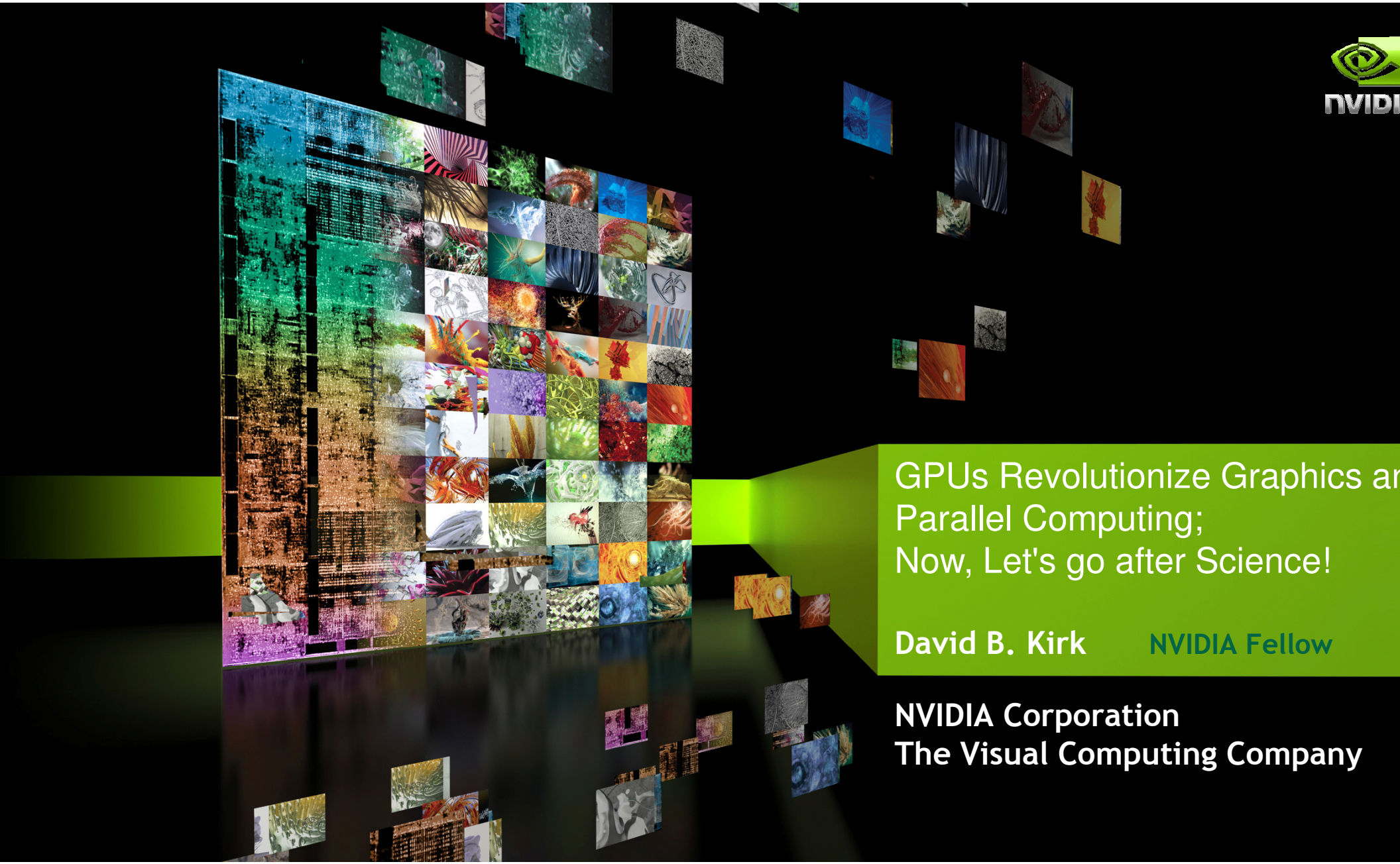


GPUs Revolutionize Graphics and Parallel Computing; Now, Let's go after Science!

David B. Kirk NVIDIA Fellow

NVIDIA Corporation
The Visual Computing Company

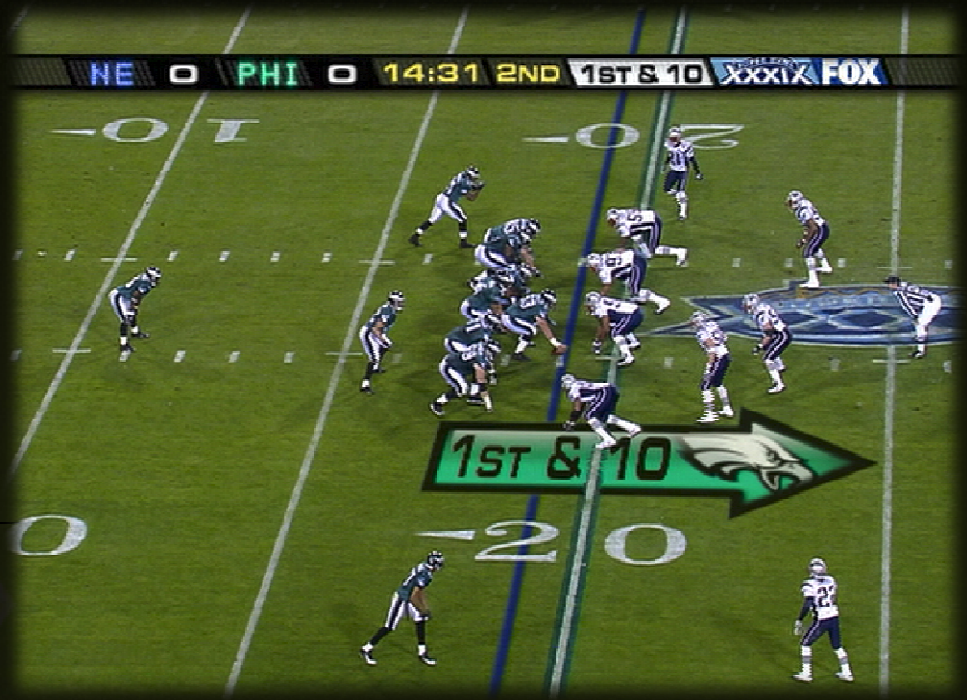

CINEMA
Fallou


CO


GRID
Need For Speed Undercov


103.3
A380
Charmin Ultra
Tide
Bounty
Pampers
ARIEL
Folgers
IAMS
Actimel

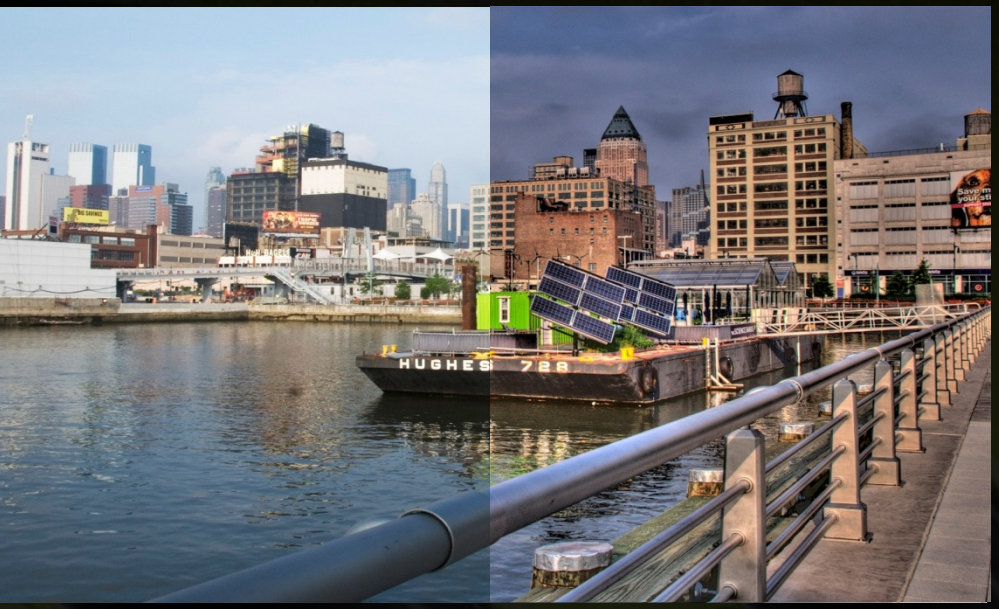

Sunnyvale Volkswagen
82
Google
OLKSWAGEN near SUNNYVALE, CA
Keyboard
Google
NVIDIA
Turn left
0.3mile ahead
MPH
x1000RPM
ODO 25687.8
TRIP 1256.5
D-4
2004.03.18
07:45AM

