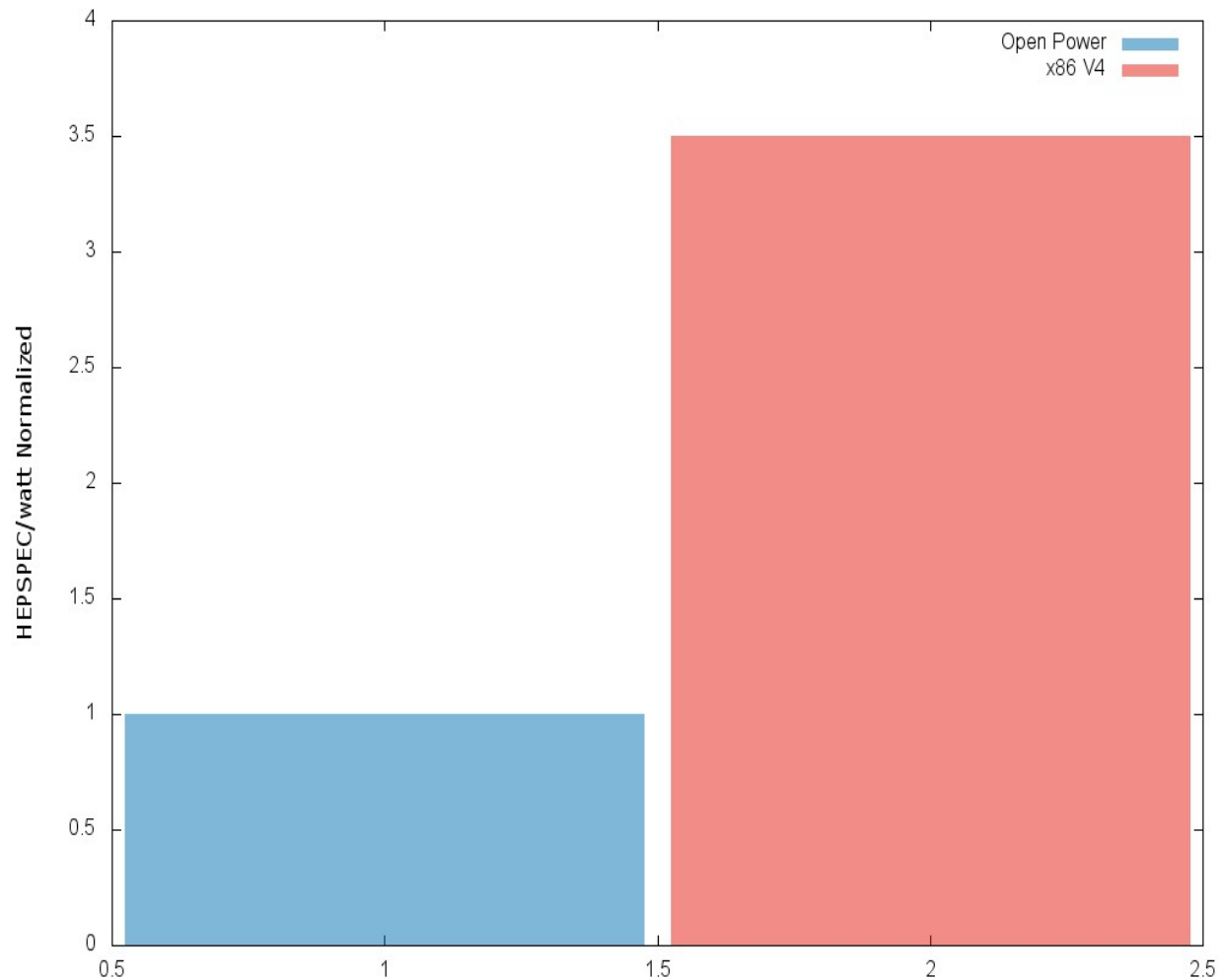


Results HEPSEC/watt

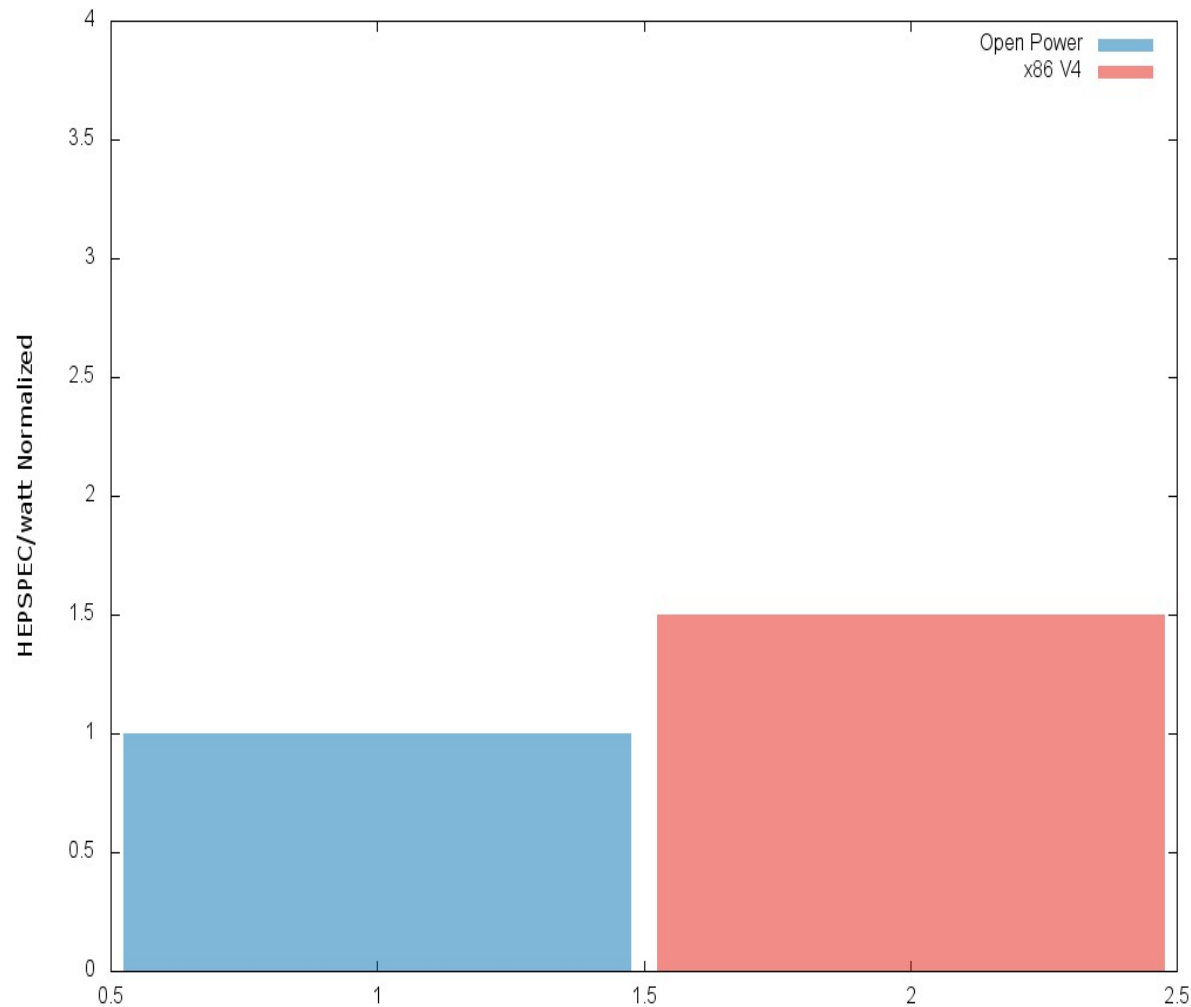
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HEPSPEC/watt per CPU Normalized: Open Power vs x86 V4

