実アプリケーションを用いた SX-9の性能評価

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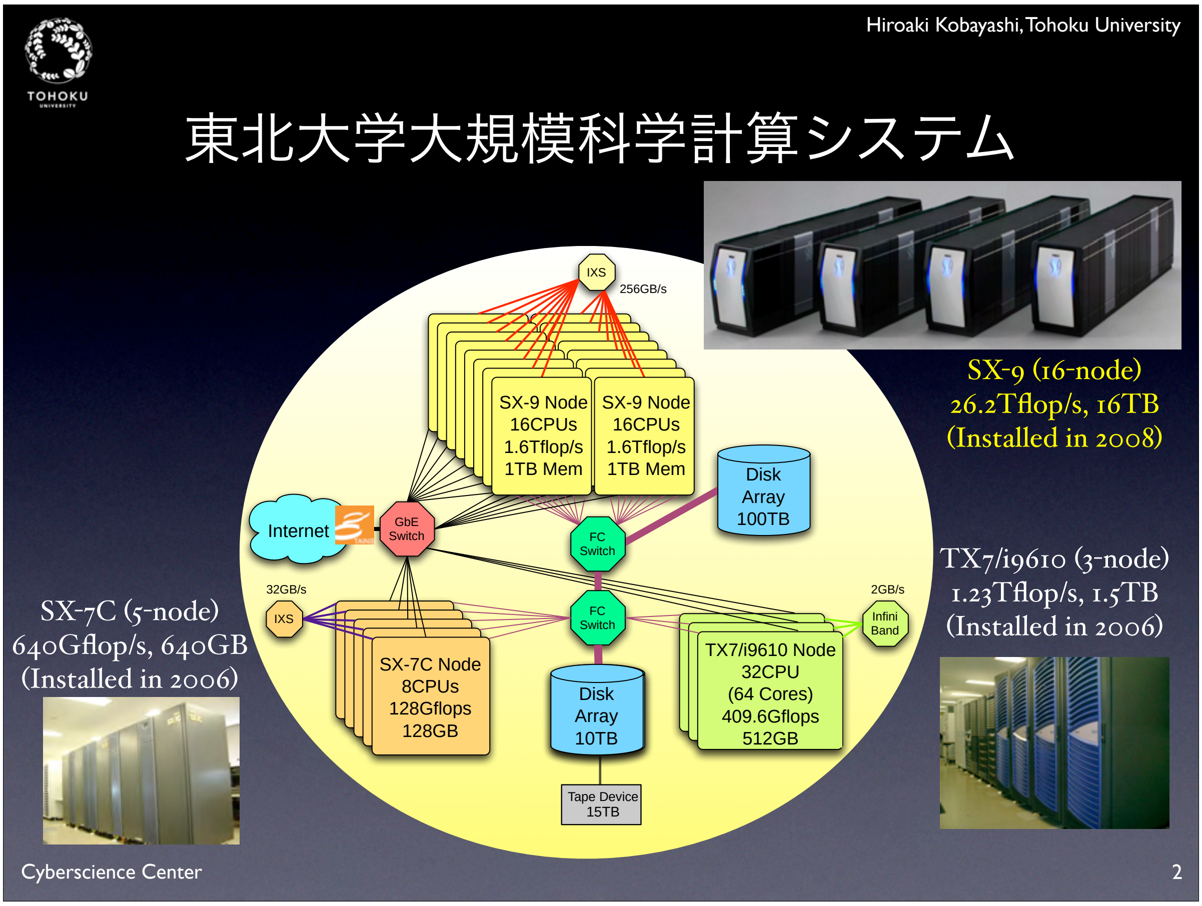

