PROGRAM EXECUTIVE OFFICE FOR
SIMULATION, TRAINING & INSTRUMENTATION

High Performance Computing for Interactive Training Simulation

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High Performance Computer

- HPC = Supercomputer

- A computer which, among existing general-purpose computers at any given time, is superlative, often in several senses: highest computation rate, largest memory, or highest cost. Predominantly, the term refers to the fastest “number crunchers,” that is, machines designed to perform numerical calculations at the highest speed that the latest electronic device technology and the state of the art of computer architecture allow.

- Processors: Teraflops (10^{12})
- Storage: Terabytes
- Network: Gigabits/sec (10^{9})

	Single	Double	Quad
1X	2 Gbit/s	4 Gbit/s	8 Gbit/s
4X	8 Gbit/s	16 Gbit/s	32 Gbit/s
12X	24 Gbit/s	48 Gbit/s	96 Gbit/s

Top 10 Super Computers

Rank	Rmax Rpeak (Tflops)	Name	Computer Processor cores	Maker	Site Country, Year
1	1026 1375.8	*Roadrunner*	**IBM BladeCenter QS22/LS21** 122400 (Cell/Opteron)	IBM	Los Alamos National Laboratory United States, 2008
2	478.2 596.4	*Blue Gene/L*	**eServer Blue Gene Solution** 212992 (Power)	IBM	Lawrence Livermore National Laboratory United States, 2004
3	450.3 557.1	*Intrepid*[1]	**Blue Gene/P Solution** 163840 (Power)	IBM	Argonne National Laboratory United States, 2008
4	326 503.8	*Ranger*	**Sun Constellation System** 62976 (Opteron), Infiniband	Sun	Texas Advanced Computing Center United States, 2008
5	205 260.2	*Jaguar*	**Cray XT4** 30976 (Opteron)	Cray	Oak Ridge National Laboratory United States, 2008
6	167.3 222.8	*JUGENE*	**Blue Gene/P Solution** 65536 (Power)	IBM	Jülich Research Centre Germany, 2007
7	126.9 172.0	*Encanto*	**SGI Altix ICE 8200** 14336 (Xeon), InfiniBand	SGI	New Mexico Computing Applications Center United States, 2007
8	117.9 170.9	*EKA*	**Cluster Platform 3000** 14240 (Xeon), InfiniBand	HP	Computational Research Laboratories India, 2007
9	112.5 139.3		**Blue Gene/P Solution** 40960 (Power)	IBM	IDRIS France, 2008
10	106.1 122.9		**SGI Altix ICE 8200EX** 10240 (Xeon), InfiniBand	SGI	Total France, 2008

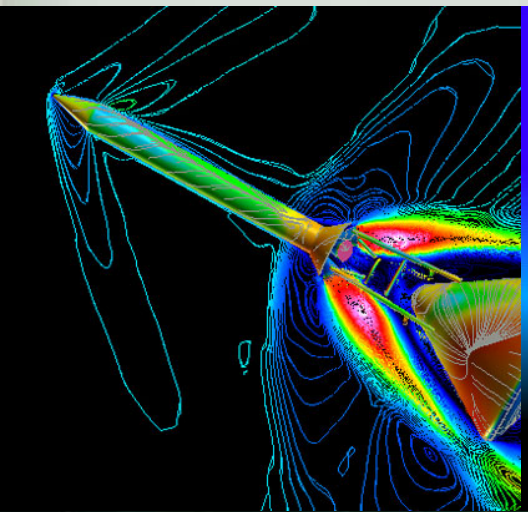
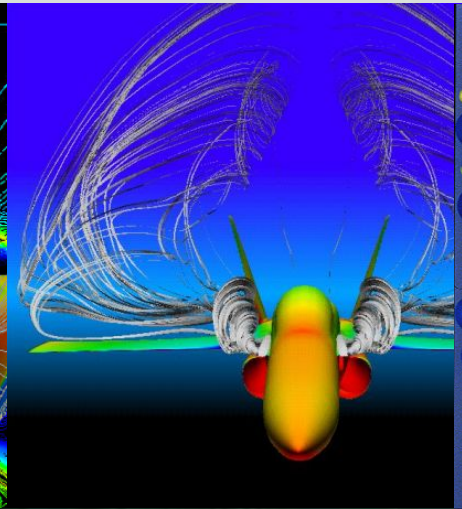
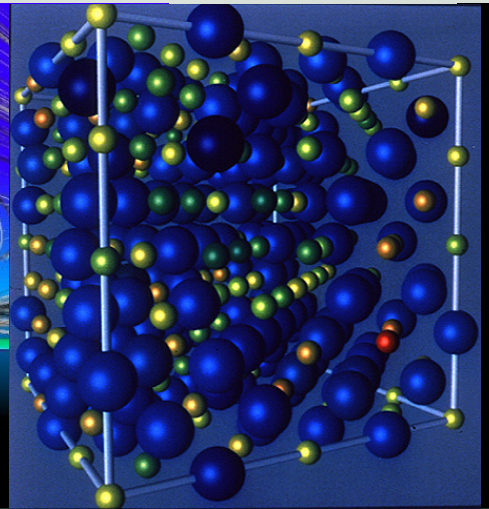
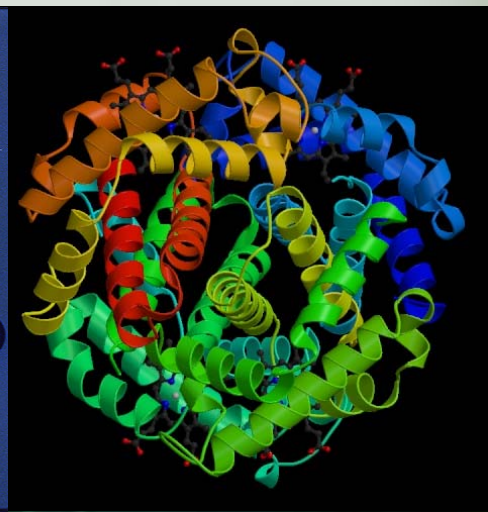
HPC Applications