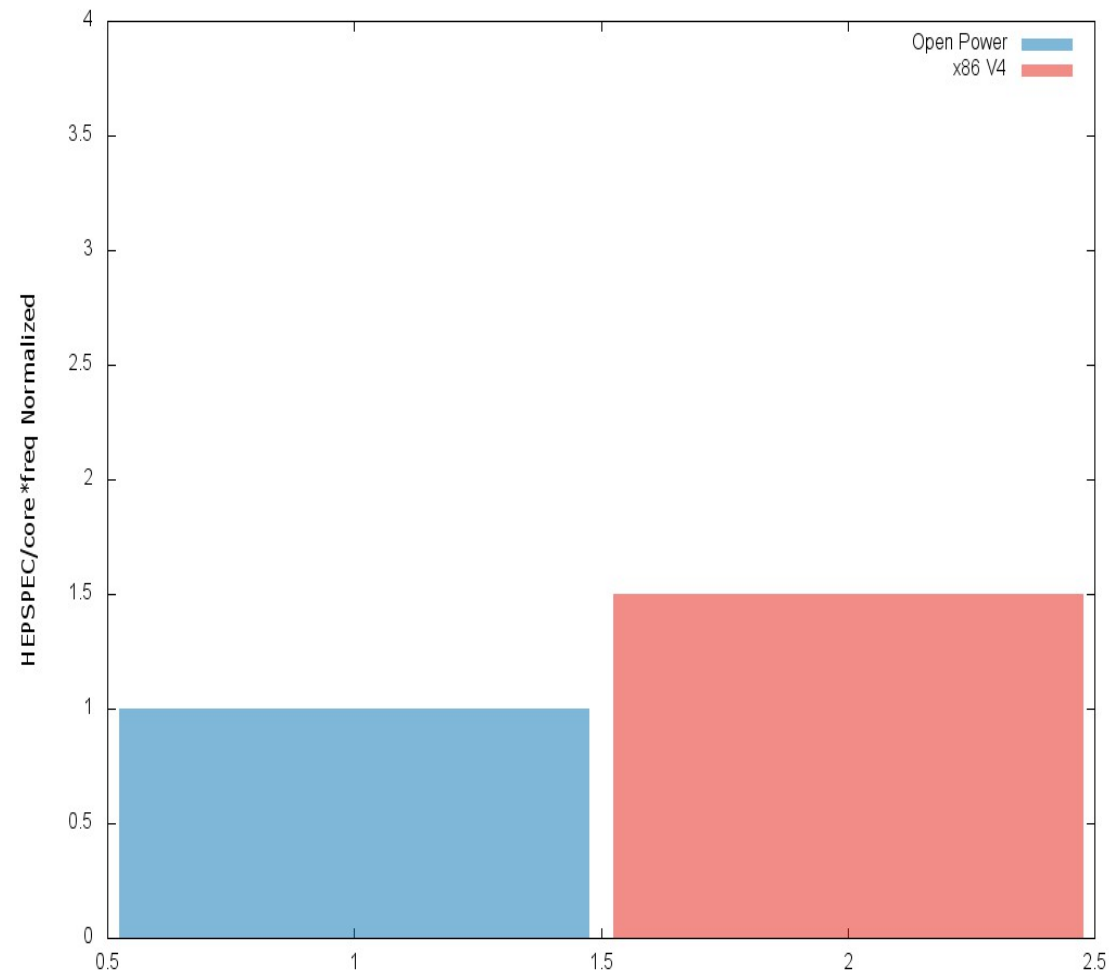


HEPSPEC/watt per max Threads Normalized: Open Power vs x86 V4

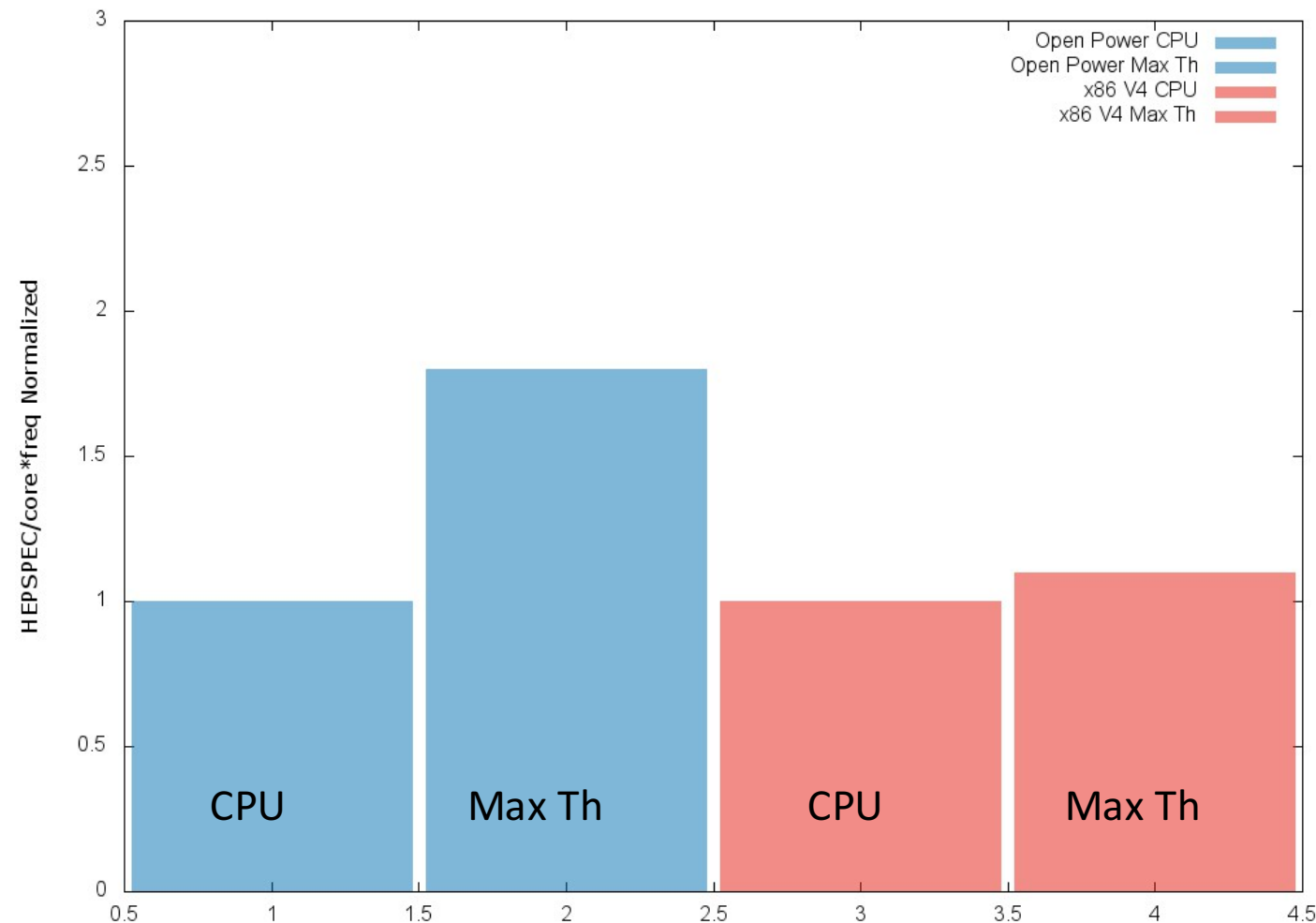


Results HEPSPC/(threds*freq)

HEPSPEC/(core*freq) per CPU Normalized: Open Power vs x86 V4



HEPSPEC/(core*freq) Normalized: Open Power vs x86 V4



STREAM

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Memory performance Benchmark: STREAM <http://www.cs.virginia.edu/stream/> + allocazione dinamica della memoria