東北大学大規模科学計算システム

IXS
256GB/s
SX-9 Node 16CPUs 1.6Tflop/s 1TB Mem
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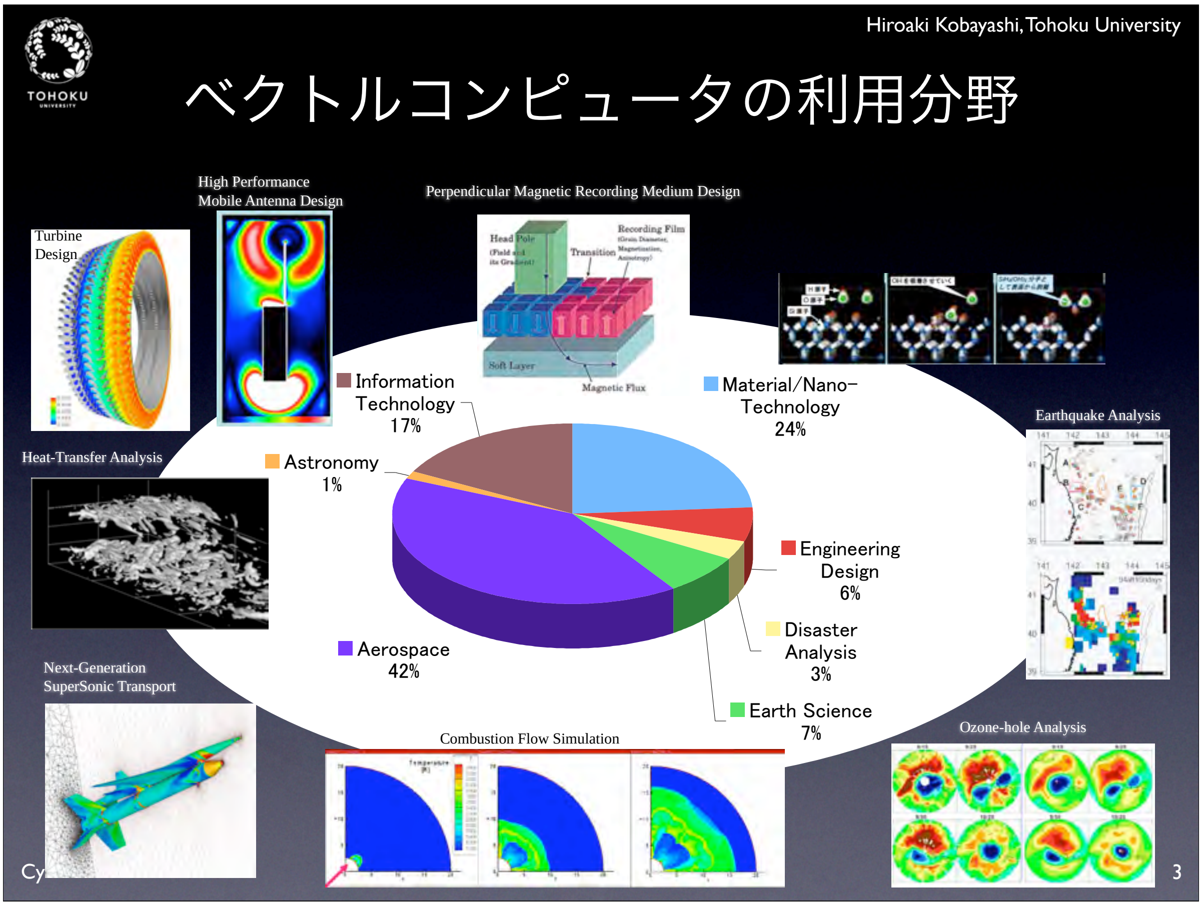
Disk Array 100TB
Internet
GbE Switch
FC Switch
32GB/s
IXS
FC Switch
2GB/s
Infini Band
SX-7C Node 8CPUs 128Gflops 128GB
Disk Array 10TB
TX7/i9610 Node 32CPU (64 Cores) 409.6Gflops 512GB
Tape Device 15TB