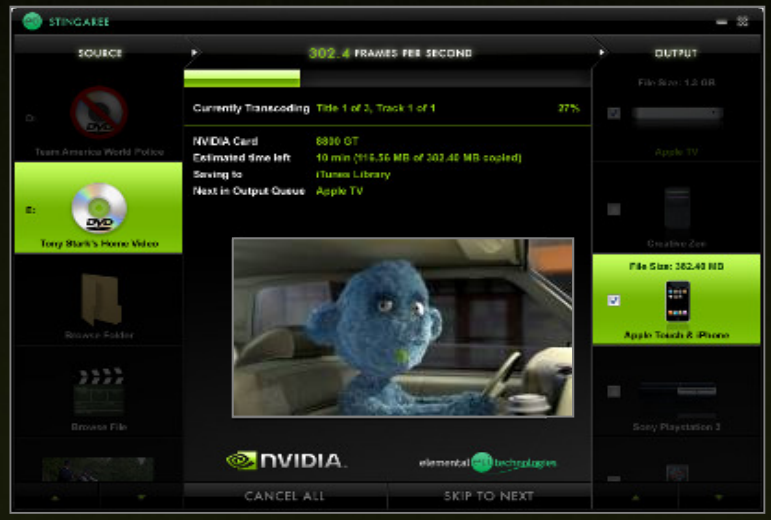


Nastia Liukin

NBC Virtual Set

Ann Curry


HUGHES 788

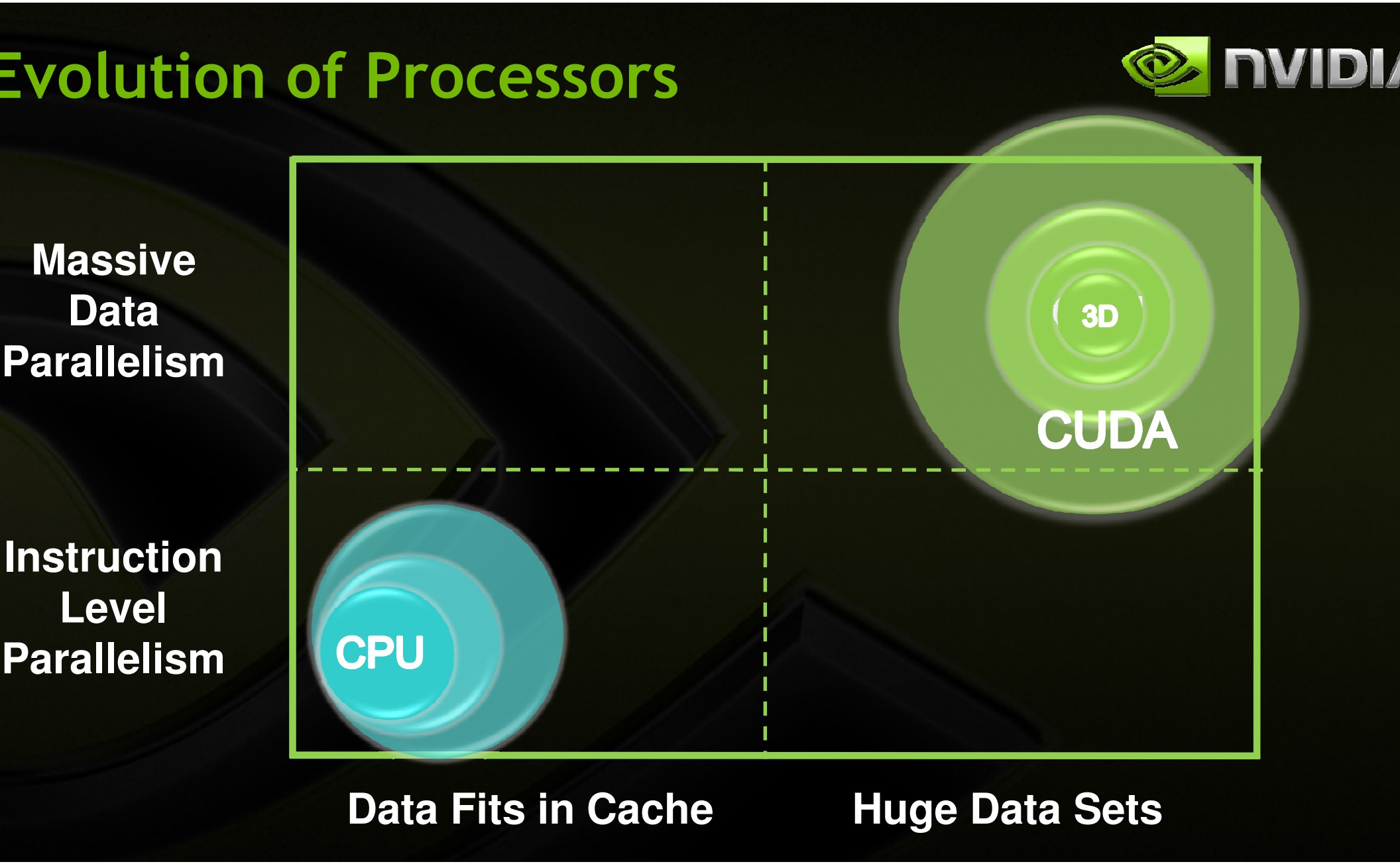

STINGAREE
SOURCE
302.4 FRAMES PER SECOND
OUTPUT
Currently Transcoding
NVIDIA Card
8800 GT
Estimated time left
Saving to
iTunes Library
Next in Output Queue
Apple TV
NVIDIA
CANCEL ALL
SKIP TO NEXT