COPY: $a(i) = b(i)$

SCALE: $a(i) = q * b(i)$

SUM: $a(i) = b(i) + c(i)$

TRIAD: $a(i) = b(i) + q * c(i)$

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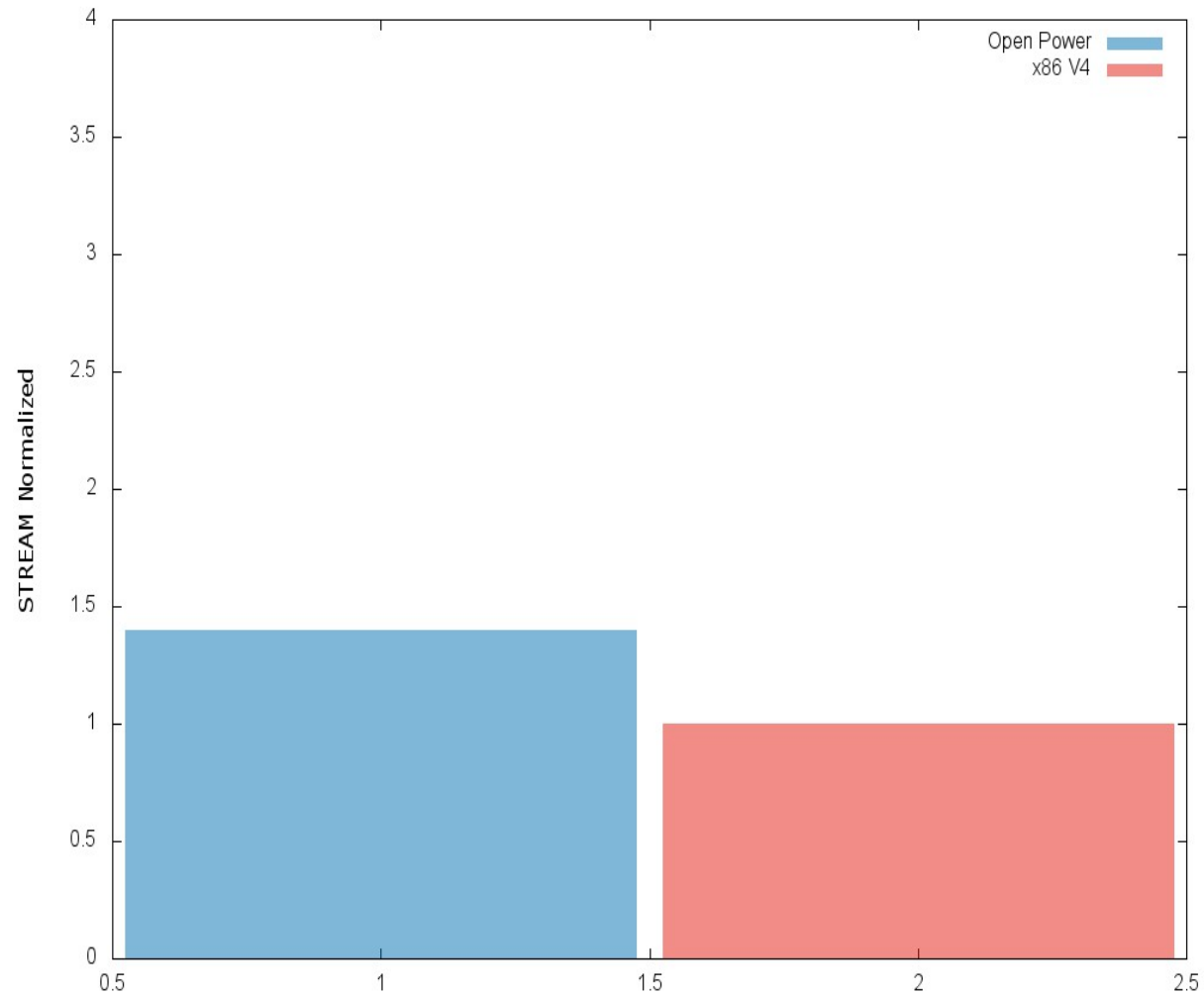
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Results Stream