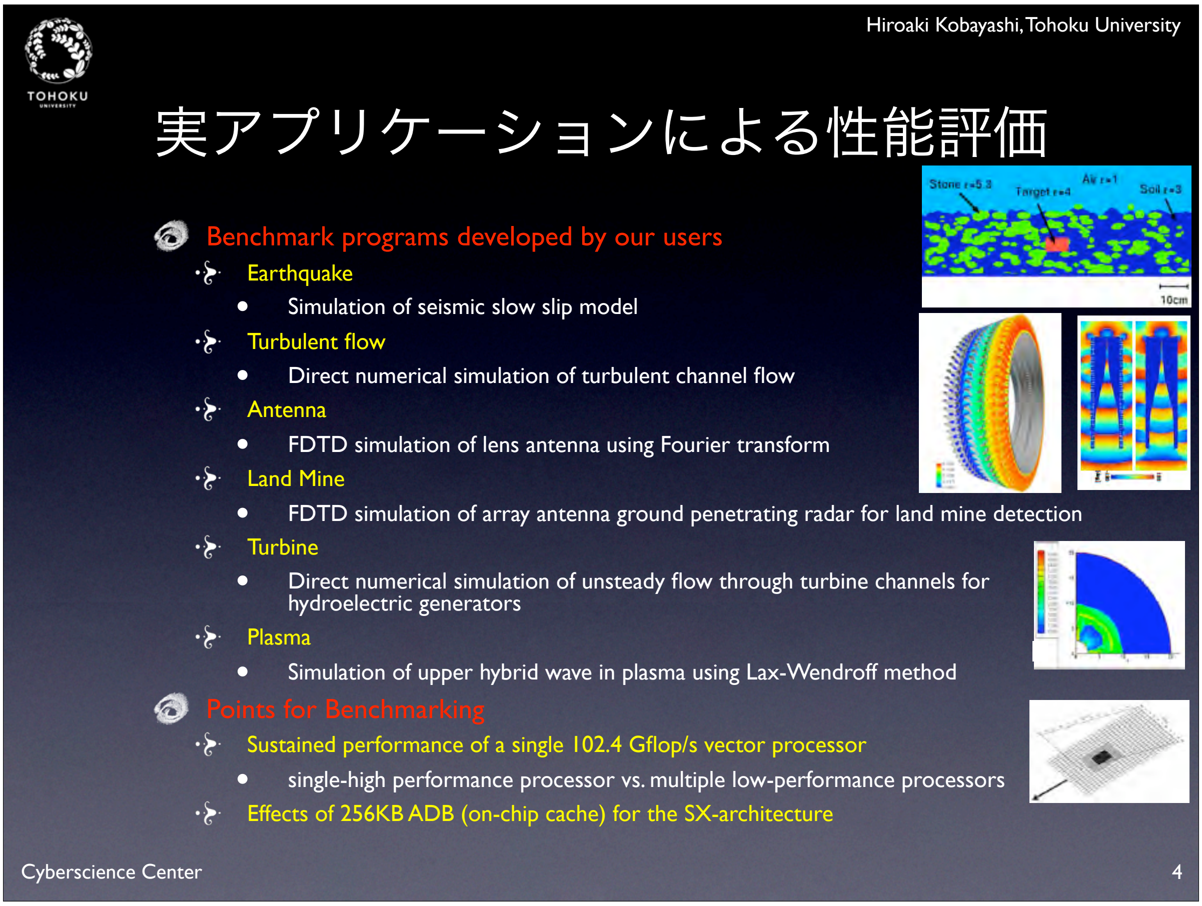
SX-9 (16-node)
26.2Tflop/s, 16TB
(Installed in 2008)

TX7/i9610 (3-node)
1.23Tflop/s, 1.5TB
(Installed in 2006)

SX-7C (5-node)
640Gflop/s, 640GB
(Installed in 2006)



ベクトルコンピュータの利用分野

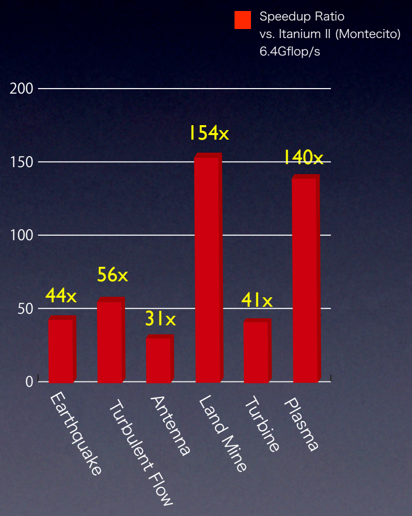


実アプリケーションによる性能評価

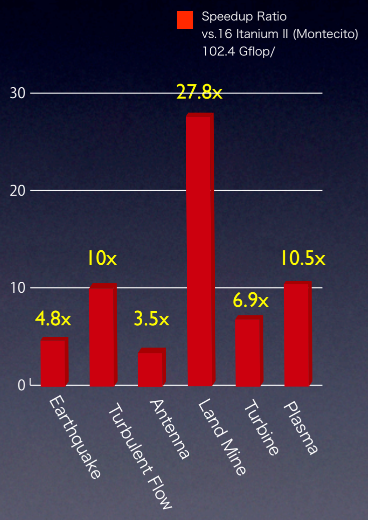
- Benchmark programs developed by our users
  - Earthquake
    - Simulation of seismic slow slip model
  - Turbulent flow
    - Direct numerical simulation of turbulent channel flow
  - Antenna
    - FDTD simulation of lens antenna using Fourier transform
  - Land Mine
    - FDTD simulation of array antenna ground penetrating radar for land mine detection
  - Turbine
    - Direct numerical simulation of unsteady flow through turbine channels for hydroelectric generators
  - Plasma
    - Simulation of upper hybrid wave in plasma using Lax-Wendroff method
- Points for Benchmarking
  - Sustained performance of a single 102.4 Gflop/s vector processor
    - single-high performance processor vs. multiple low-performance processors
  - Effects of 256KB ADB (on-chip cache) for the SX-architecture