SD

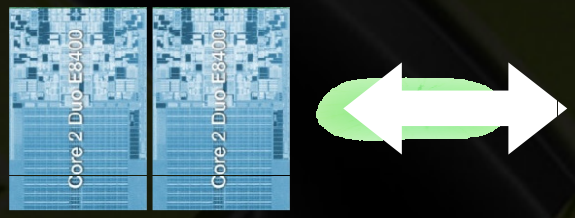
HD

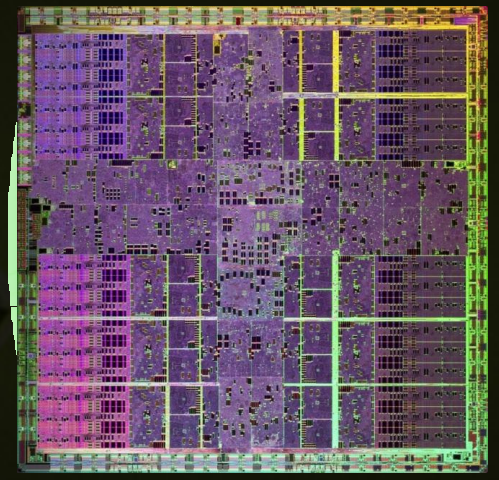

SimHD™
ArcSoft

Evolution of Processors



CUDA GPU Enables Heterogeneous Parallel Computing



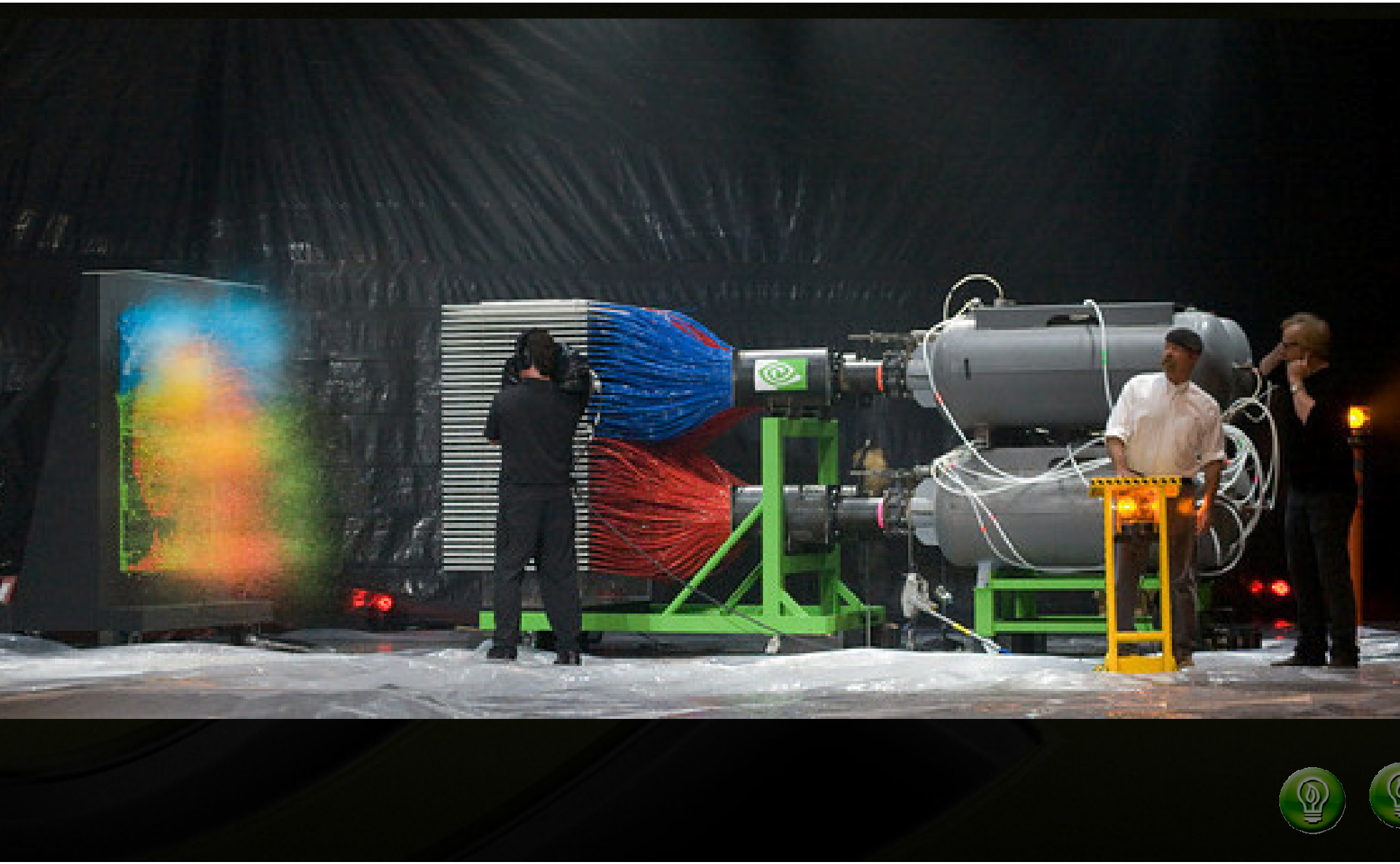


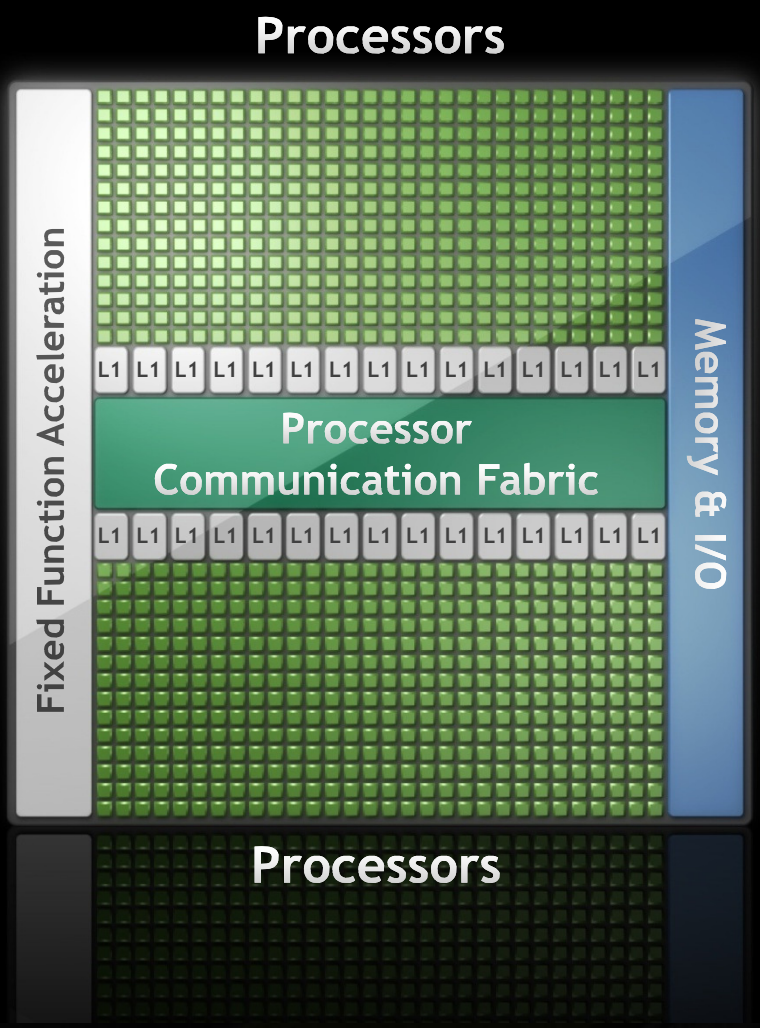
4 cores

Multi-Core CPU

240 cores

Parallel-Core GPU





NVIDIA Tesla 10-Series GPU

Massively parallel, many core architecture

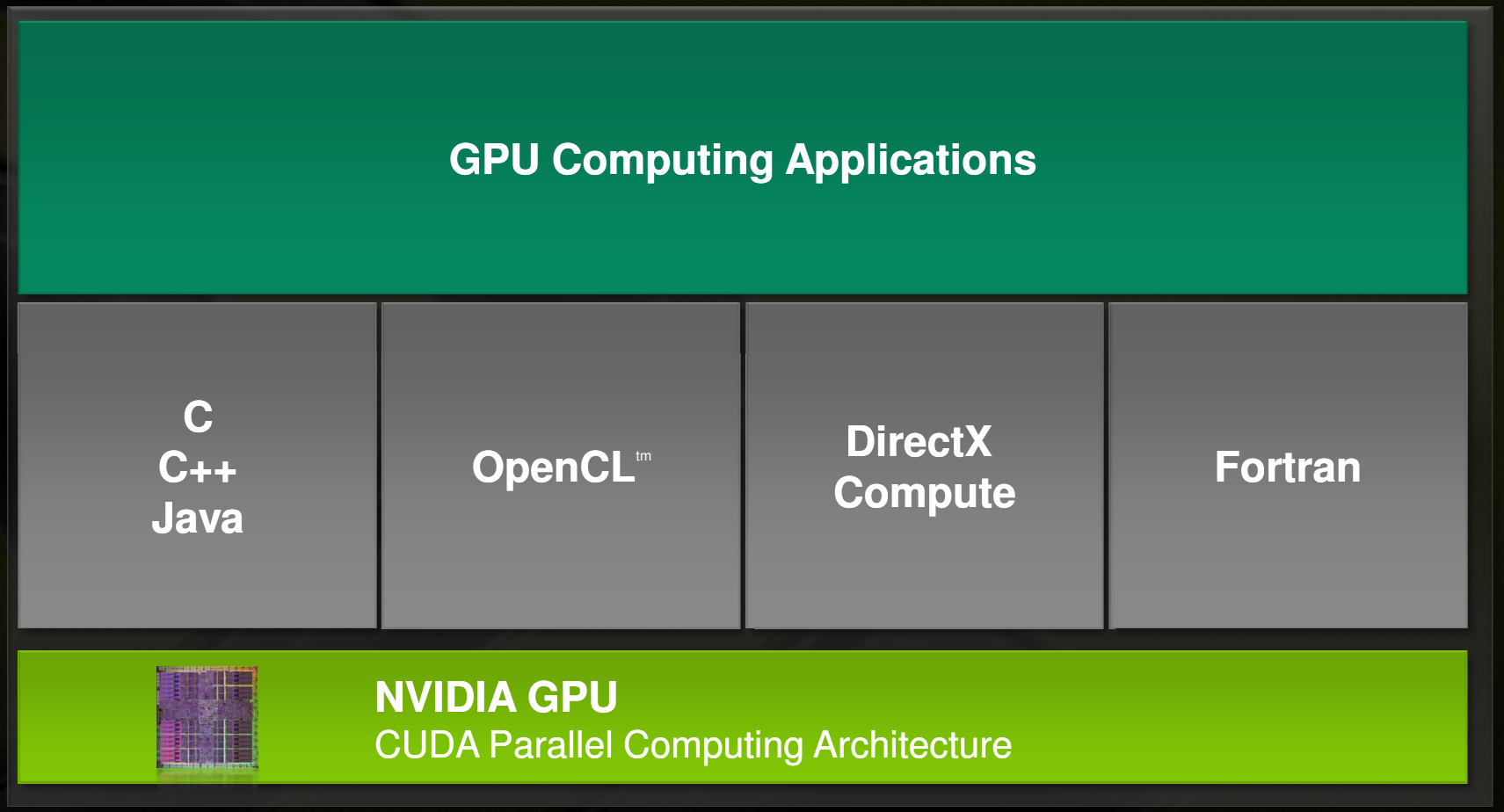
240 Processor Cores

1 Teraflops - 1,000 times Cray X-MP

IEEE Compliant Double Precision Floating Point

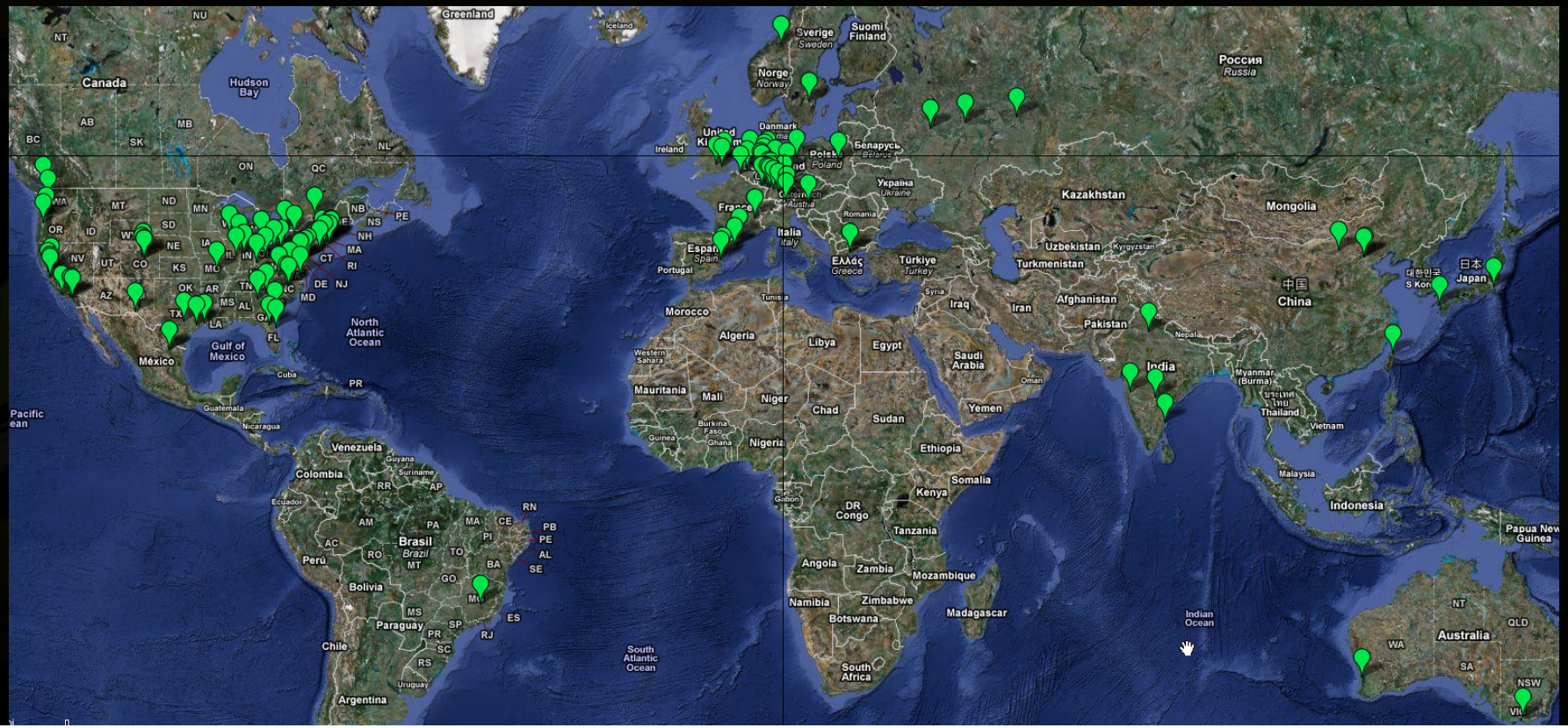
Designed for Scientific Computing

CUDA Parallel Computing Architecture



CUDA: Most Widely Adopted Parallel Programming Model

- 1000+ Research Papers
- 200+ universities teaching CUDA
- 120 Million CUDA GPUs
- 60,000+ Active Developers



CUDA Ecosystem

Over 200 Universities Teaching CUDA

UIUC
MIT
Harvard
Berkeley
Cambridge
Oxford
…

IIT Delhi
Tsinghua
Dortmundt
ETH Zurich
Moscow
NTU
…

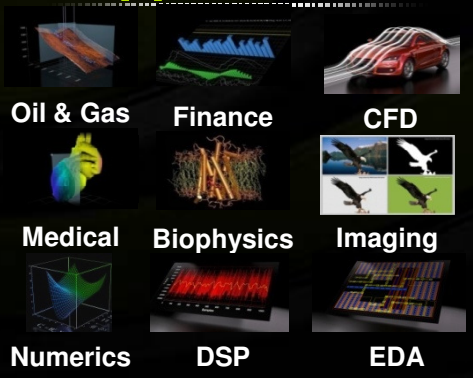
Languages

C, C++
DirectX
Fortran
Java
OpenCL
Python

Compilers

PGI Fortran
CAPs HMPP
MCUDA
MPI
NOAA Fortran2C
OpenMP

Applications



Libraries