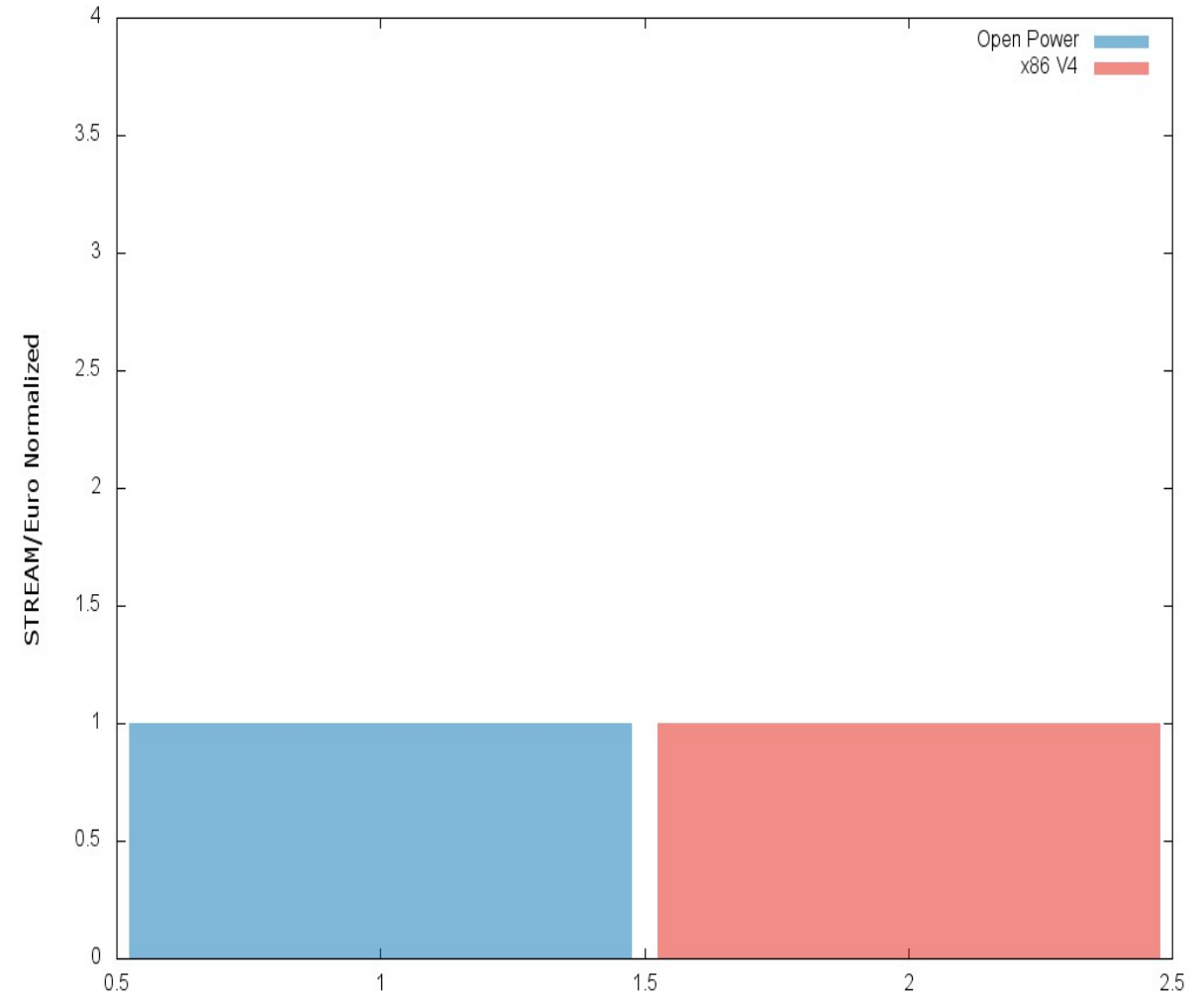
HPC & ENTERPRISE SOLUTIONS

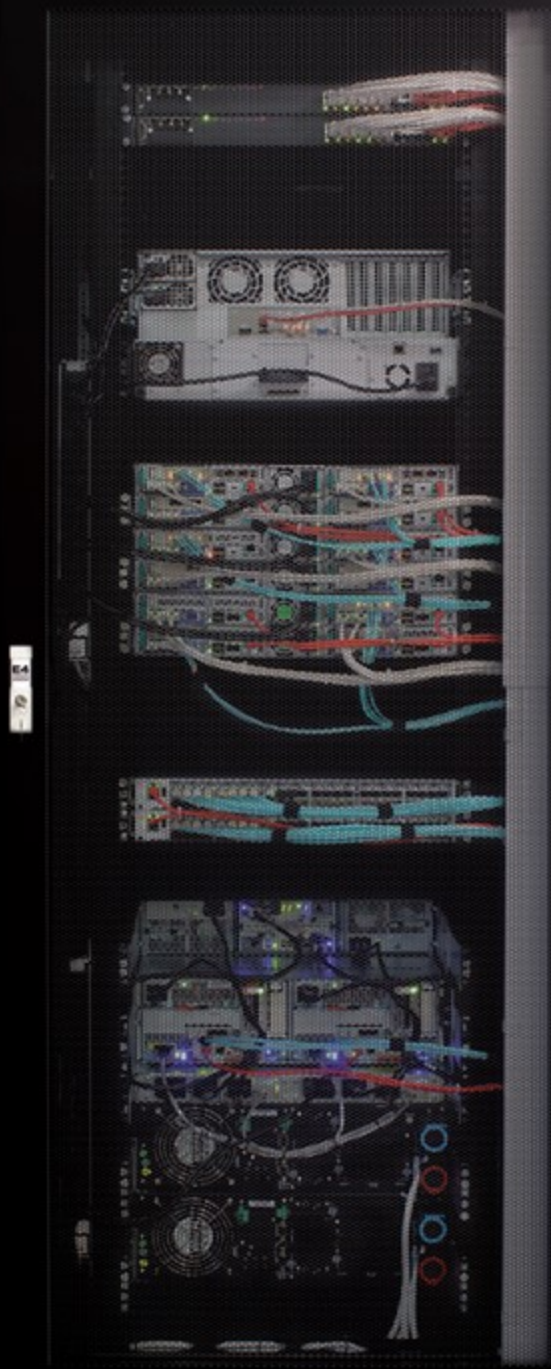


STREAM Normalized: Open Power vs x86 V4



STREAM/Euro Normalized: Open Power vs x86 V4





THANK YOU



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www.e4company.com