Green Computing Systems Research and Development with Industry

Hironori Kasahara

Professor, Dept. of Computer Science & Engineering

Director, Advanced Multicore Processor Research Institute

Waseda University, Tokyo, Japan

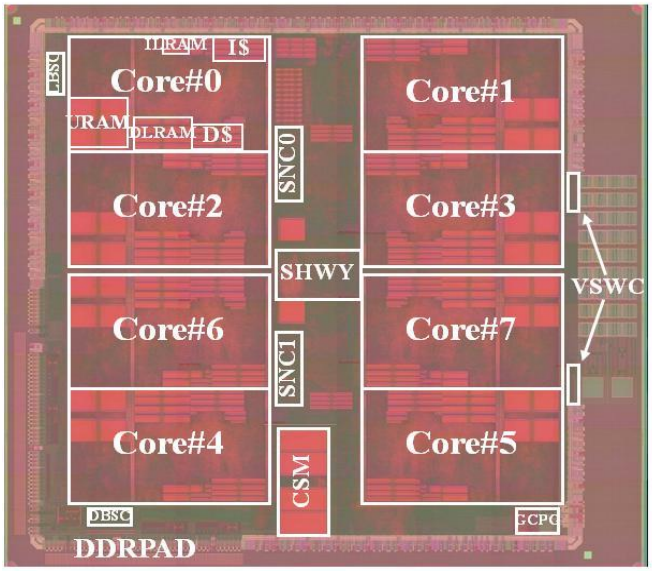
IEEE Computer Society Board of Governors

IEEE Computer Society Multicore Strategic Technical Committee (STC) Chair

URL: http://www.kasahara.cs.waseda.ac.jp/

ITRI Waseda Forum, 2012.10.15(Monday), Waseda University

Multi/Many-core Everywhere



OSCAR Type Multi-core Chip by Renesas in METI/NEDO Multicore for Real-time Consumer Electronics Project (Leader: Prof.Kasahara)

The 37th (June 20,2011) &38th (Nov.14.2011) Top 500 No.1, Riken Fujitsu "K" 705,024 cores Peak 11.28 PFLOPS, (88,128procs) LINPACK 10.510 PFLOPS (93.2%)

Multi-core from embedded to supercomputers

- **Consumer Electronics (Embedded)**
  - Mobile Phone, Game, TV, Car Navigation, Camera,
  - IBM/ Sony/ Toshiba Cell, Fujitsu FR1000,
  - Panasonic Uniphier, NEC/ARM MPCore/MP211/NaviEngine,
  - Renesas 4 core RP1, 8 core RP2, 15core Hetero RP-X,
  - Plurarity HAL 64(Marvell), Tilera Tile64/ -Gx100(->1000cores),
  - DARPA UHPC (2017: 80GFLOPS/W)
- **PCs, Servers**
  - Intel Quad Xeon, Core 2 Quad, Montvale, Nehalem(8cores),
  - Larrabee(32cores), SCC(48cores), Night Corner(50 core+:22nm),
  - AMD Quad Core Opteron (8, 12 cores)
- **WSs, Deskside & Highend Servers**
  - IBM(Power4,5,6,7), Sun (SparcT1,T2), Fujitsu SPARC64fx8
- **Supercomputers**
  - Earth Simulator:40TFLOPS, 2002, 5120 vector proc.
  - BG/Q (A2:16cores) Water Cooled20PFLOPS, 3-4MW (2011-12),
  - BlueWaters(HPCS) Power7, 10 PFLOP+(2011.07),
  - Tianhe-1A (4.7PFLOPS,6coreX5670+ Nvidia Tesla M2050),
  - Godson-3B (1GHz40W 8core128GFLOPS) -T (64 core,192GFLOPS:2011)
  - RIKEN Fujitsu "K" 10PFLOPS(8core SPARC64VIIIfx, 128GGFLOPS)

High quality application software, Productivity, Cost performance, Low power consumption are important

Ex, Mobile phones, Games

Compiler cooperated multi-core processors are promising to realize the above futures

Green Computing Systems R&D Center

Waseda University

Supported by METI (Mar. 2011 Completion)

＜R & D Target＞

Hardware, Software, Application for Super Low-Power Manycore Processors

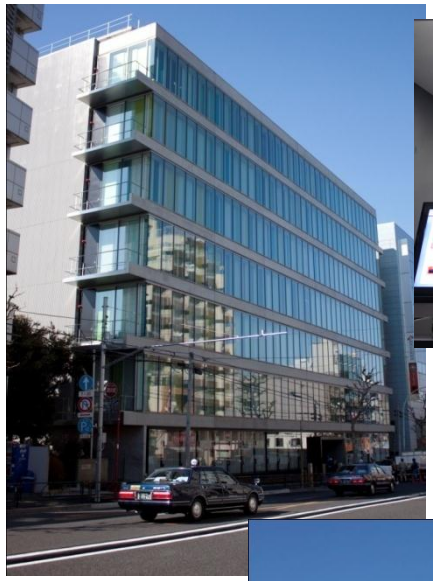
- **More than 64 cores**
- **Natural air cooling (No fan)**
  Cool, Compact, Clear, Quiet
- **Operational by Solar Panel**

