CPU Performance/Power Measurements at the Grid Computing Centre Karlsruhe

SPEC Colloquium, Dresden, 2007-06-22

Manfred Alef

Forschungszentrum Karlsruhe
Institute for Scientific Computing
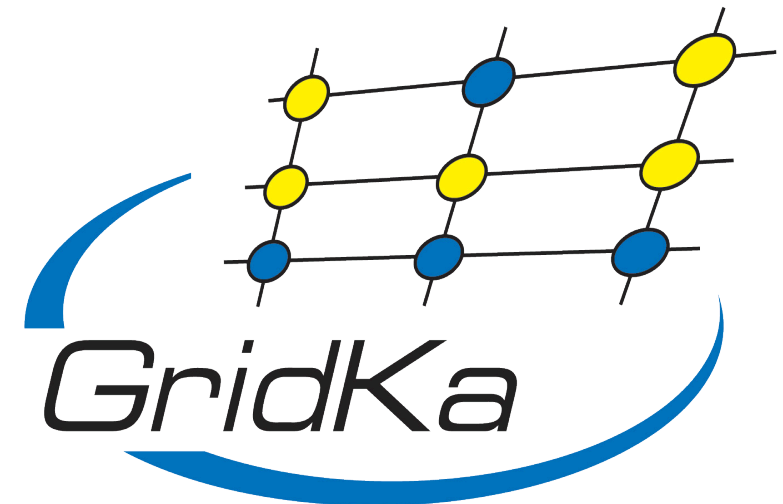Hermann-von-Helmholtz-Platz 1
D-76344 Eggenstein-Leopoldshafen

http://www.fzk.de, http://www.gridka.de
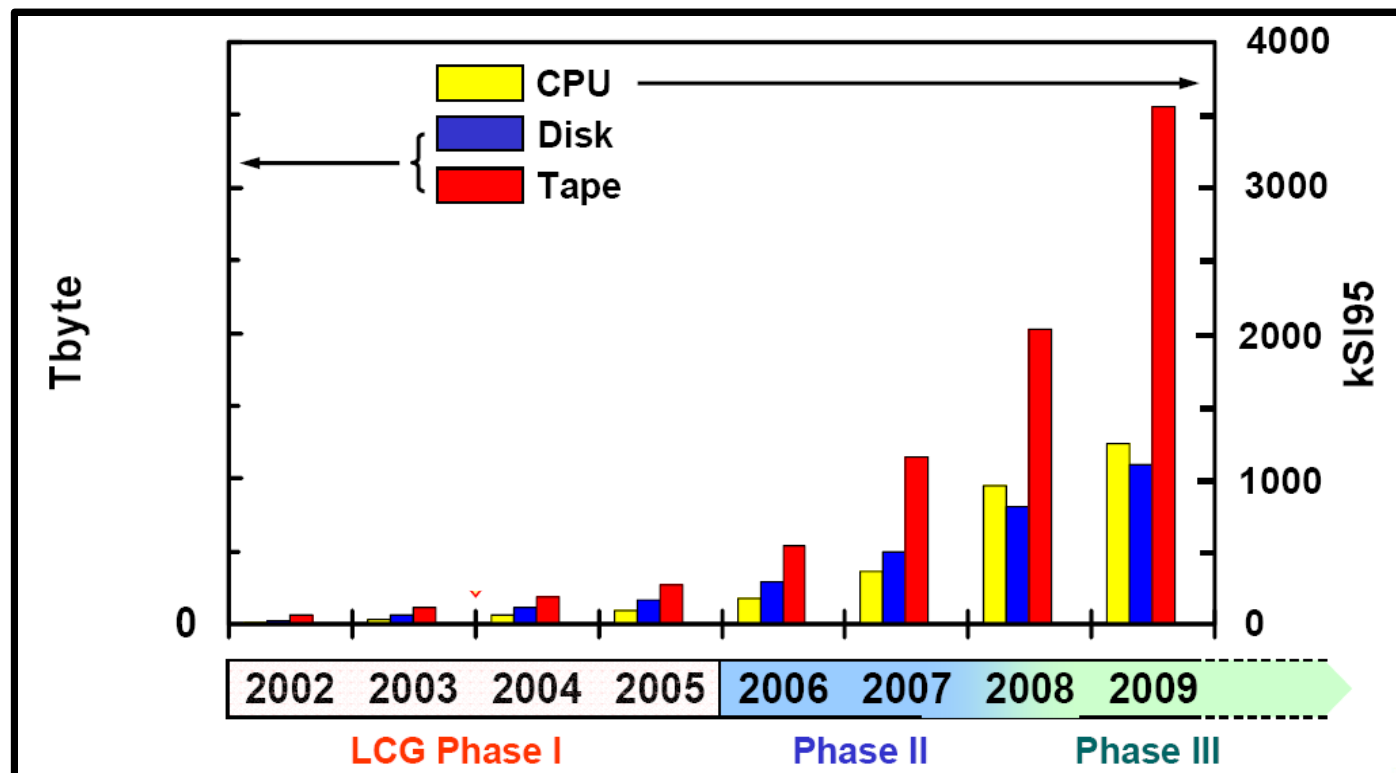
firstname.lastname@iwr.fzk.de

Grid Computing Centre Karlsruhe (GridKa):

➔ Founded 2001:

- German tier-1 computing centre
  for 4 LHC experiments

- German computing centre
  for 4 non LHC experiments
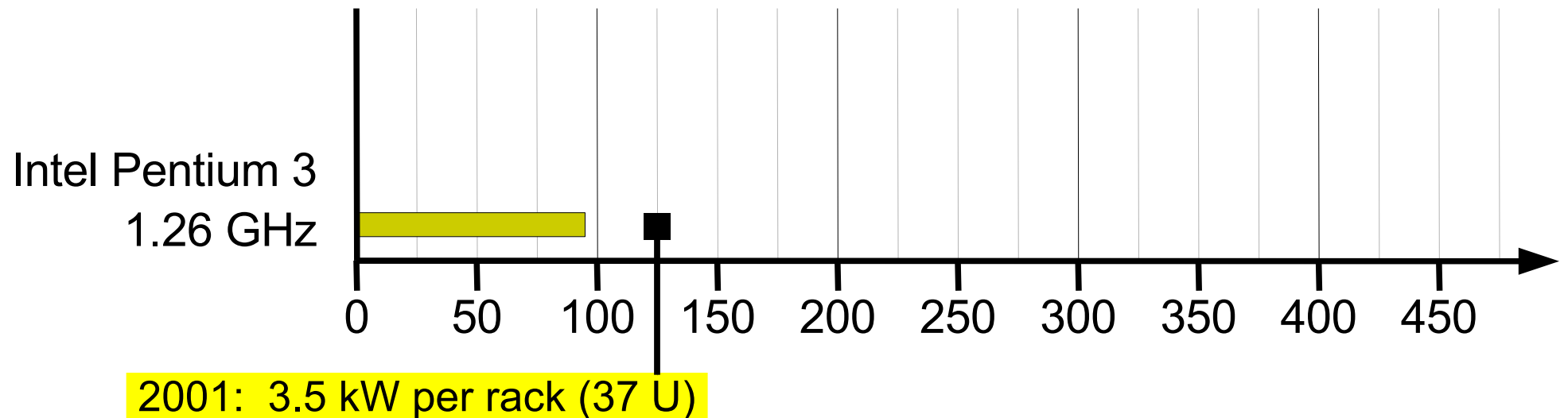
- ...

Grid Computing Centre Karlsruhe (GridKa):

➜ Required hardware ressources (2001):

First Tasks:

➔   Estimation of expected power and cooling needs

➔   Insufficient capacity of the air cooling system

➔   2001-2002:
      Public invitation for tenders of water-cooled 19" cabinets
      (Amount of heat dissipation to be removed = ?)

Electric Power Consumption (W)
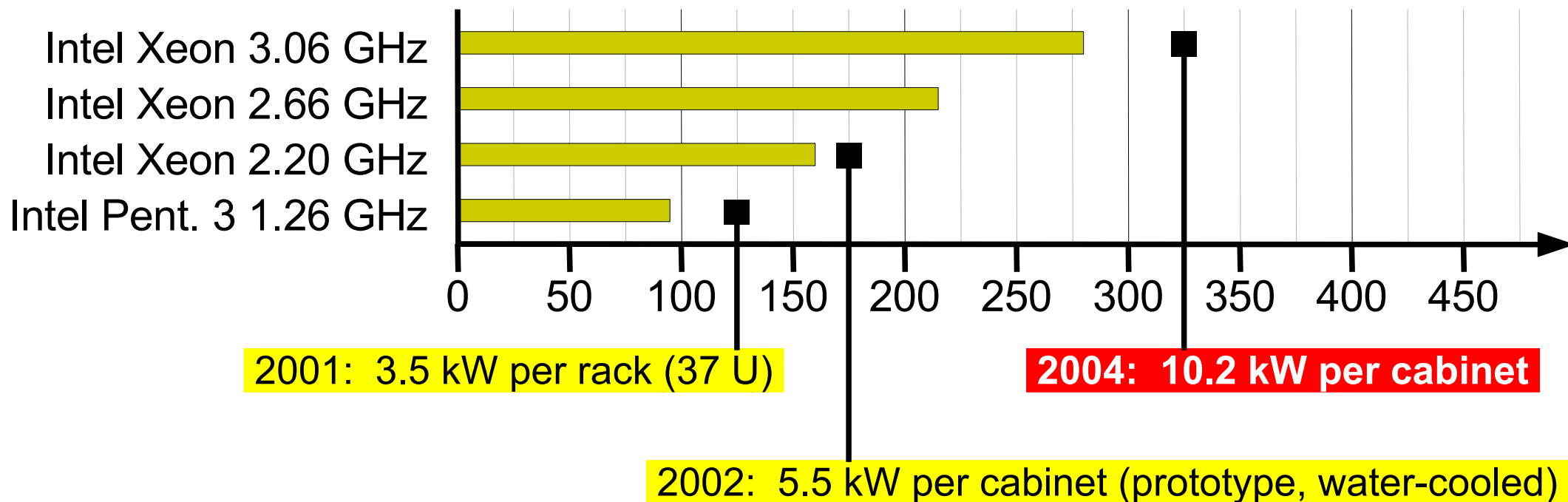
Intel Pentium 3
1.26 GHz

0   50   100   150   200   250   300   350   400   450

2001: 3.5 kW per rack (37 U)