FFT
BLAS
LAPACK
Image processing
Video processing
Signal processing
Vision

Consultants

acceleware
HPC
ANEO
SCALABLE GRAPHICS
CAPS
STONE RIDGE TECHNOLOGY
EM Photonics
TECH
GASS
WIPRO
GPU Tech

OEMs

DELL
hp
PENGUIN COMPUTING
CRAY
Sun
SUPERMICRO
sgi
FUJITSU
BULL
APPRO
lenovo
NEC

Released Applications

CUDA

Bio-Sciences

GROMACS using OpenMM

NAMD alpha

VMD, 1.8.7 beta

HOOMD

Bio-Informatics

- GPU HMMER
- MUMmerGPU: Sequence Alignment
- Accelereyes: MATLAB plugin

Medical Imaging

- GPULib: IDL acceleration
- Acceleware CT Recon
- Digisens CT Recon
- Accelereyes: MATLAB plugin

Defense

- GPU VSIPL: Signal Processing
- GPULib: IDL acceleration
- Ikena: Imagery Analysis, Video Forensics
- GIS: Manifold
- Accelereyes: MATLAB plugin

Oil and Gas

- Acceleware: Time Migration
- SeismicCity: Prestack
- Headwave: Prestack
- OpenGeoSolutions: Spectral Decomp
- Mercury: 3D viz
- ffA: 3D Seismic proces
- GIS: Manifold

EDA

CST: 3D EM

Agilent: ADS SPICE

Synopsys: TCAD

Weather & Ocean Modeling

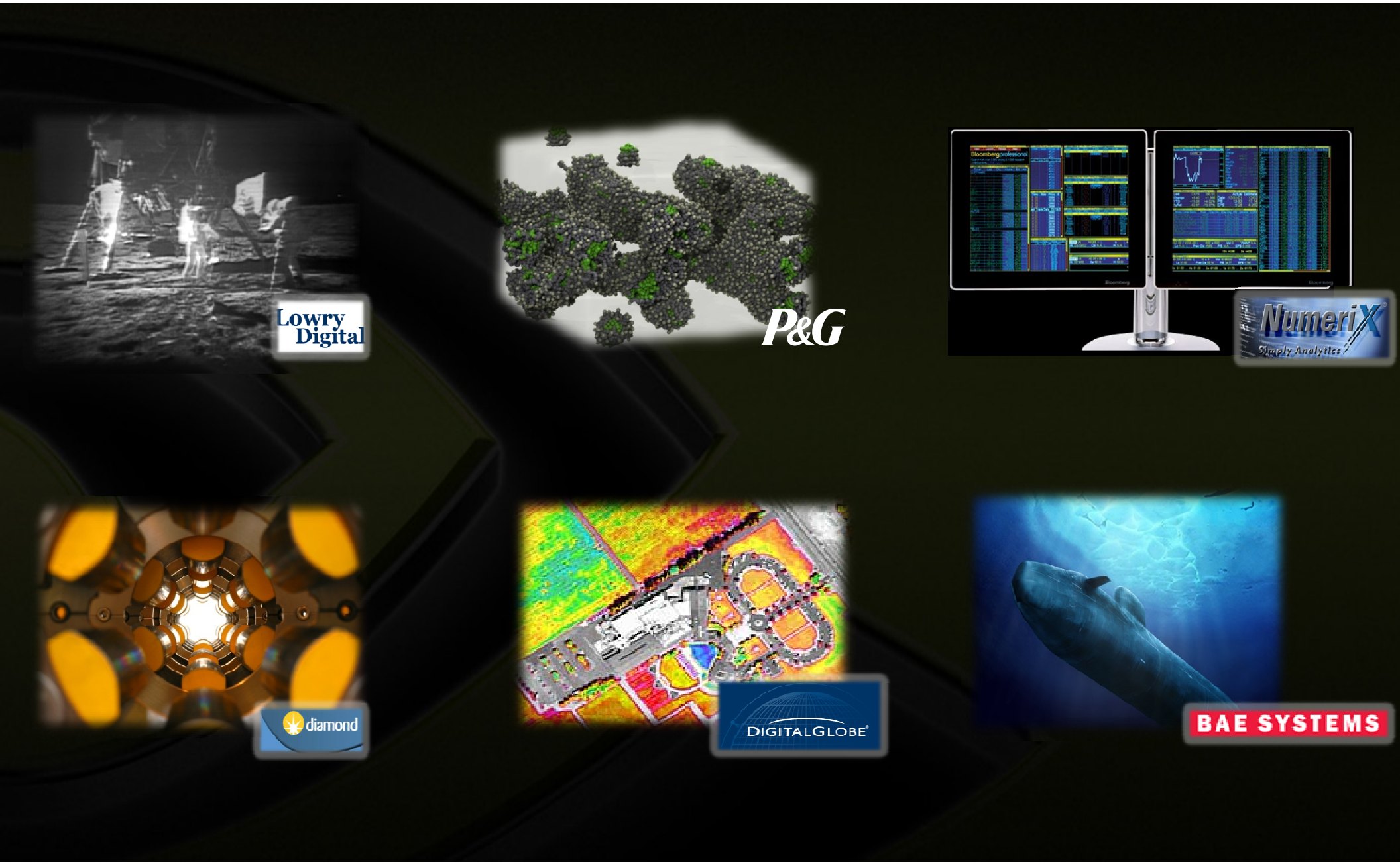
- WRF beta release
- Particle simulation Boltzmann solver
- Tsunami simulation: Tokyo Tech
- NOAA new model being developed