SX-9 単一CPU性能 (vs. Intel ItaniumII)

Comparison with Single Itanium II Performance
(102.4Gflop/s vs 6.4Gflop/s)

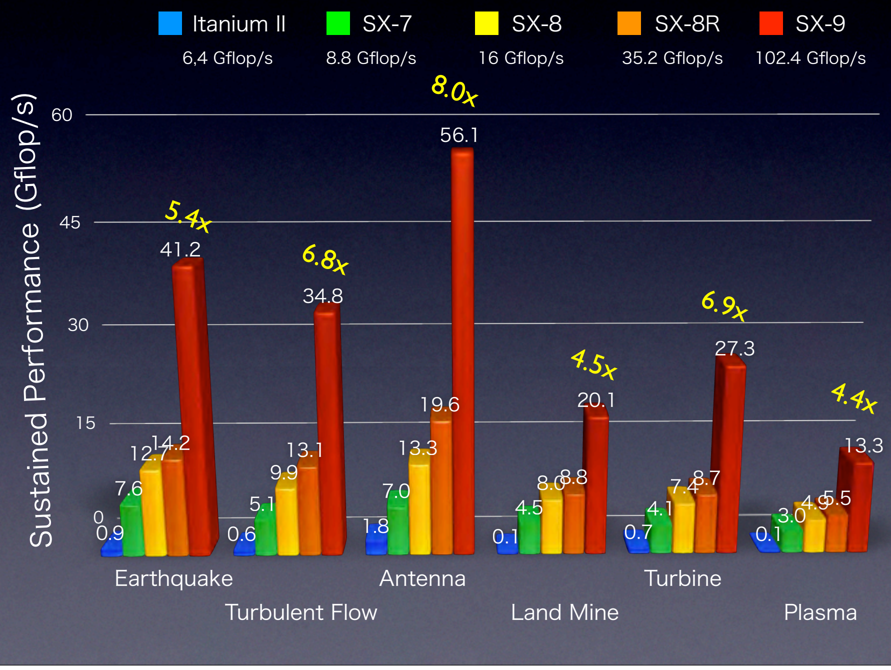


Comparison with 16-Itanium II Performance
(the Same 102.4Gflop/s Peak Performance)



ベクトルプロセッサの性能比較

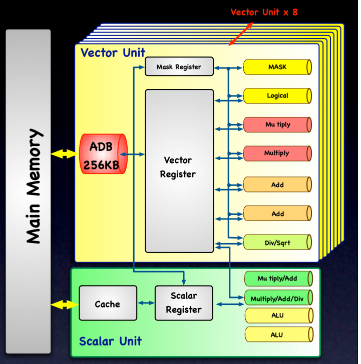
Sustained Single CPU Performance (Measured)

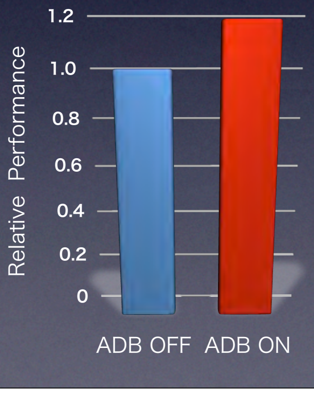


ADBの効果(1/3)

Land Mine

```
01       DO 10 k=0,Nz
02            DO 10 i=0,Nx
02' !cdir ON_ADB(H_y, H_z)
03                 DO 10 j=0,Ny
04                    E_x(i,j,k) = C_x_a(i,j,k)*E_x(i,j,k)
05  &                      + C_x_b(i,j,k) * (( H_z(i,j,k) -H_z(i,j-1,k))/dy
06  &                      -(H_y(i,j,k) -H_y(i,j,k-1))/dz -E_x_Current(i,j,k))
07                    E_y(i,j,k) = C_y_a(i,j,k)*E_y(i,j,k)
08  &                       + C_y_b(i,j,k) * ((H_x(i,j,k) -H_x(i,j,k-1))/dz
09  &                       -(H_z(i,j,k) -H_z(i-1,j,k))/dx -E_y_Current(i,j,k))
10                    E_z(i,j,k) = C_z_a(i,j,k)*E_z(i,j,k)
11  &                      + C_z_b(i,j,k) * ((H_y(i,j,k)-H_y(i-1,j,k) )/dx
12  &                      -(H_x(i,j,k)-H_x(i,j-1,k))/dy -E_z_Current(i,j,k))
13 10 CONTINU
```