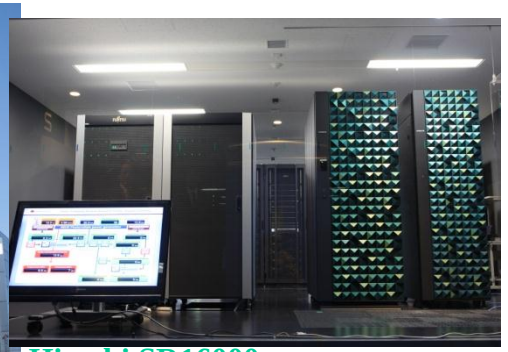
<Industry, Government, Academia>

Hitachi, Fujitsu, NEC, Renesas, Olympus, Toyota, Denso, Mitsubishi, Toshiba, etc

＜Ripple Effect＞

- **Low CO_2 (Carbon Dioxide) Emissions**
- **Creation Value Added Products**
  - **Consumer Electronics, Automobiles, Servers**



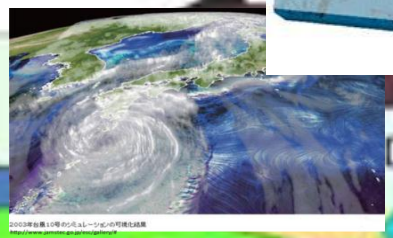


Hitachi SR16000:
Power7 128coreSMP
Fujitsu M9000
SPARC VII 256 core SMP

Beside Subway Waseda Station, Near Waseda Univ. Main Campus

Research, development and practical utilization through industry-government-academia partnerships (spillover effect)

Environment



Industrial business

Robot

Home/industrial many-core

Automotive/car-mounted systems (car navigation, integrated control, infrastructure coordination)

Dedicated server

Super computer (global warming, earthquake, bio, new devices)

Waseda University: Research & Development
Low power consumption/ many-core system technology