Finance

- Numerix: Counterparty
- Scicomp: Derivative Pricing
- Hanweck: Options Pricing
- Exegy: Risk Analysis
- Aqumin: 3D Viz

Electro-magnetics

- Acceleware: FDTD Solver
- Quantum electrodynamics library
- CST Microwave Studio
- GPMAD : Particle beam dynamics simulator


Lowry Digital
P&G
Bloomberg professional
NumeriX
Simply Analytics
diamond
DIGITALGLOBE
BAE SYSTEMS

More Information

http://www.nvida.com/tesla

Products

Vertical Solutions

CUDA GPU Programming Training

GPU Developer Conference

Sept 30 – Oct 2, 2009

San Jose, CA

http://www.nvidia.com/gtc

“GPUs have evolved to the point where many real world applications are easily implemented on them and run significantly faster than on multi-core systems.

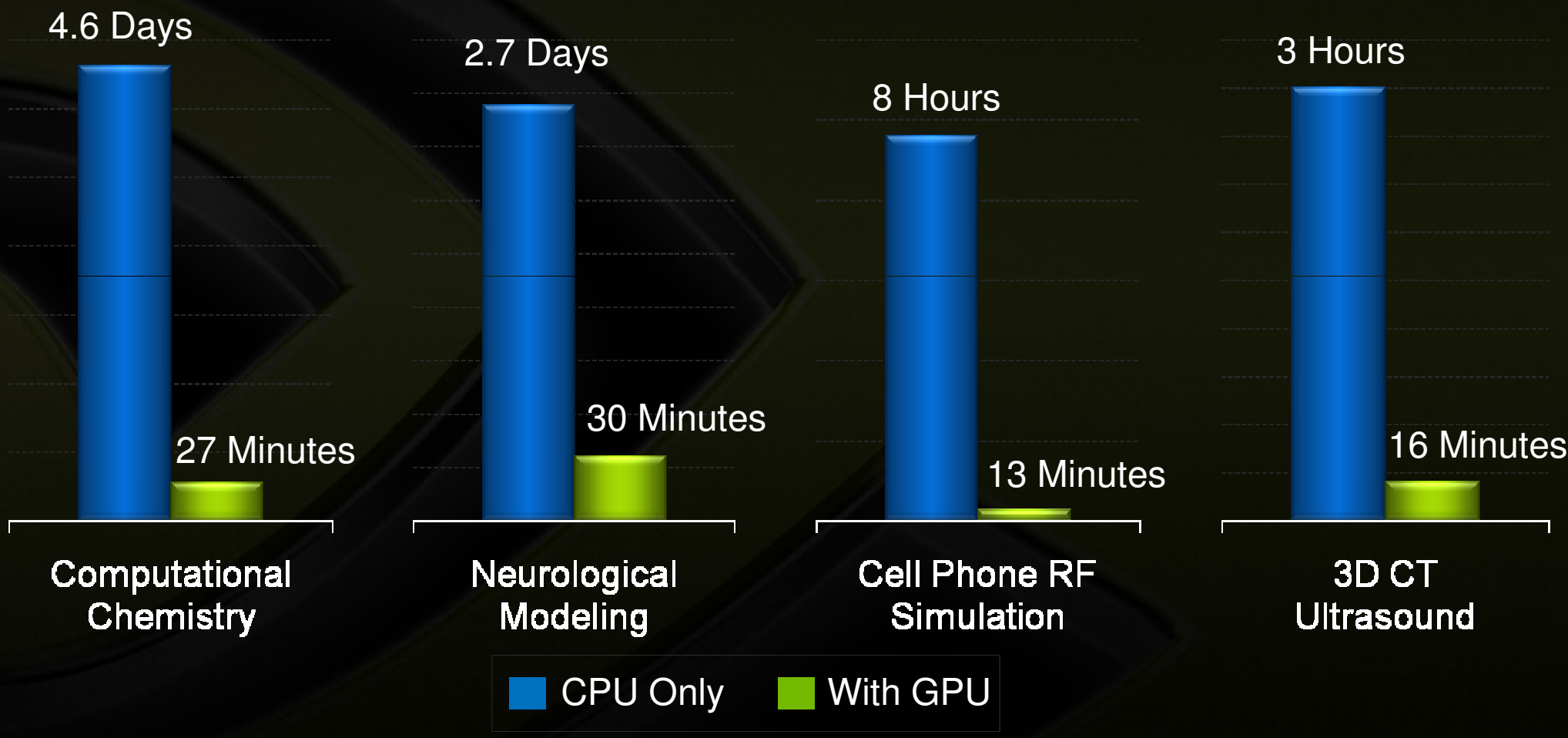
Future computing architectures will be hybrid systems with parallel-core GPUs working in tandem with multi-core CPUs.”

Jack Dongarra
University of Tennessee
Developer of Linpack benchmark

Huge Speed-Ups from GPU Computing

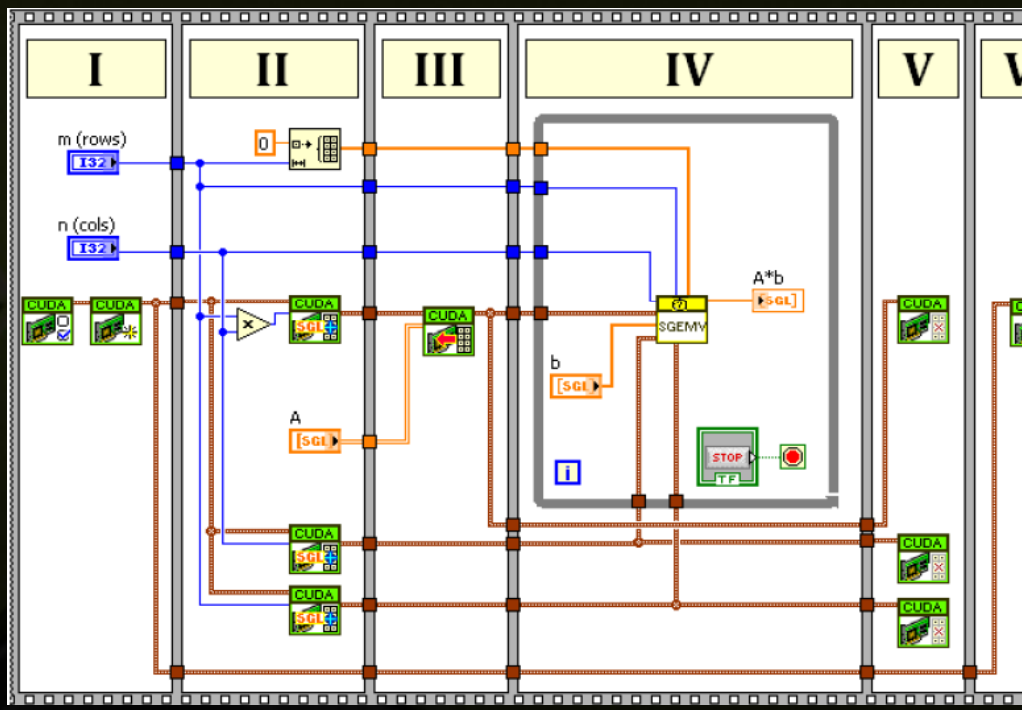
Algorithm	Field	Speedup
2-Electron Repulsion Integral	Quantum Chemistry	**130X**
Lattice Boltzmann	CFD	**123X**
Euler Solver	CFD	**16X**
Gromacs	Molecular Dynamics	**137X**
Lattice QCD	Physics	**30X**
Multifrontal Solver	FEA	**20X**
nbody	Astrophysics	**100X**
Simultaneous Iterative Reconstruction Technique	Computed Tomography	**32X**