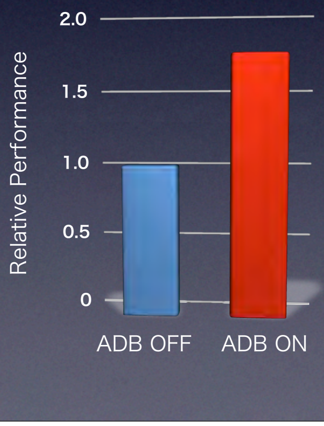


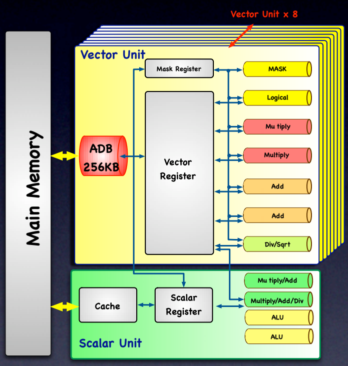


ADBの効果 (2/3)

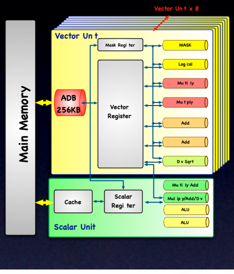
Earthquake

```
do i=1,ncells
  do j=1,ncells
    wf_dip(i)=wf_dip(i)+gd_dip(j,i)*wary(j)
  end do
end do
```

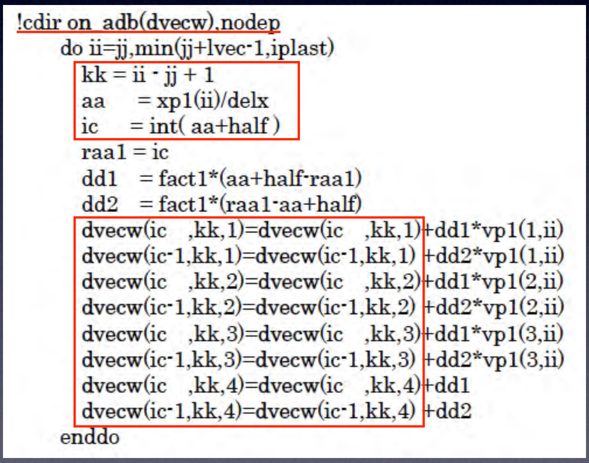




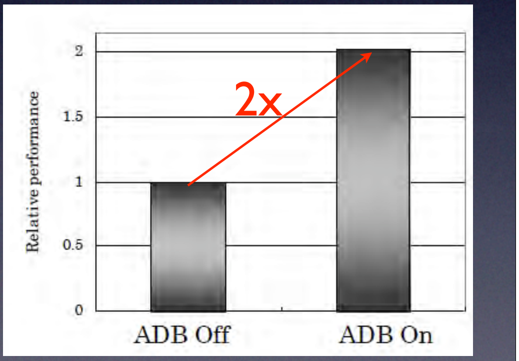
ADBの効果 (3/3)