Information appliance

Mobile many-core

Server many-core

Cloud computing center

Internet TV/DVD

Solar cell-driven cool server

Camera

Camcorder

Smartphone

Netbook

Desktop server
Desk-side server

Mobile phone

Industrial business

Solar cell-driven 1seg viewing

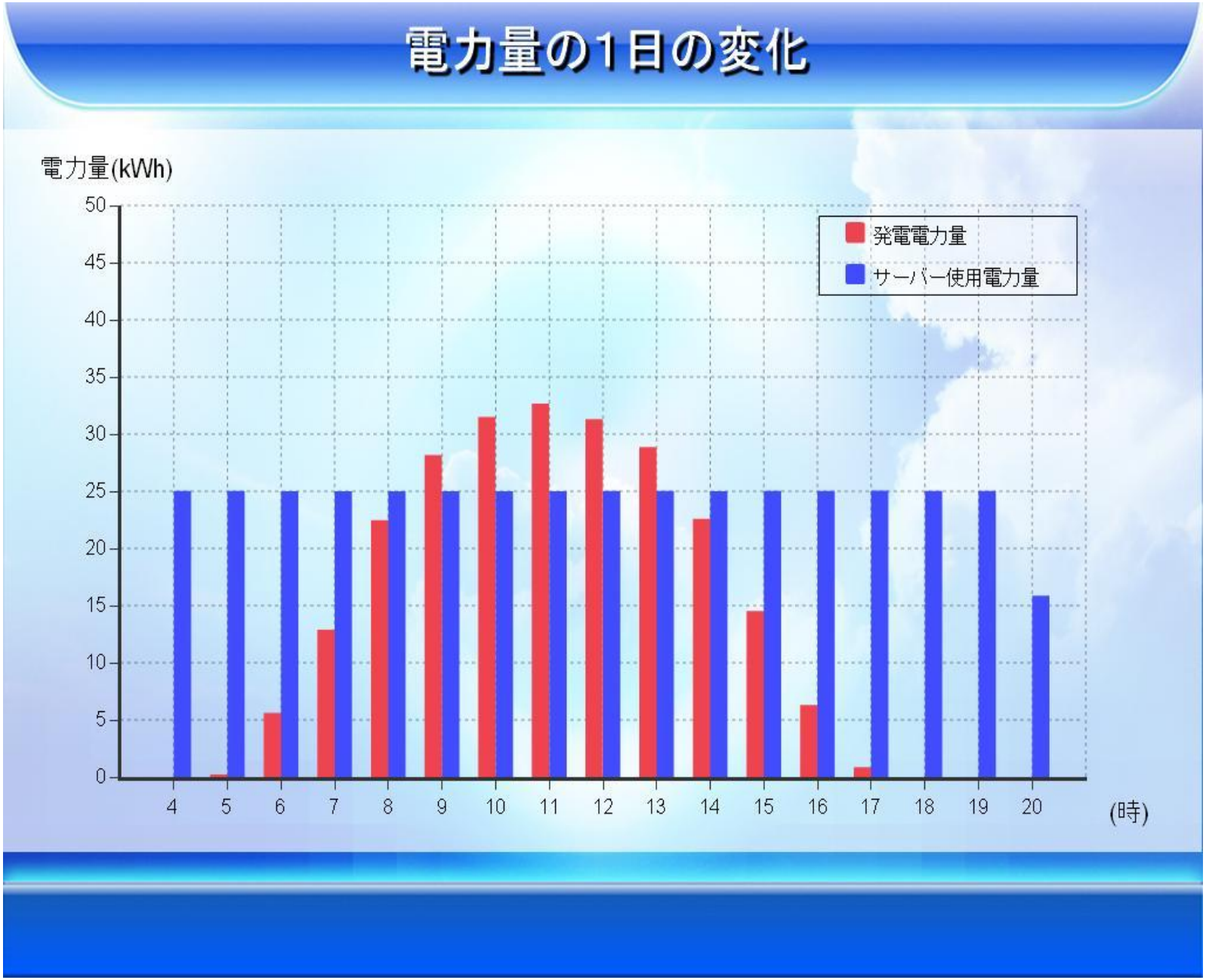
Industrial business

Cancer Treatment
Carbon Ion
Radiotherapy

Industry

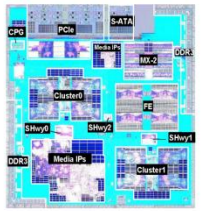
Lives

2012.4.2（Clear) Power Generation and Server Consumption: One day Trends



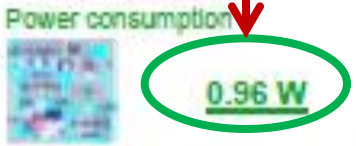
Super Low Power Web Server Using Embedded Multicore Processor RPX

1W with 8 SH4A processor cores



WASEDA UNIVERSITY Computer Science and Engineering

Kasahara Laboratory



by RPX embedded multicore Web-server.

[Japanese | English]