Accelerating Time to Discovery



LabVIEW with CUDA

- Native interface for CUDA functions and libraries
  - Call cuBLAS functions
  - Call user-defined functions
- Support for Multiple GPUs
- 10-50x Speedups using GPUs

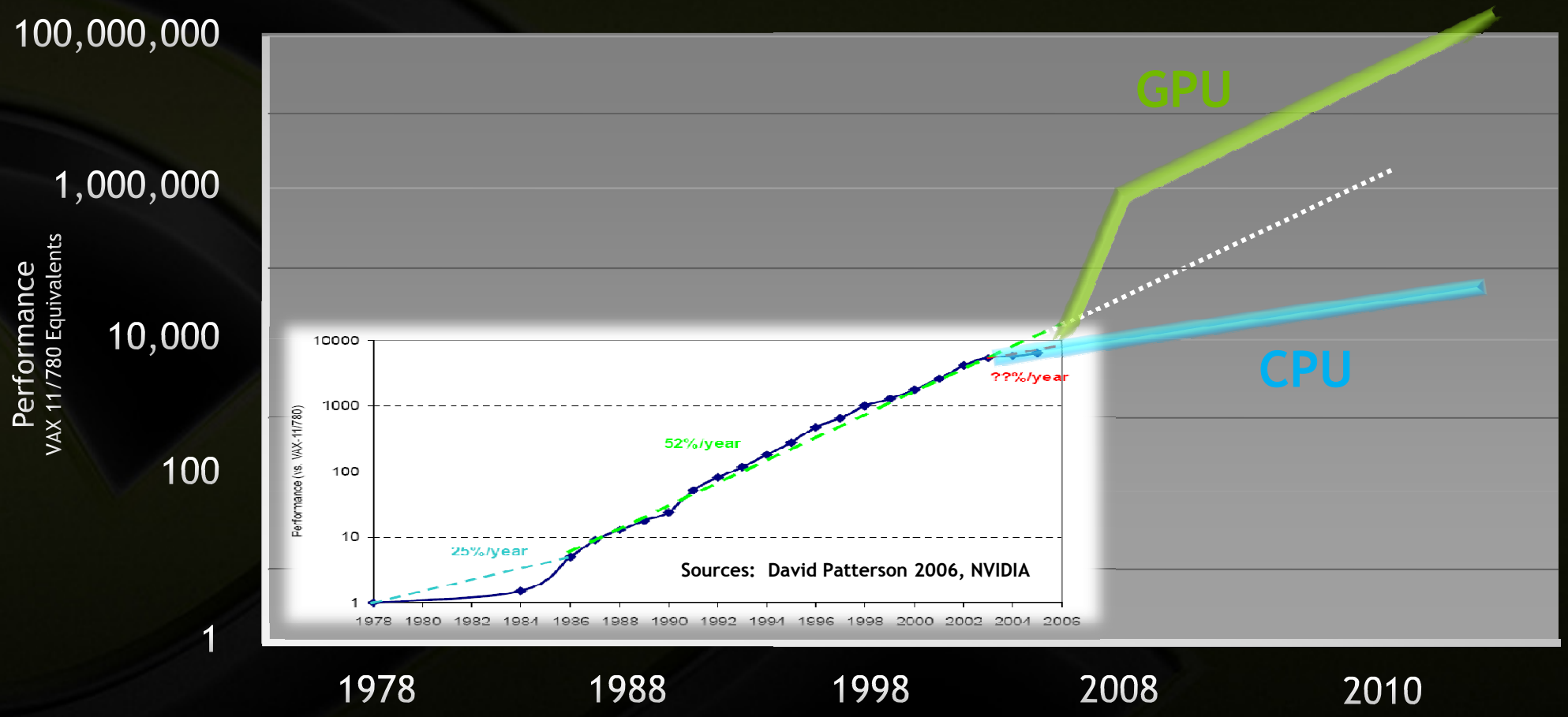


Tesla in Tsubame Supercomputer

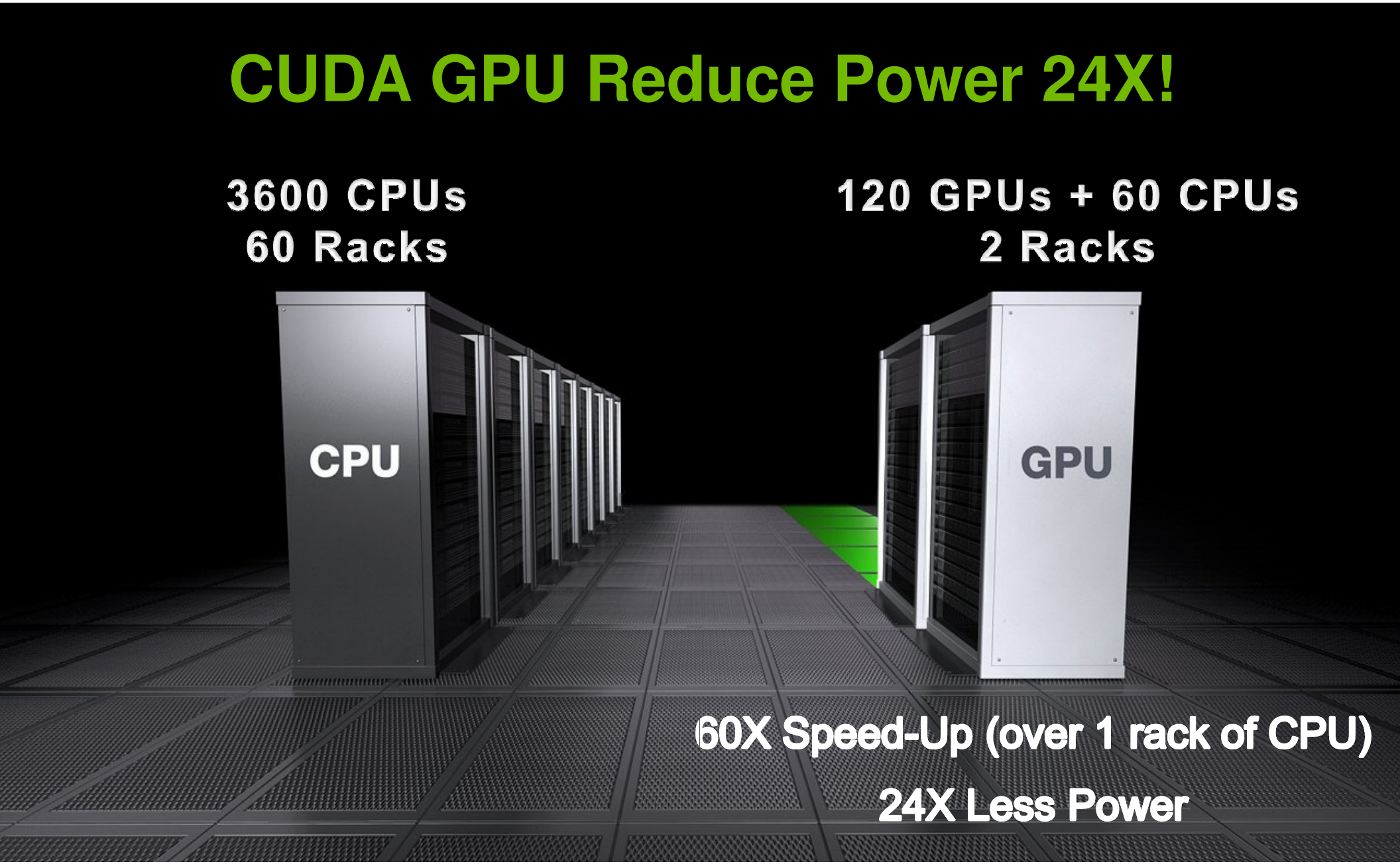
"the Tesla GPUs delivered speed-ups that we had never seen before – this will be a tremendous boost for our scientists and engineers"