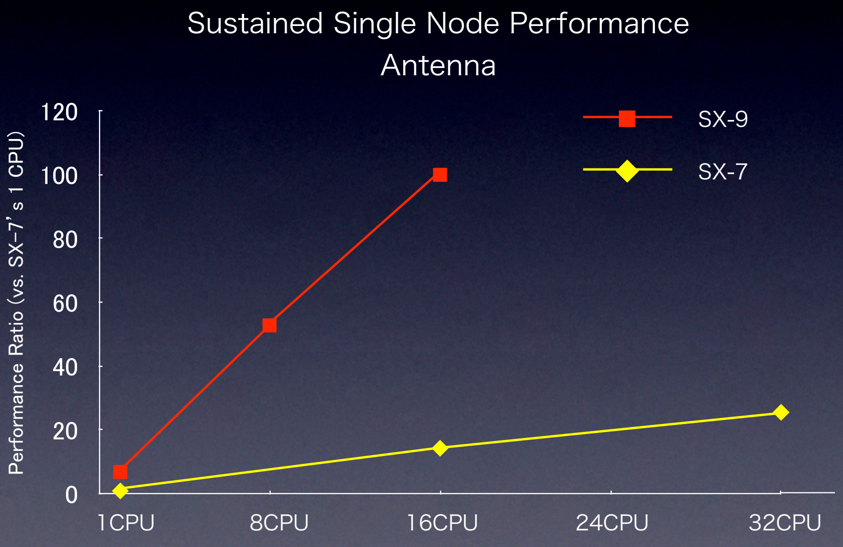
Plasma



```
!cdir on  adb(dvecw),nodep
      do ii=jj,min(jj+lvec-1,iplast)
         kk = ii - jj + 1
         aa      = xp1(ii)/delx
         ic      = int( aa+half )
         raa1 = ic
         dd1   = fact1*(aa+half-raa1)
         dd2   = fact1*(raa1-aa+half)
         dvecw(ic   ,kk,1)=dvecw(ic   ,kk,1)+dd1*vp1(1,ii)
         dvecw(ic-1,kk,1)=dvecw(ic-1,kk,1) +dd2*vp1(1,ii)
         dvecw(ic   ,kk,2)=dvecw(ic   ,kk,2)+dd1*vp1(2,ii)
         dvecw(ic-1,kk,2)=dvecw(ic-1,kk,2) +dd2*vp1(2,ii)
         dvecw(ic   ,kk,3)=dvecw(ic   ,kk,3)+dd1*vp1(3,ii)
         dvecw(ic-1,kk,3)=dvecw(ic-1,kk,3) +dd2*vp1(3,ii)
         dvecw(ic   ,kk,4)=dvecw(ic   ,kk,4)+dd1
         dvecw(ic-1,kk,4)=dvecw(ic-1,kk,4) +dd2
      enddo
```

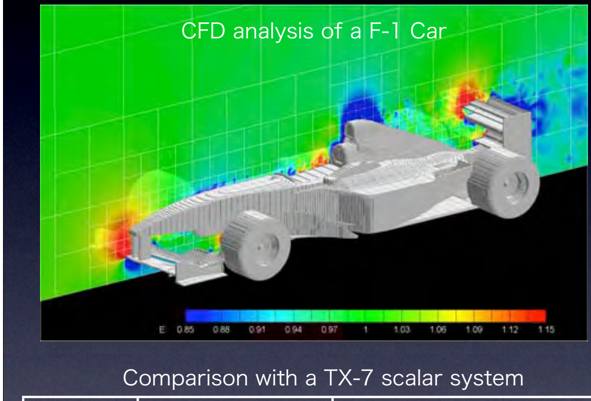


SX-9 ノード性能



CFDコードによる16ノード性能

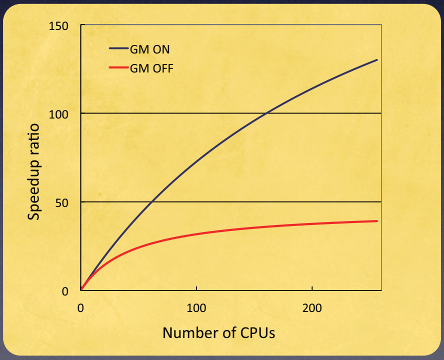
Large-Scaled Computation of Incompressive Flows on Cartesian Mesh Using a Vector-Parallel Supercomputer by Takahashi&Nakahashi et al., Parallel CFD2008, Lyon France, 5/18-22, 2008


CFD analysis of a F-1 Car
E 0.85 0.88 0.91 0.94 0.97 1 1.03 1.06 1.09 1.12 1.15

- Almost 99.9 % vector performance was achieved.
- 0.2 billion cells were solved by present method.
- Flat MPI shows better parallel efficiency than hybrid.
- 130x speedup obtained on the 16 nodes with 256 CPUs
- 50 min on 16 nodes, 6 days on a single CPU
  - 128 days on a single itanium core

Comparison with a TX-7 scalar system

	TX7(ItaniumII)		SX-9		
Cores	1	64	1	16	256
Peak Perf.	6.4GF (1x)	409.GF (64x)	102.G (16x)	1.6TF (256x)	26TF (4096x)
Sustained Speedup	1x	36x	20x	285x	3700x



Scalability of SX-9

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