Scientific Linux* 3/4 i386, 1 copy of cpuburn-1.4** per CPU
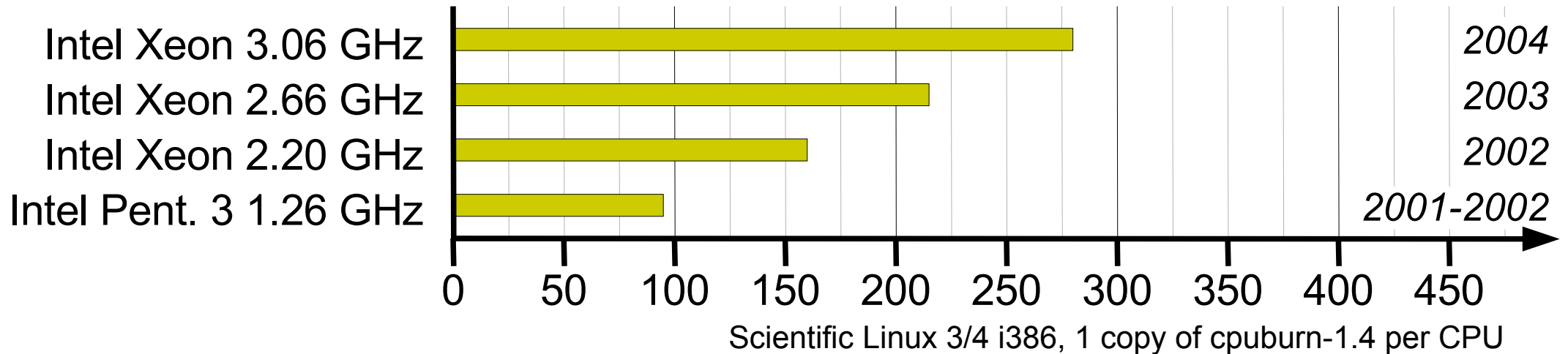[* https://www.scientificlinix.org; ** http://pages.sbcglobal.net/redelm]

First Tasks:

➔ Estimation of expected power and cooling needs

➔ 2001-2002:
Public invitation for tenders of water-cooled 19" cabinets
(Amount of heat dissipation to be removed: $\rightarrow$ 10 kW)

Electric Power Consumption (W)

Intel Xeon 3.06 GHz
Intel Xeon 2.66 GHz
Intel Xeon 2.20 GHz
Intel Pent. 3 1.26 GHz

0   50   100   150   200   250   300   350   400   450

2001: 3.5 kW per rack (37 U)

2004: 10.2 kW per cabinet

2002: 5.5 kW per cabinet (prototype, water-cooled)

Scientific Linux 3/4 i386, 1 copy of cpuburn-1.4 per CPU

Electric Power Consumption (W)

Intel Xeon 3.06 GHz — *2004*
Intel Xeon 2.66 GHz — *2003*
Intel Xeon 2.20 GHz — *2002*
Intel Pent. 3 1.26 GHz — *2001-2002*

0 50 100 150 200 250 300 350 400 450

Scientific Linux 3/4 i386, 1 copy of cpuburn-1.4 per CPU

System Performance (SPECint_rate_base2000)

Intel Xeon 3.06 GHz — *2004*
Intel Xeon 2.66 GHz — *2003*
Intel Xeon 2.20 GHz — *2002*
Intel Pent. 3 1.26 GHz — *2001-2002*