Private Page

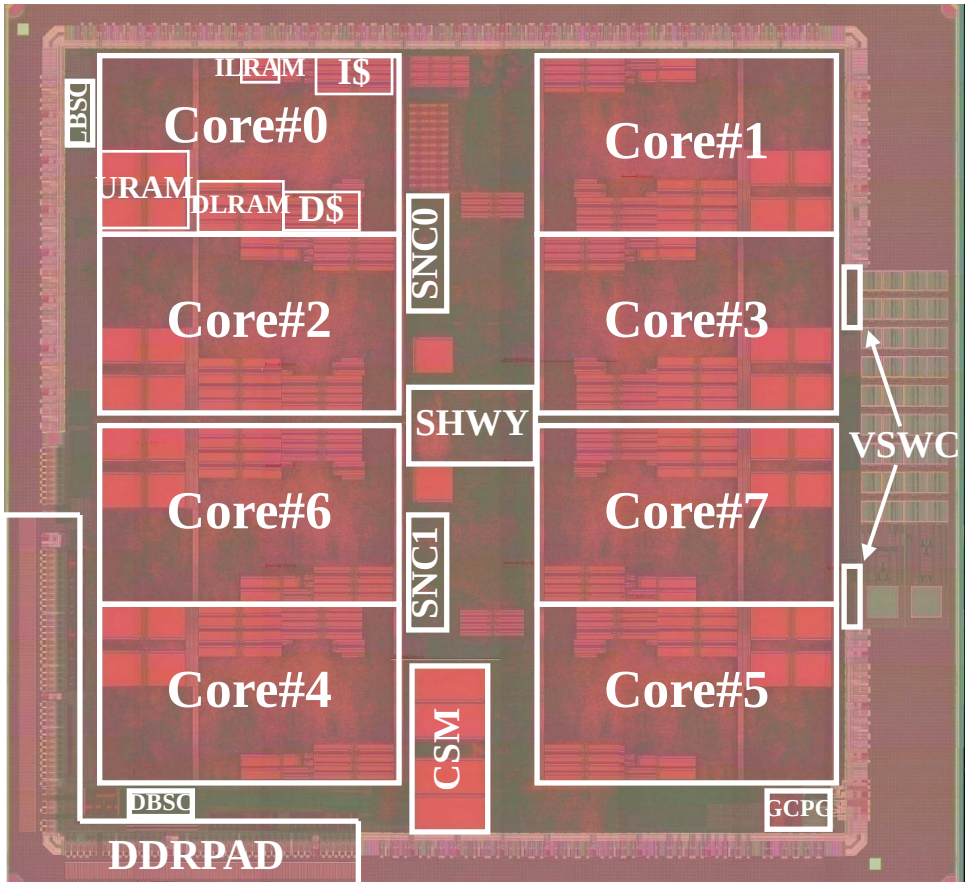
Contents

- Professor Kasahara
- Associate Professor
- Publications
- Members

News

2012.4.25	OSCAR API 2.0 has been released
2012.4.2	Low power embedded multicore RPX server started Kasahara & Kimura Laboratory's web service and power consumption indication.
2011.10.07	Prof. Hironori Kasahara has been elected to the IEEE Computer Society Board of Governors(2012-2014). Thank you very much for your kind supports.
2011.09.06	Information for the 25th Anniversary Workshop LCPC2012 (International Workshop on Languages and Compilers for ParallelComputing) Sep. 11-13, 2012 was upped.

Renesas-Hitachi-Waseda Low Power 8 core RP2 Developed in 2007 in METI/NEDO project



Process Technology	90nm, 8-layer, triple-Vth, CMOS
Chip Size	104.8mm^2 (10.61mm x 9.88mm)
CPU Core Size	6.6mm^2 (3.36mm x 1.96mm)
Supply Voltage	1.0V–1.4V (internal), 1.8/3.3V (I/O)
Power Domains	17 (8 CPUs, 8 URAMs, common)

IEEE ISSCC08: Paper No. 4.5, M.ITO, … and H. Kasahara, "An 8640 MIPS SoC with Independent Power-off Control of 8 CPUs and 8 RAMs by an Automatic Parallelizing Compiler"

Demo of NEDO Multicore for Real Time Consumer Electronics at the Council of Science and Engineering Policy on April 10, 2008

第74回総合科学技術会議【平成20年4月10日】

第74回総合科学技術会議の様子(1)

第74回総合科学技術会議の様子(2)

第74回総合科学技術会議の様子(3)

第74回総合科学技術会議の様子(4)

CSTP Members

Prime Minister:
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Minister of State for Science, Technology and Innovation Policy:
Mr. F. KISHIDA

Chief Cabinet Secretary:
Mr. N. MACHIMURA

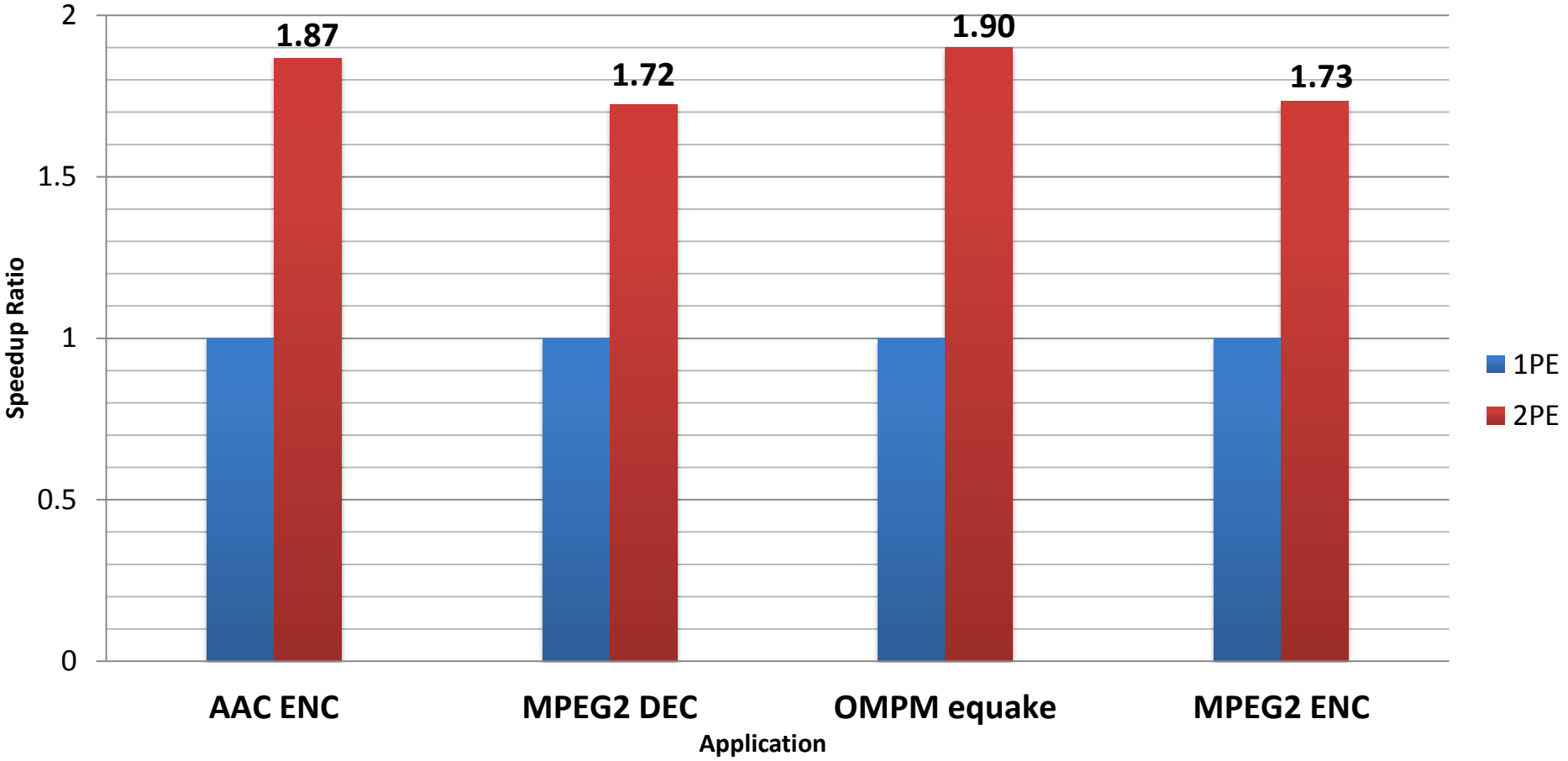
Minister of Internal Affairs and Communications :
Mr. H. MASUDA