Dr. Satoshi Matsuoka
Tokyo Institute of Technology

The GPU Computing Revolution

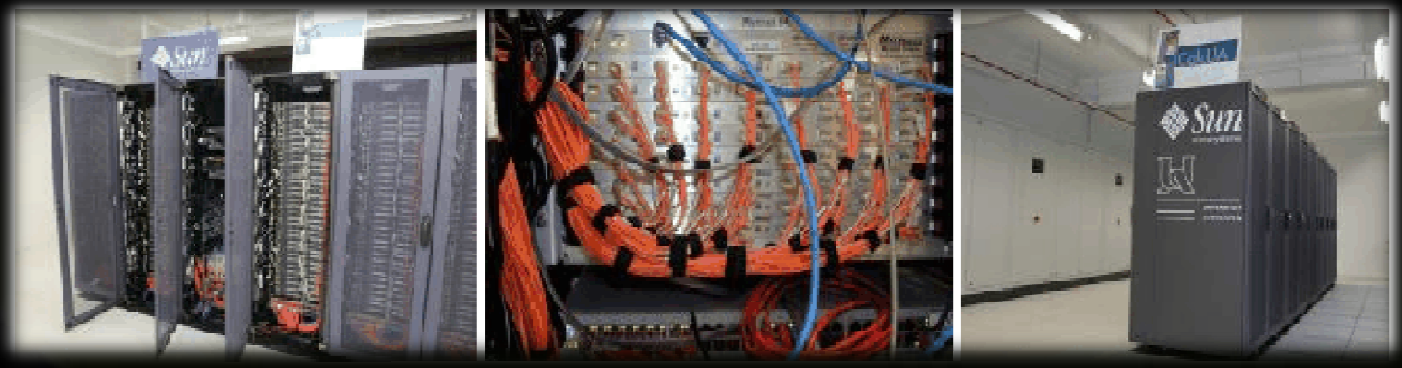


CUDA GPU Reduce Power 24X!

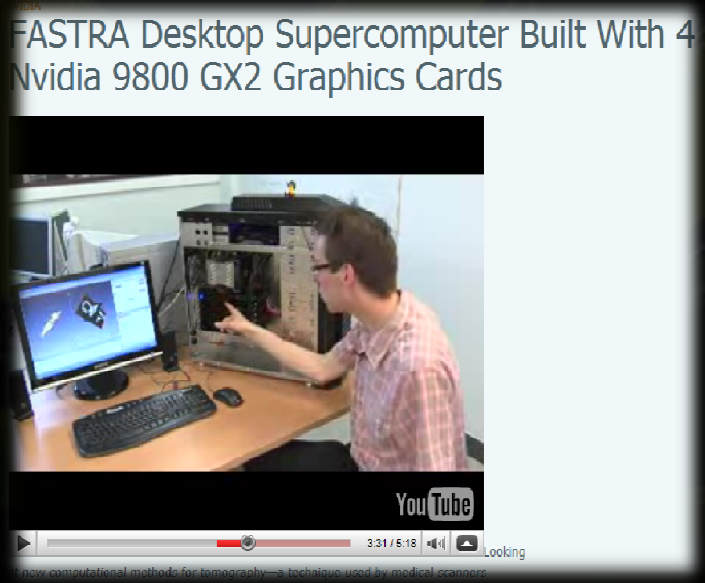


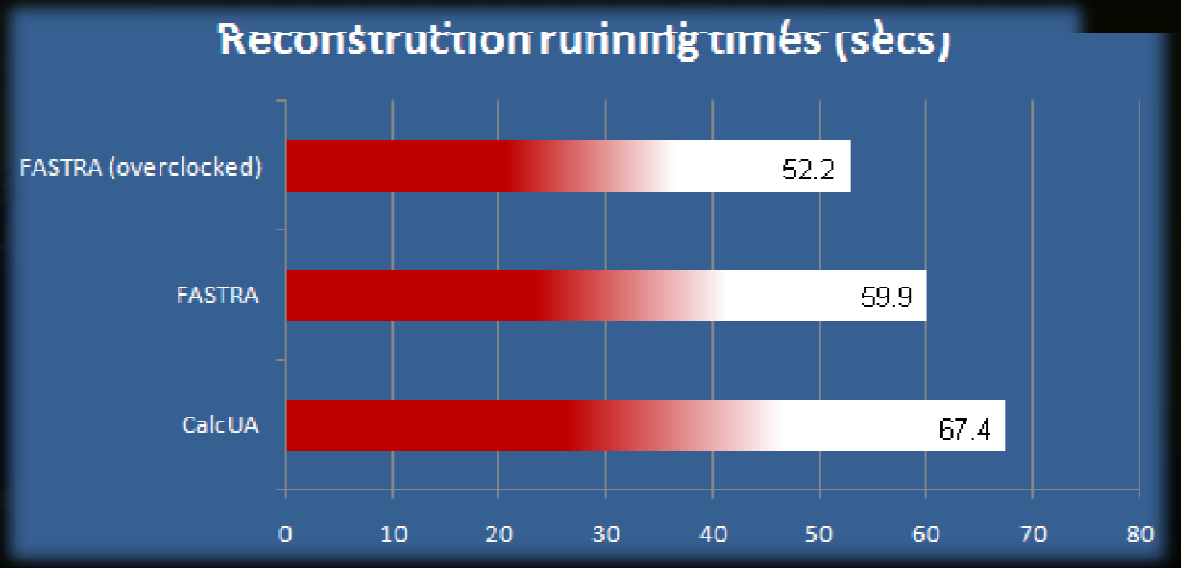
“Homemade” Supercomputer Revolution

CalcUA
256 Nodes (512 cores)



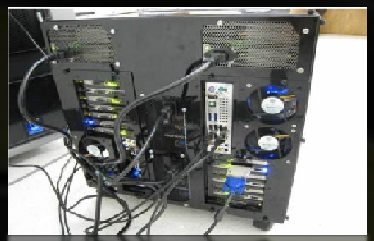
FASTRA
8 GPUs in a Desktop





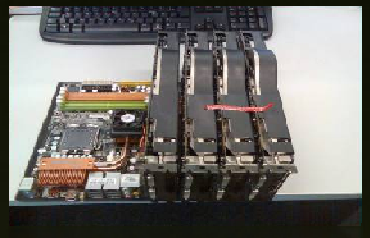
http://fastra.ua.ac.be/en/index.html

“Homemade” Supercomputer Revolution

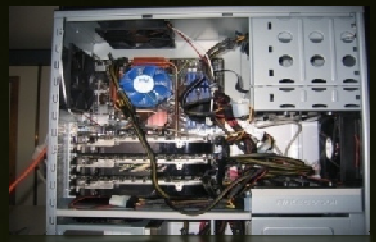


16 GPUs
MIT, Harvard

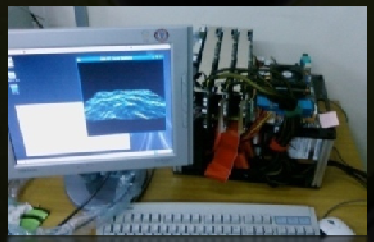
8 GPUs
University of Antwerp
Belgium



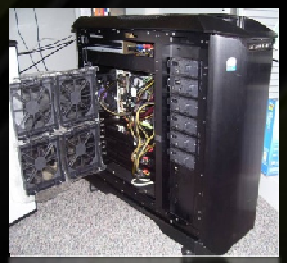
4 GPUs
TU Braunschweig,
Germany



3 GPUs
University of Illinois

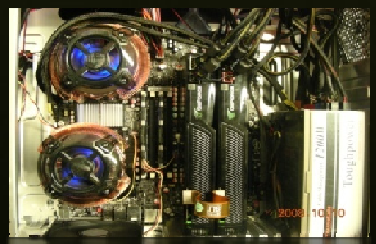


3 GPUs
Yonsei University,
Korea



3 GPUs
Rice University

3 GPUs
University of
Cambridge, UK



2 GPUs
Georgia Tech

Tesla Personal Supercomputer

Supercomputing Performance

- Massively parallel CUDA Architecture
- 960 cores. 4 Teraflops
- 250x the performance of a desktop

Personal

- One researcher, one supercomputer
- Plugs into standard power strip

Accessible

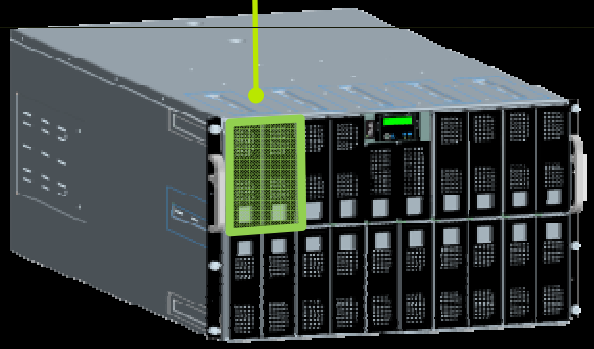
- Program in C for Windows, Linux
- Priced like a PC Workstation