2 copies

0 5 10 15 20 25 30 35 40 45

Scientific Linux 3/4 i386, gcc-3.4.x -O3 -funroll-loops -march, 1 benchmark copy per CPU
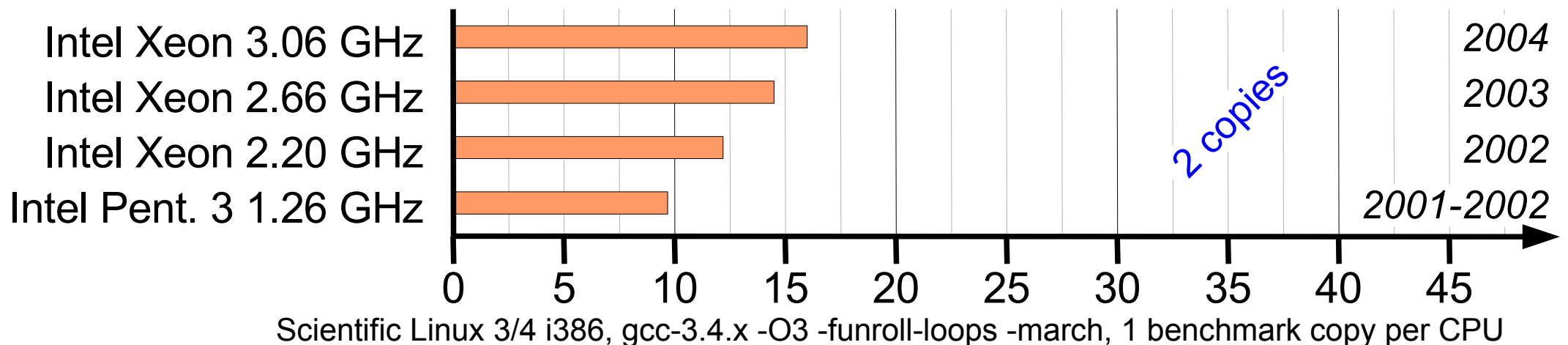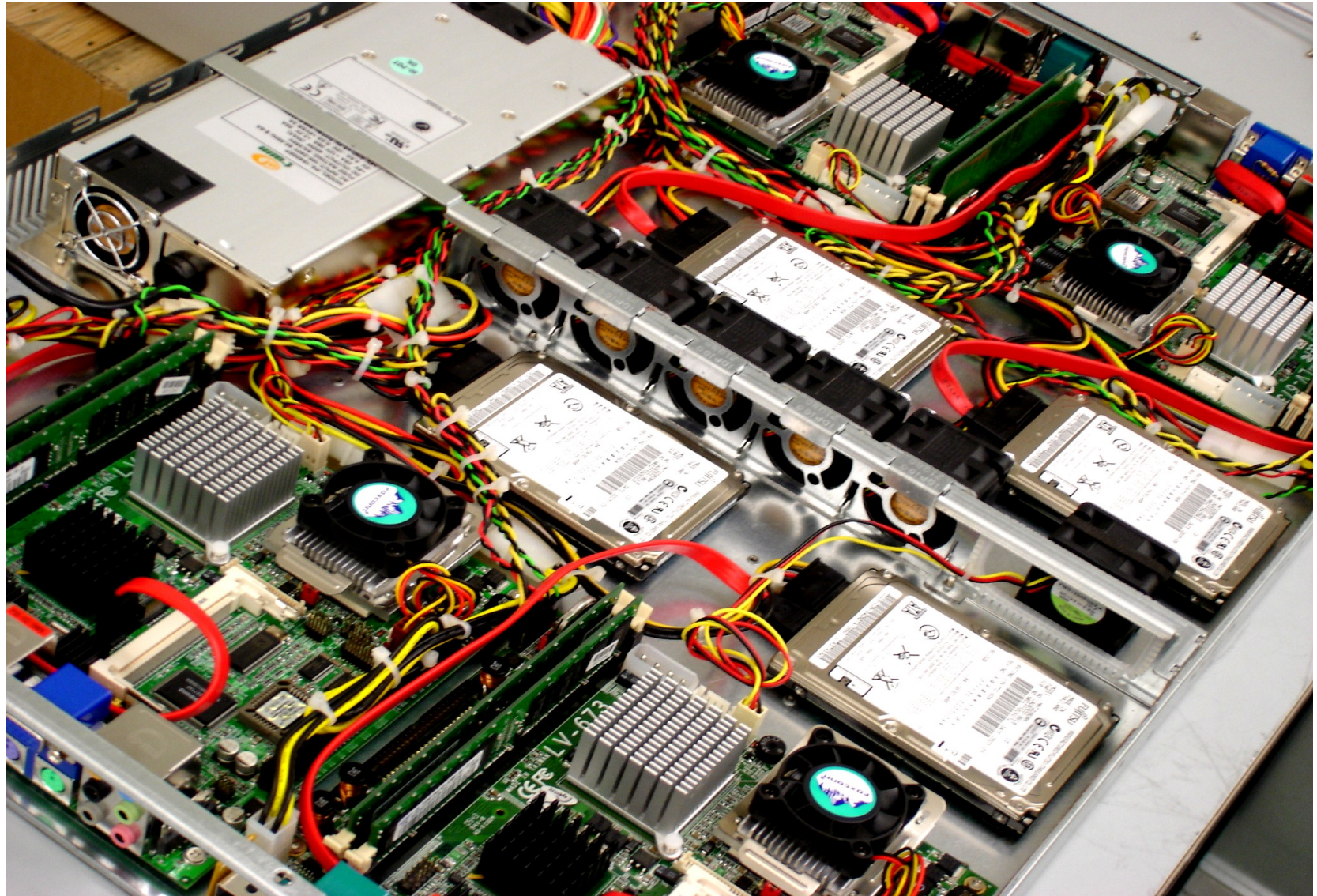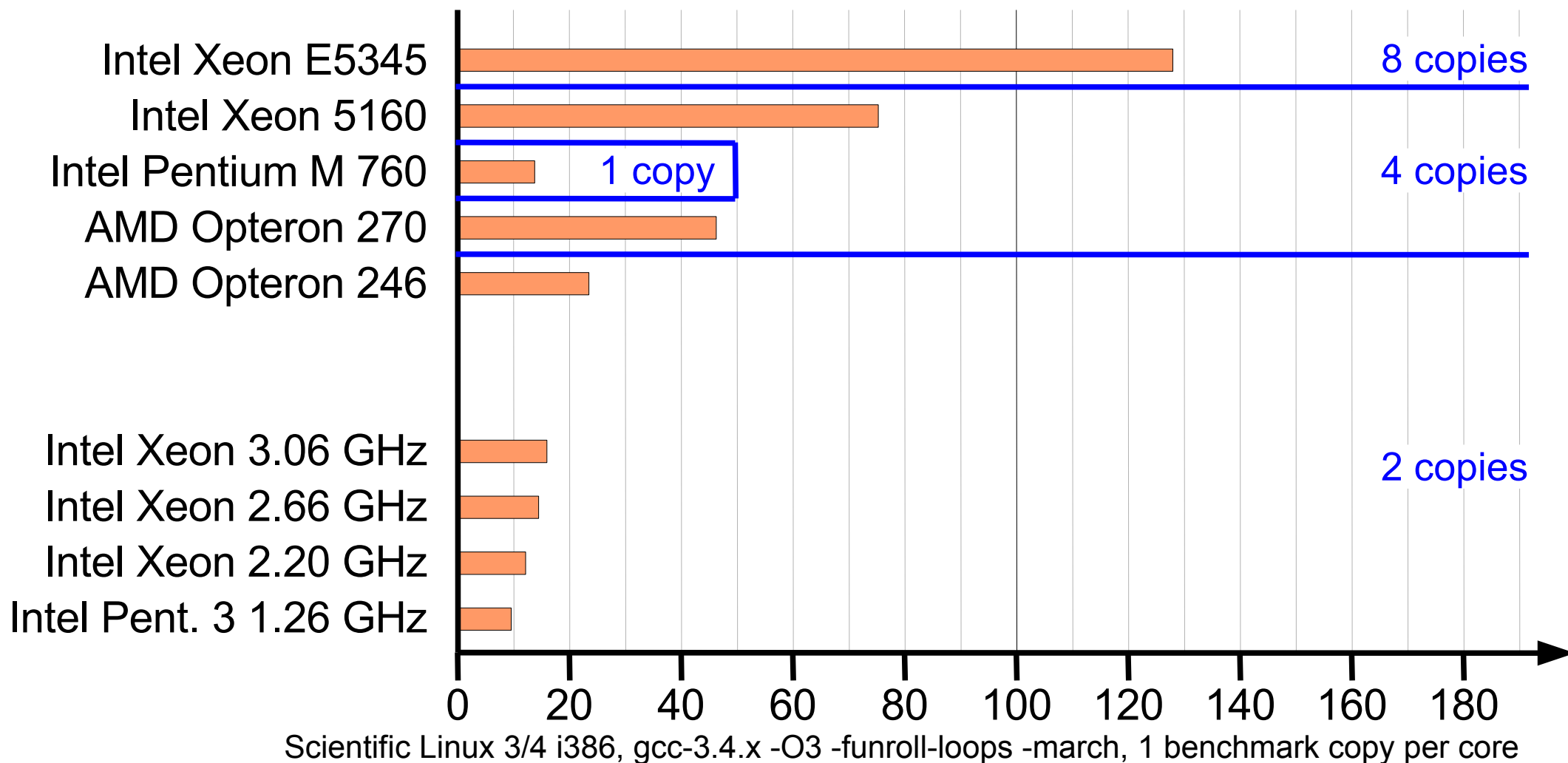
Consequences:

➔ Extensive performance and power measurements

➔ Procurements since 2004:
Added limit of power consumption per system

➔ Procurements since 2005:
Penalties for power consumption (4 EUR/W$_{max}$)

Intel Pentium M 760
4 systems per 1U
(2005)

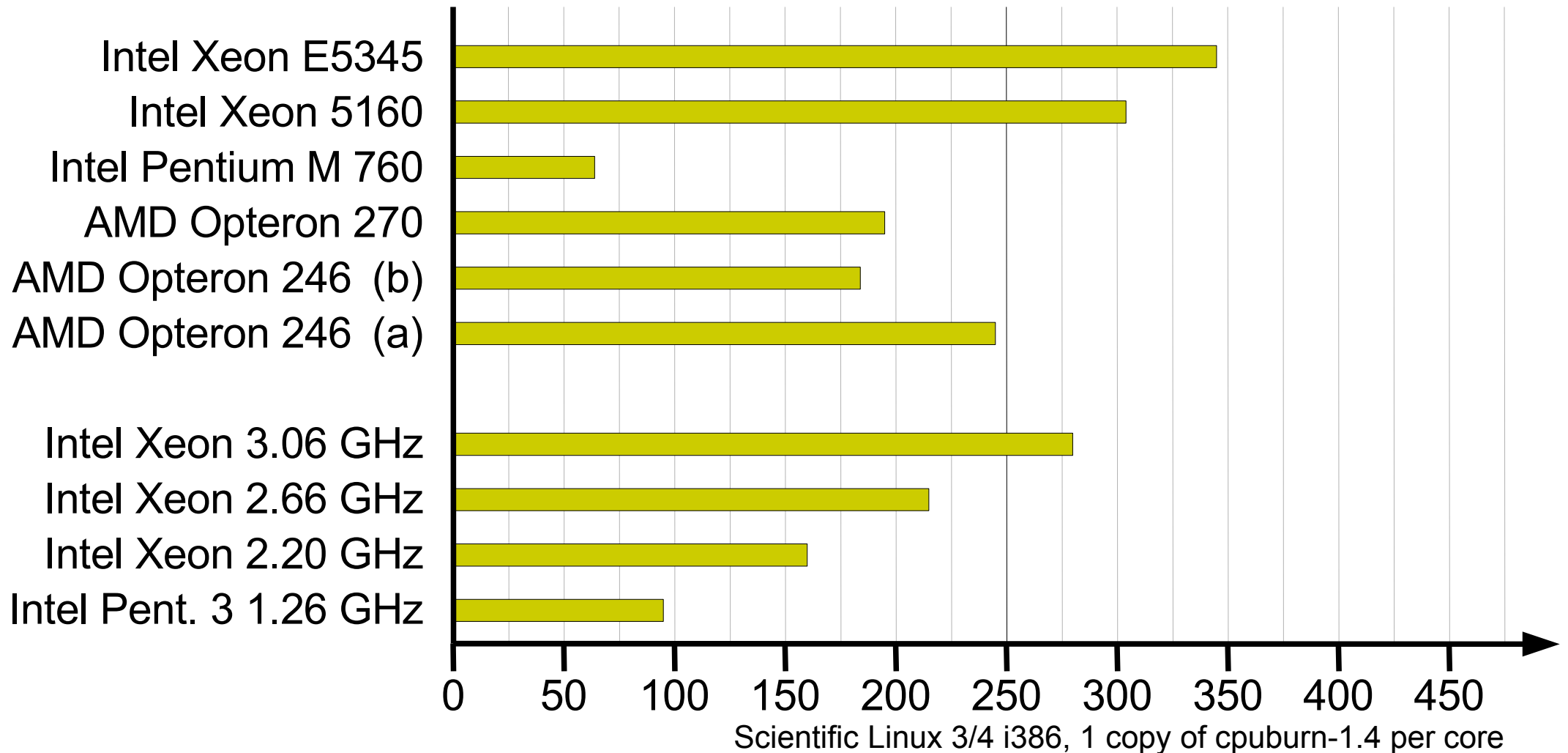## System Performance (SPECint_rate_base2000)
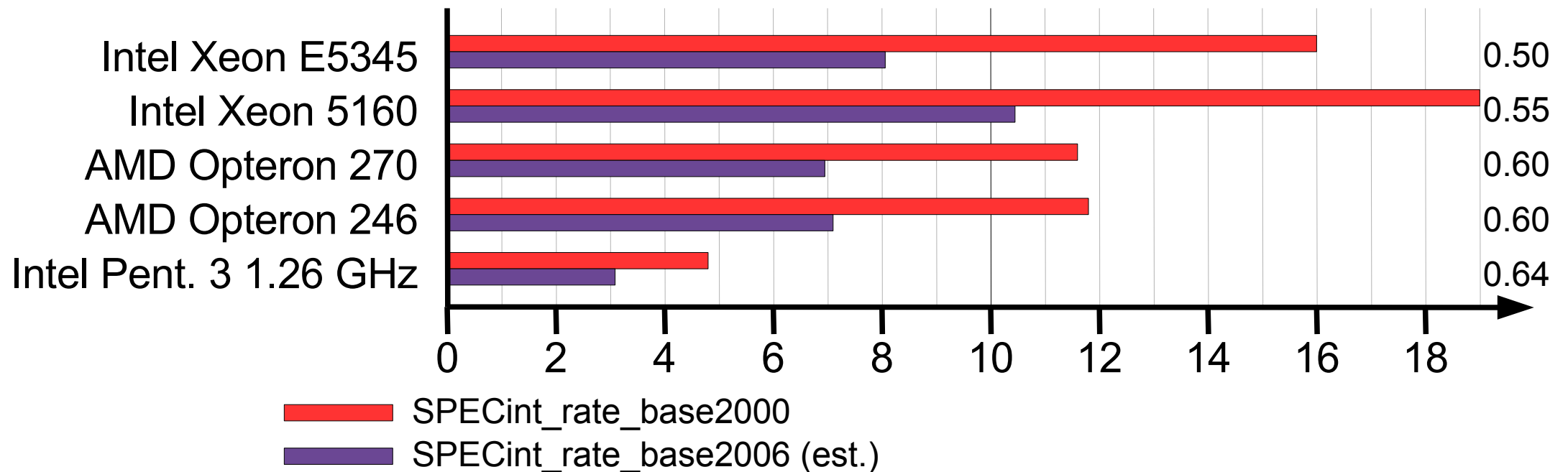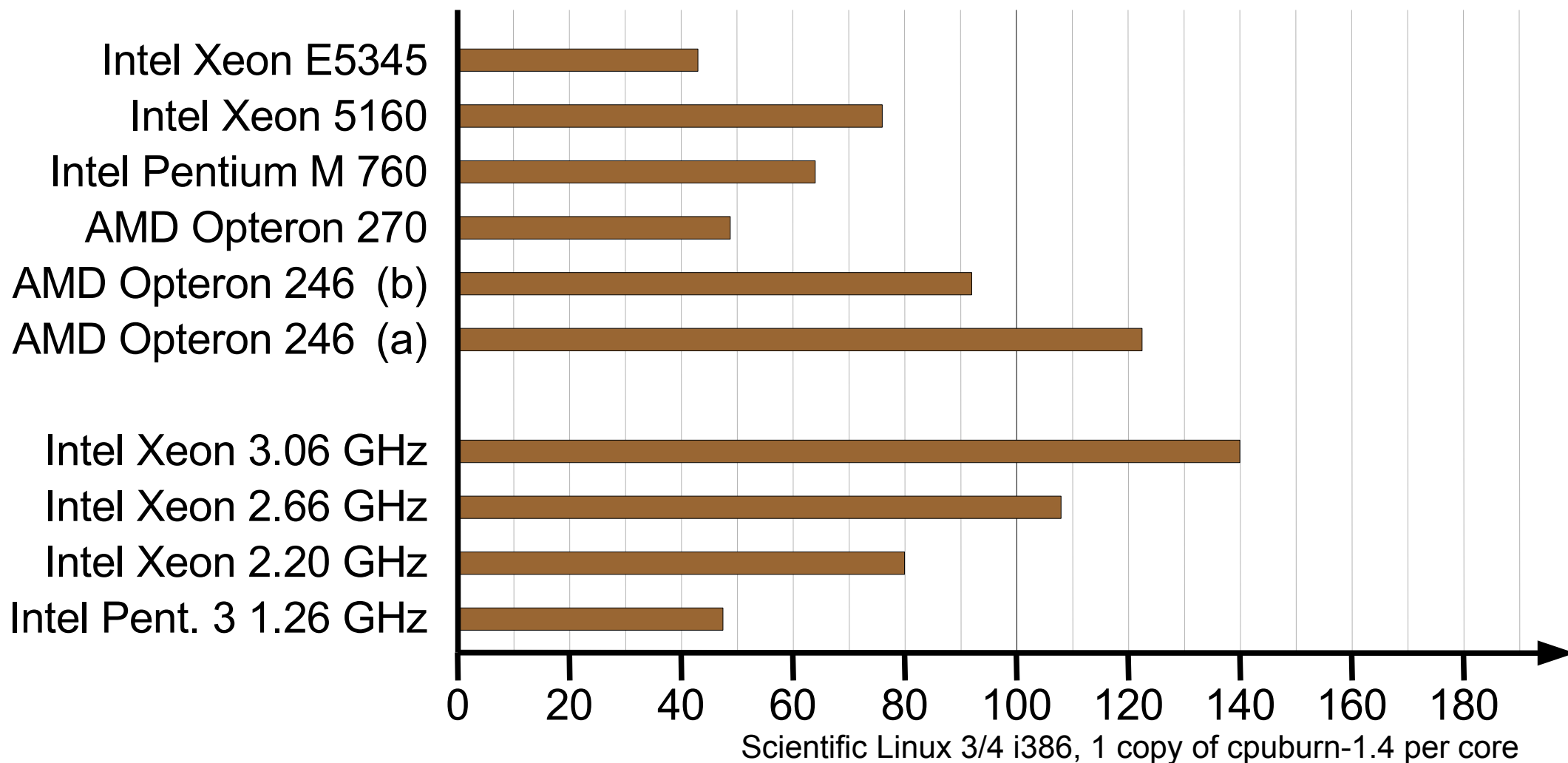