Minister of Finance :
Mr. F. NUKAGA

Minister of Education, Culture, Sports, Science and Technology:
Mr. K. TOKAI

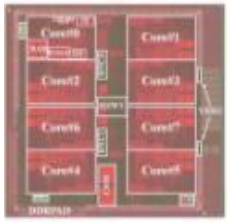
Minister of Economy,Trade and Industry:
Mr. A. AMARI

Performance of OSCAR Compiler & API on 2 ARMv7-cores Qualcomm MSM8960 (Snapdragon) Android 4.0 for Smart Phones



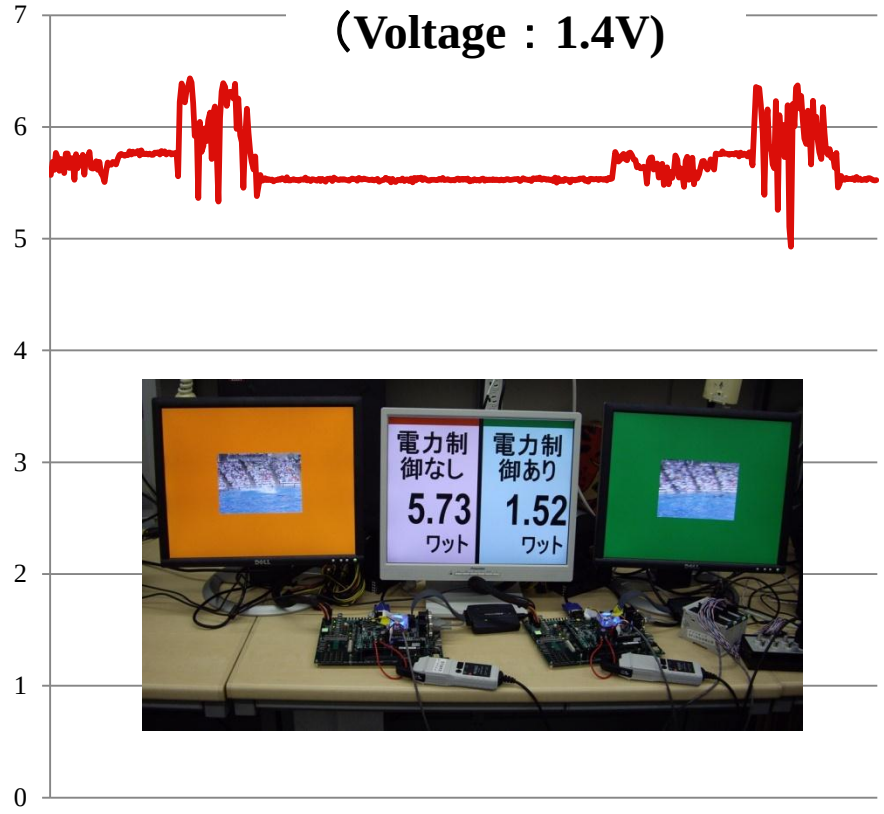
1.81 times speedup by 2 cores on the average against 1 core