New Class of Hybrid CPU-GPU Servers

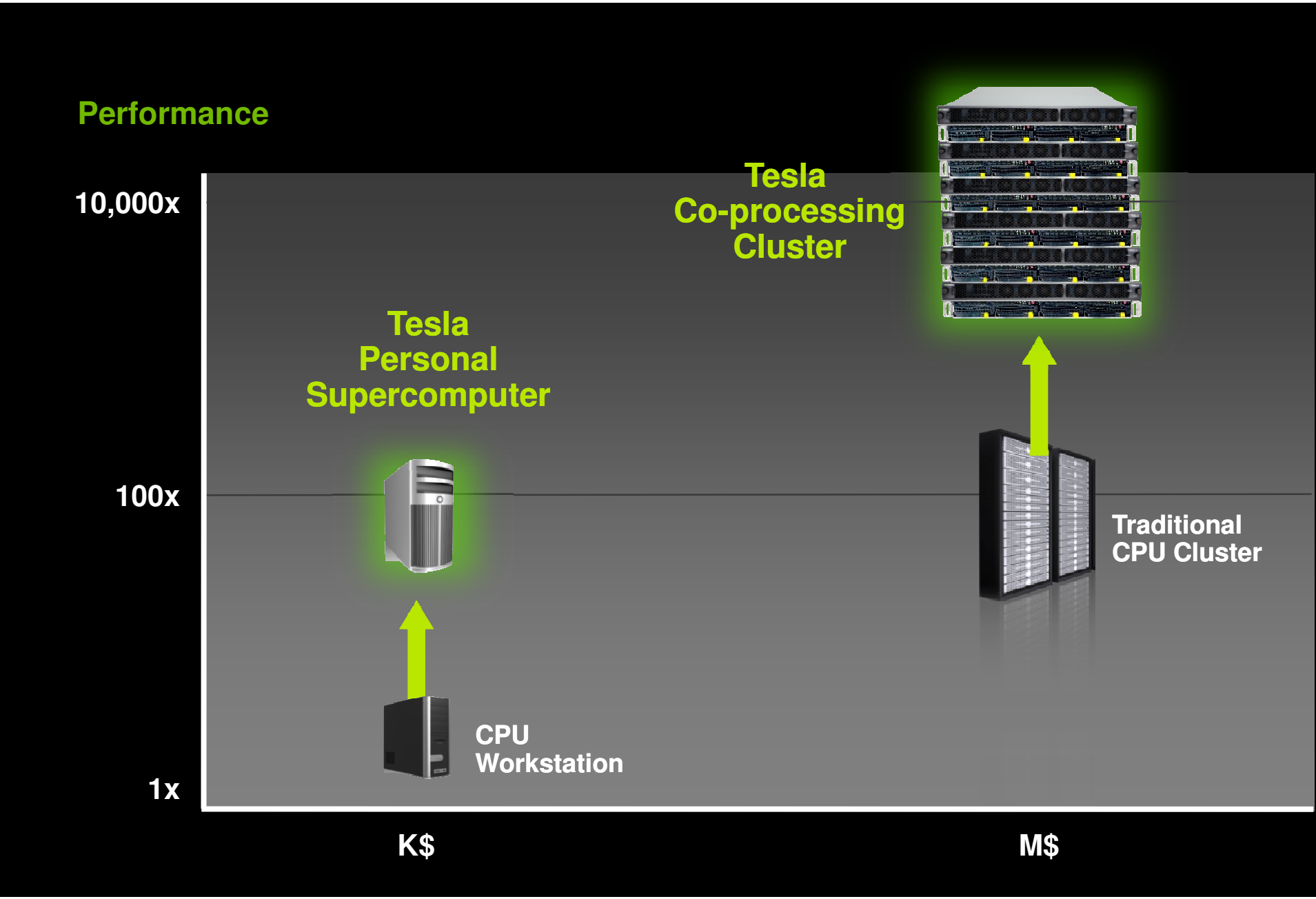
2 Tesla
M1060 GPUs

SuperMicro 1U
GPU Server

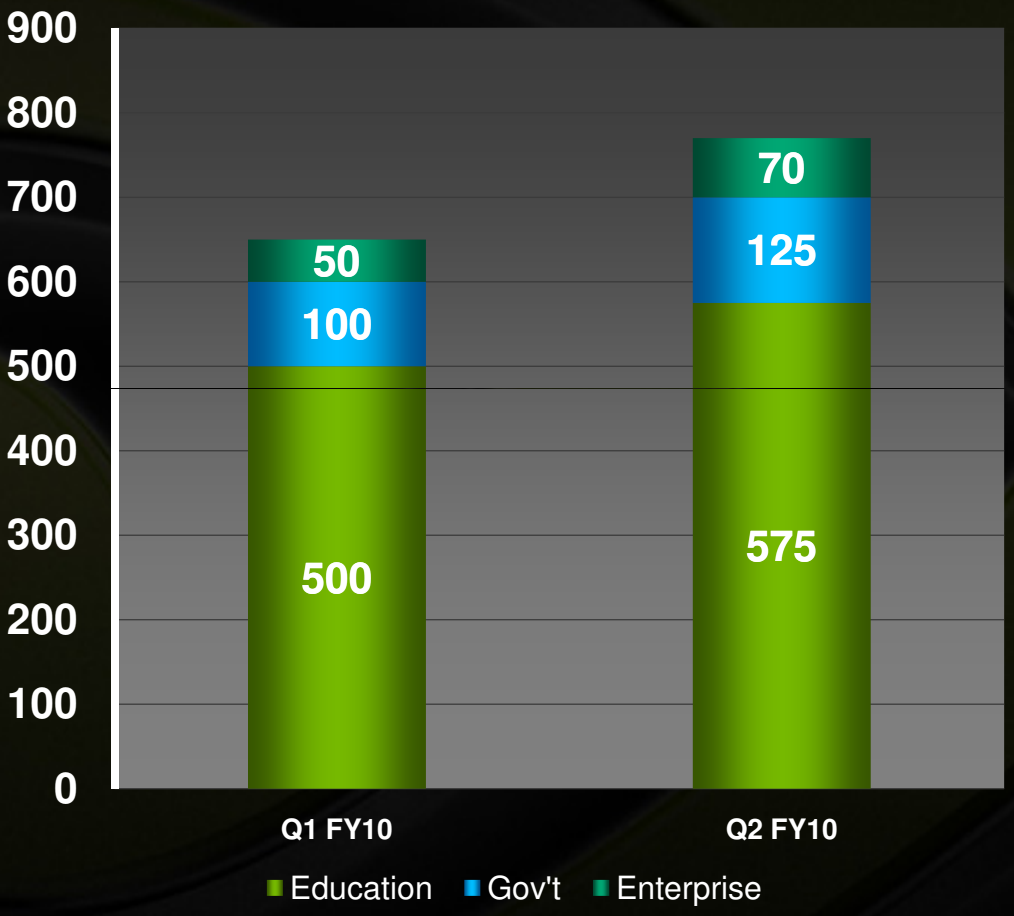
Upto 18 Tesla
M1060 GPUs



Bull Bullx
Blade Enclosure


Performance
10,000x
100x
1x
Tesla
Co-processing
Cluster
Tesla
Personal
Supercomputer
Traditional
CPU Cluster
CPU
Workstation
K$
M$

Tesla Server Installations



	# of GPU
Commercial cluster	>3000
Government	>2000
Chinese Academy of Sciences - Industrial Process Institute	828
Tokyo Institute of Technology Supercomputing Center	680
NCSA – National Center for Supercomputing Applications	384
Seismic processing	256
Pacific Northwest National Labs – Biomedical research	256
CSIRO – Australian National Supercomputing Center	252
Riken – Japanese Astrophysical research	220
Seismic processing	200
Chinese Academy of Sciences – Institute of Modern Physics	200

Final Thoughts

- GPU and heterogeneous parallel architecture will revolutionize computing
- Parallel computing key to solve some of the most interesting and important human challenges ahead
- Learning parallel programming is an imperative for students in computing and sciences

From Virtua Fighter to Tsubame

1995 – NV1	2008 – GT200
0.8M transistors	1,200M transistors
50MHz	1.3GHz
1M Bytes	4G Bytes
0 GFLOPS	1 TFLOPS
$5M R&D	$1B R&D

Another 1000x in 15 years?


NVIDIA® TESLA™
PERSONAL SUPERCOMPUTER