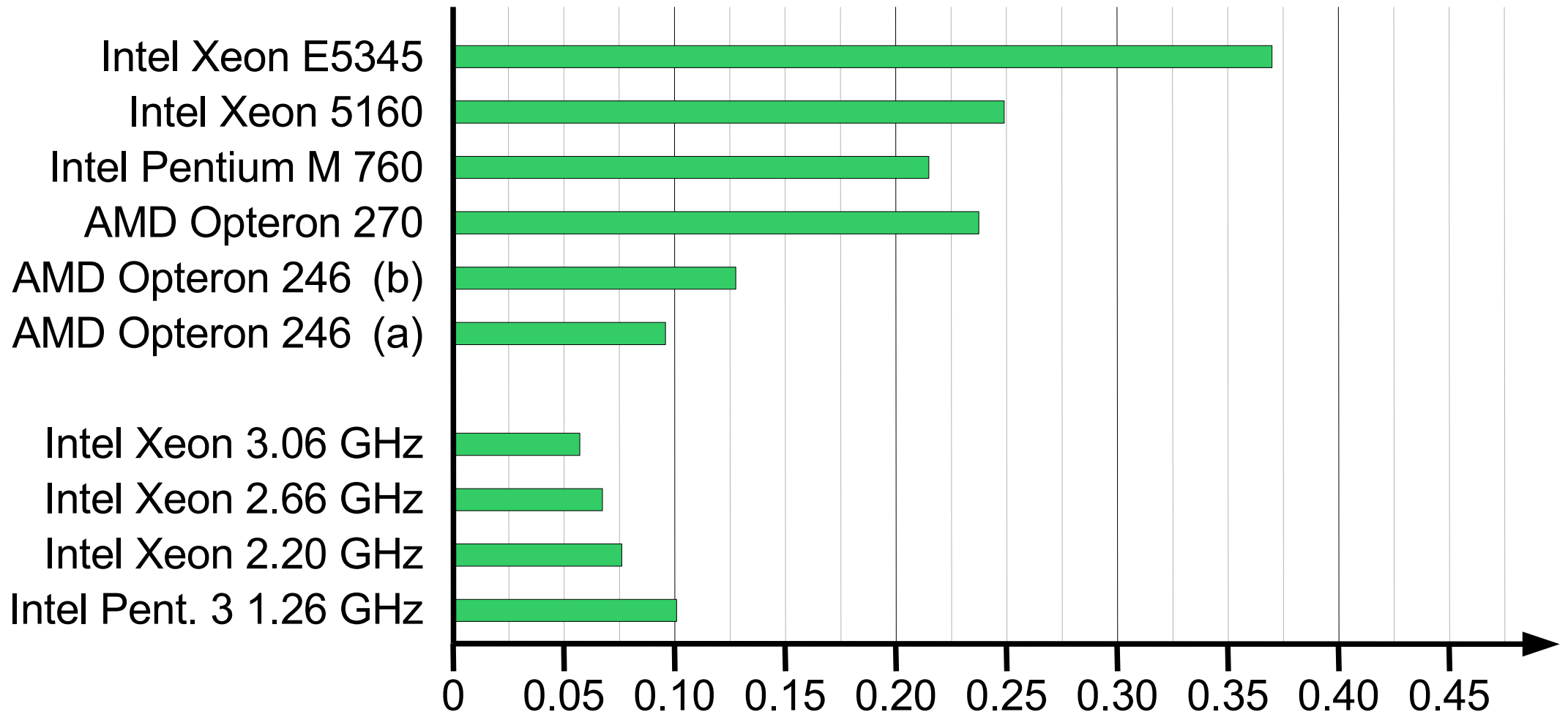Scientific Linux 3/4 i386, gcc-3.4.x -O3 -funroll-loops -march, 1 benchmark copy per core