Power Reduction of MPEG2 Decoding to 1/4 on 8 Core Homogeneous Multicore RP-2 by OSCAR Parallelizing Compiler

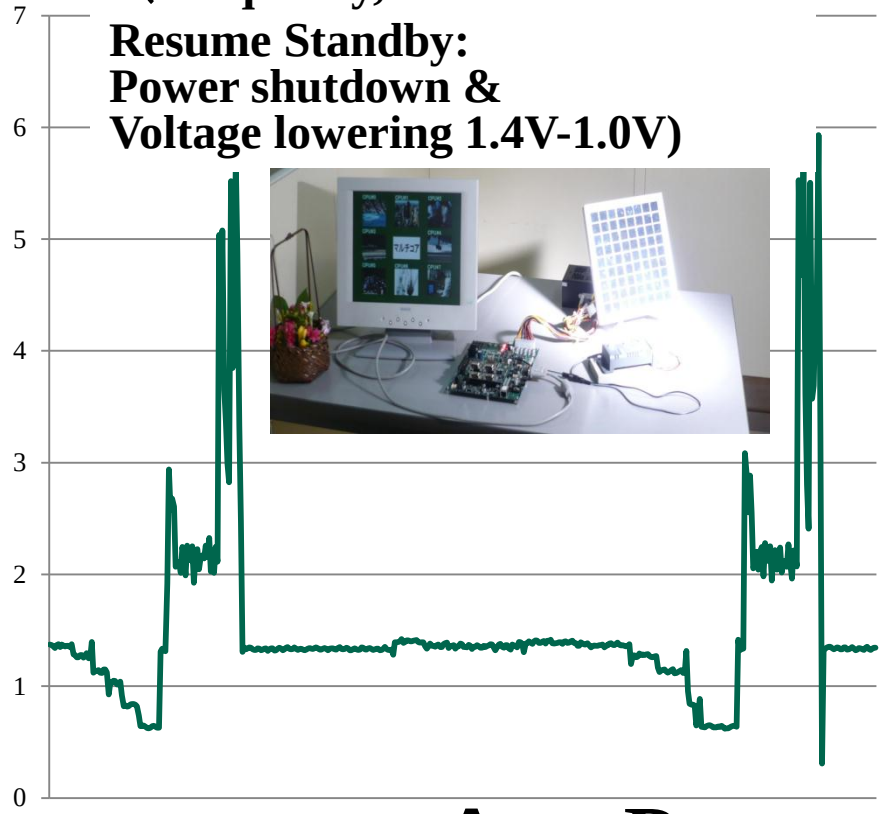


MPEG2 Decoding with 8 CPU cores

Without Power Control (Voltage：1.4V)



With Power Control (Frequency, Resume Standby: Power shutdown & Voltage lowering 1.4V-1.0V)



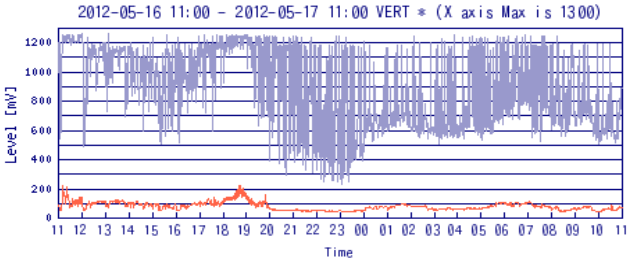
Avg. Power 5.73 [W]