Electric Power Consumption (W)

Scientific Linux 3/4 i386, 1 copy of cpuburn-1.4 per core

Electric Power Consumption (W per Core)

Processor	Power
Intel Xeon E5345	~43
Intel Xeon 5160	~76
Intel Pentium M 760	~64
AMD Opteron 270	~49
AMD Opteron 246 (b)	~92
AMD Opteron 246 (a)	~122
Intel Xeon 3.06 GHz	~140
Intel Xeon 2.66 GHz	~108
Intel Xeon 2.20 GHz	~80
Intel Pent. 3 1.26 GHz	~47

Scientific Linux 3/4 i386, 1 copy of cpuburn-1.4 per core

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

Efficiency (SPECint_rate_base2000 per W)
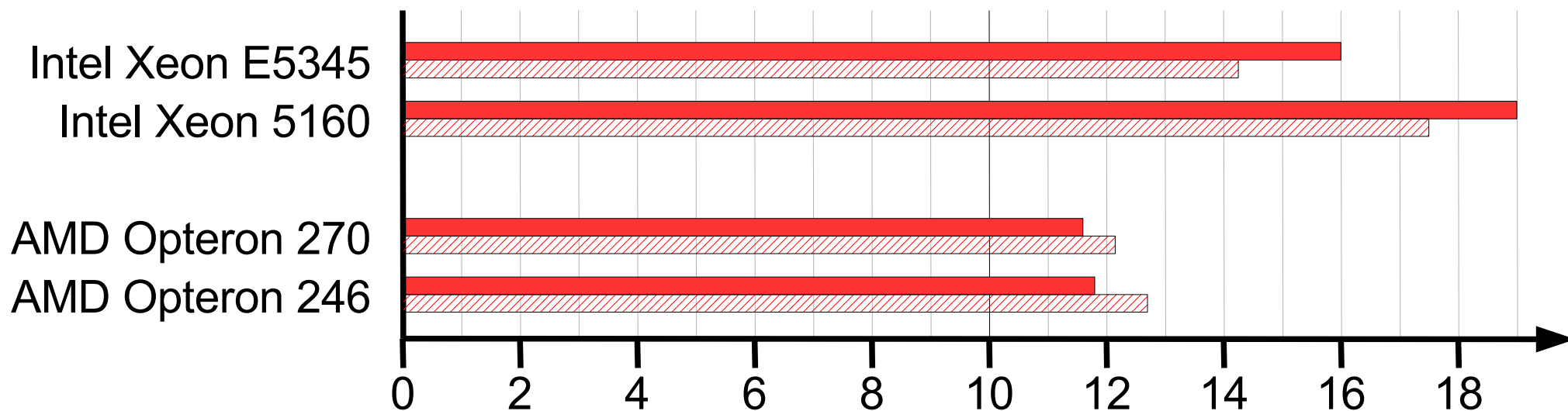
Conclusions:

➔   Benchmarking at GridKa based on SPEC CPU2000, according to the requirements of WLCG project

➔   CPU performance + power measurements

➔   Results demonstrate diversion in the performance/power efficiency of current cluster hardware

Conclusions:

➔ Goals of CPU benchmarking and power measurements at GridKa – planning of infrastructure and procurements:

- estimation of the energy costs during life span

- infrastructure issues (e.g. cooling devices, UPS, fuses)

➔ Desire:

- power benchmark should measure average power consumption depending on workload scenario

- runspec flag to measure upper limit of electric power consumption

Questions, Comments?

Cluster Hardware at GridKa:

➜ Intel Xeon E5345 (2.33 GHz quad core, 2x):
Barebone: Supermicro CSE-812L-520CB, Mainboard: Supermicro X7DBE, RAM: 16 GB DDR2-677, Disks: 2 IDE

➜ Intel Xeon 5160 (3.0 GHz dual core, 2x):
Barebone: Intel SR1530CL, Mainboard: Intel S5000VCL, RAM: 6 GB DDR2-677, Disk: SATA

➜ Intel Pentium M 760 (2.0 GHz, 1x):
Mainboard: AOpen i915GMm-HFS, RAM: 1 GB DDR2-533, Disk: IDE

➜ AMD Opteron 270 (2.0 GHz dual core, 2x):
Barebone: MSI-9245-100, Mainboard: MSI K1-1000D with BMC, RAM: 4 GB DDR-400, Disk: IDE

➜ AMD Opteron 246 (2.0 GHz single core, 2x):
(a) Barebone: Tyan Transport GX28, Mainboard: Tyan S2882, RAM: 2 GB DDR-333, Disk: IDE
(b) Barebone: MSI-9245, Mainboard: MSI-9145 with BMC, RAM: 2 GB DDR-400, Disk: IDE

➜ Intel Xeon 2.66 GHz and 3.06 GHz (2x):
Mainboard: TYAN Tiger i7501 S2723GN, HyperThreading off, RAM: 1 GB DDR-266, Disk: IDE

➜ Intel Xeon 2.2 GHz (2x):
Mainboard: TYAN Tiger i7500 S2720GN, HyperThreading off, RAM: 1 GB DDR-200, Disk: IDE

➜ Intel Pentium 3, 1.26 GHz (2x):
Mainboard: TYAN Thunder LE-T S2518, RAM: 1 GB SD-133, Disk: IDE