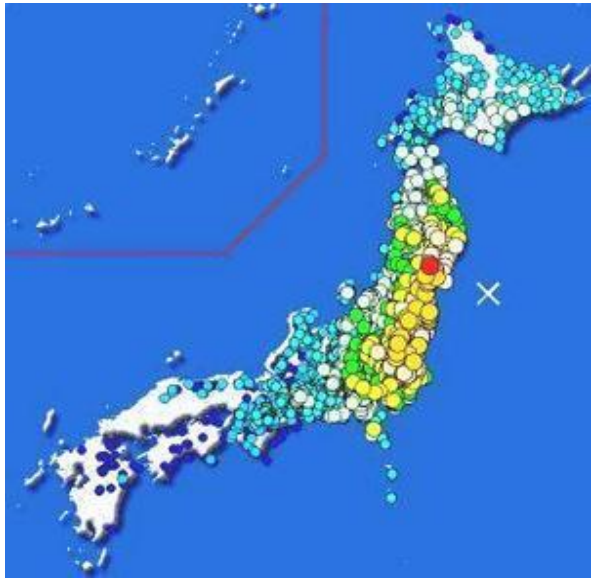
73.5% Power Reduction

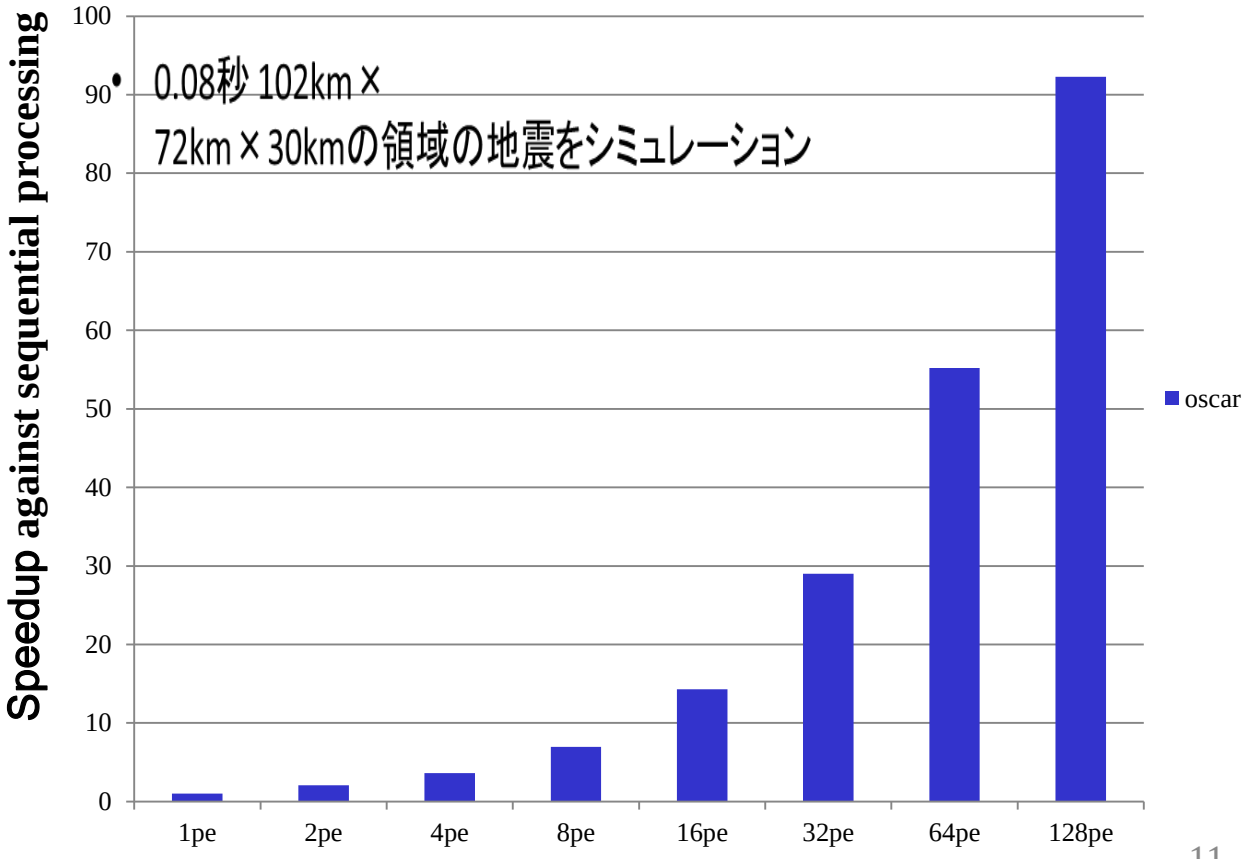
Avg. Power 1.52 [W]

92 Times Speedup against the Sequential Processing for GMS Earthquake Wave Propagation Simulation on Hitachi SR16000

（Power7 Based 128 Core Linux SMP）

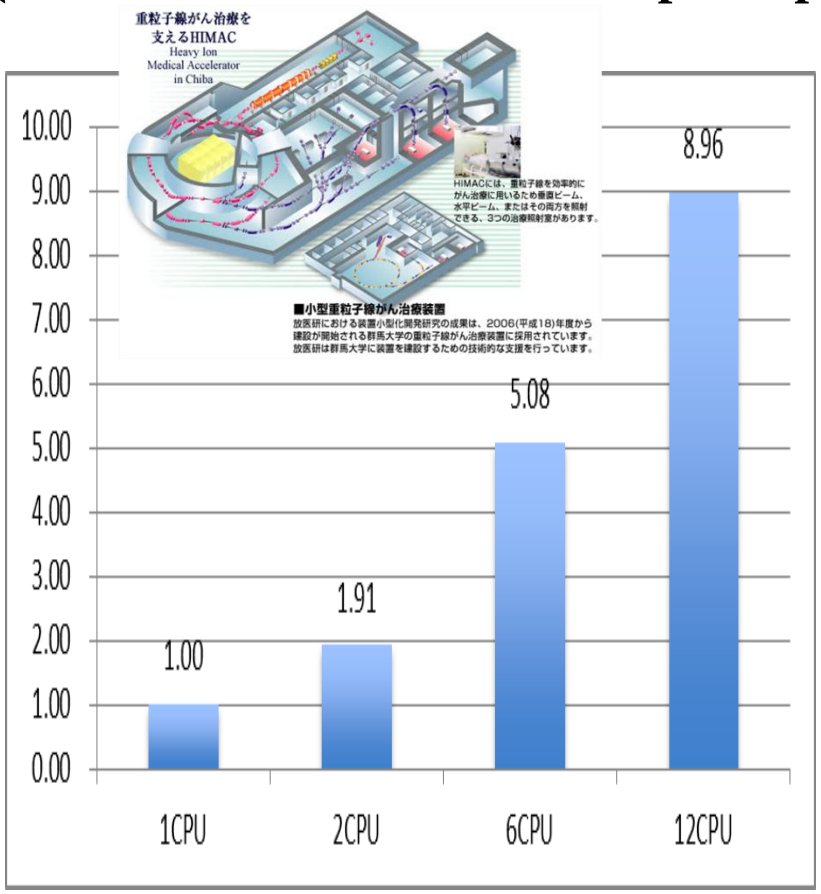


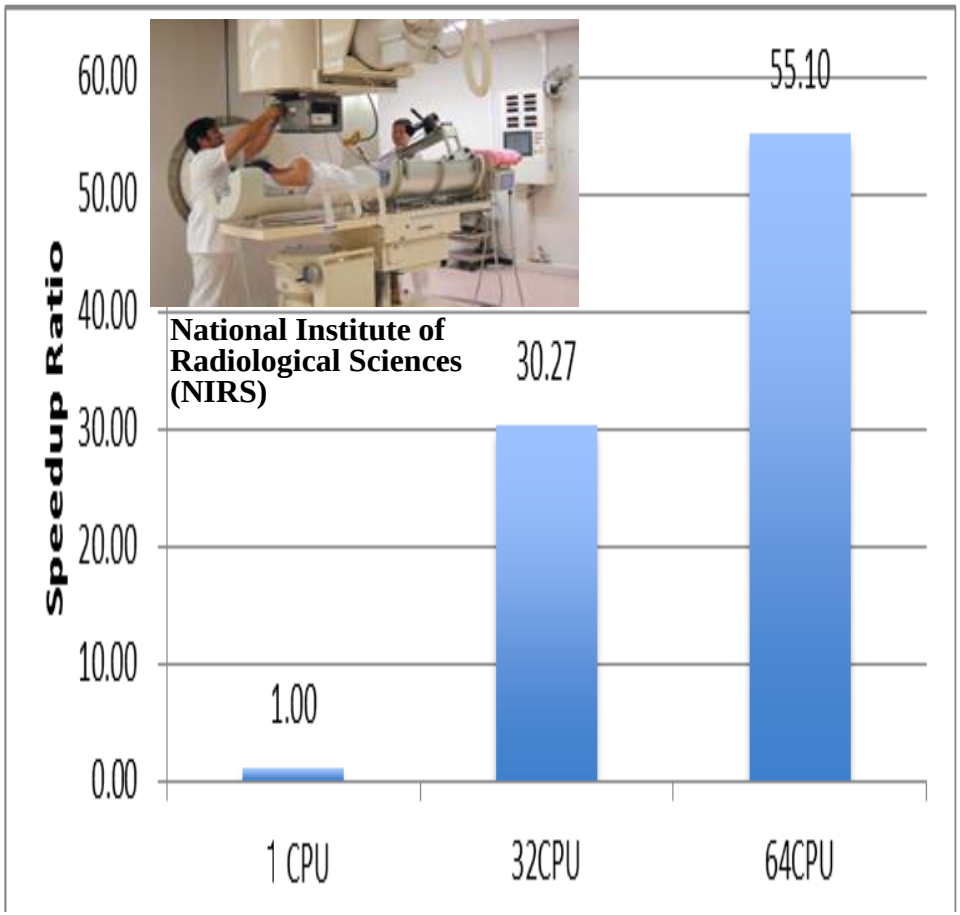




Cancer Treatment
Carbon Ion Radiotherapy

(Previous best was 2.5 times speedup on 16 processors with hand optimization)





8.9times speedup by 12 processors

Intel Xeon X5670 2.93GHz 12 core SMP (Hitachi HA8000)

55 times speedup by 64 processors

IBM Power 7 64 core SMP (Hitachi SR16000)