Typical Batch Jobs

- Computational Fluid Dynamics
- Computational Chemistry
- Protein Folding
- Cryptanalysis

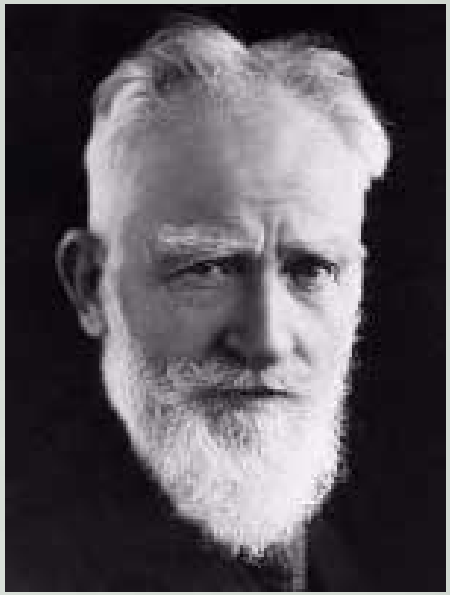
Interactive Simulation

- Urban Challenge 2004
- Joint SAF (Clutter Sim)
- Tony Cerri, Jim Blank, & Andy Ceranowitz, J9
- Bob Lucas & Dan Davis, USC ISI

Vision for Orlando Simulation Industry

- **"The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man."**
  - *Man and Superman*, 1903, George Bernard Shaw



- **Thank You to Some Unreasonable People:**
  - HON Tom Feeney, US House of Representatives
  - Jim Blake & Mike Macedonia, PEO-STRI
  - Randy Shumaker & Brian Goldiez, UCF IST
  - Dave Pratt, SAIC
  - COL Ken Wheeler, PM CONSIM
  - LTC Ray Compton & Troy Dere, RDECOM STTC
  - Cray Henry & Andy Mark, HPCMO
  - Mark Fry, IBM & Russ Patten, Mainline Info Sys
  - Dennis Liebold, SGI

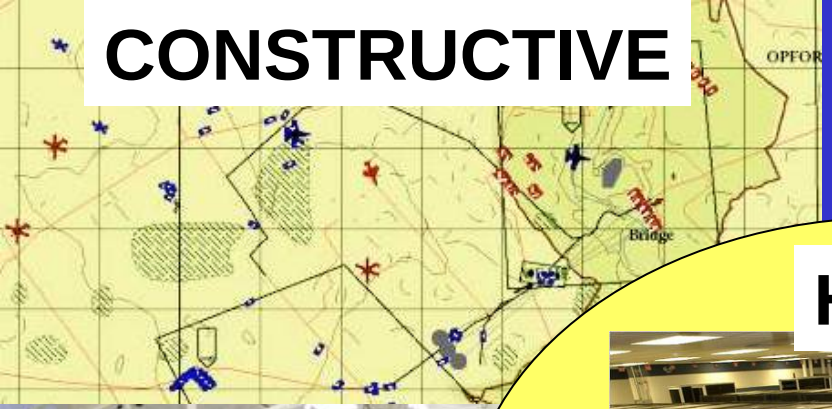
Objectives

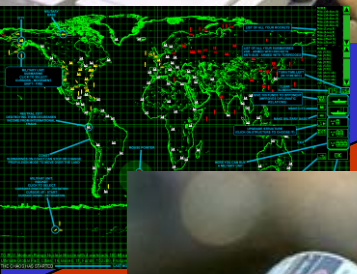
- Leverage the power of HPC as the server farm for interactive simulation for training
  - OneSAF
  - WARSIM
  - Multiplayer Game Server Farm
- Multiple simultaneous exercises supported from a single simulation center
- Physics-based object, weather, and terrain modeling (put the “reality” in virtual reality)
- Tighter network connections between applications to eliminate lag
- Cloud Computing service migration

CONSTRUCTIVE

VIRTUAL

HPC





LIVE

Simulation in the 21st Century

Sim Center	Delivery	Customer
HPC, Lights-out Centers, Distributed Operators	Customer-centric, Dot-Mil network, QoS Contracts	Game Tech, IT Desktop Access, C4I Network

HALLE at CERDEC & PEO-C3T

- ***Access to CERDEC Labs, PEO C3T, PEO IEW&S, CECOM, and FCS (BCT) NSI labs***
- ***Leverages the Center for LVC M&S and High Performance Computing Enclaves***
- ***Conduit for Distributed Network Connectivity***
- ***Supports In-Theater Network Data Collection and Reduction***

- ***Fully Instrumented ranges***
  - Experiment command and control
- ***Commercially restricted airspace*** – unrestricted to support UAS and Air operations up 8000 ft
- ***Full spectrum of terrain***
- **Designated Army experimental station** - listed in NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management

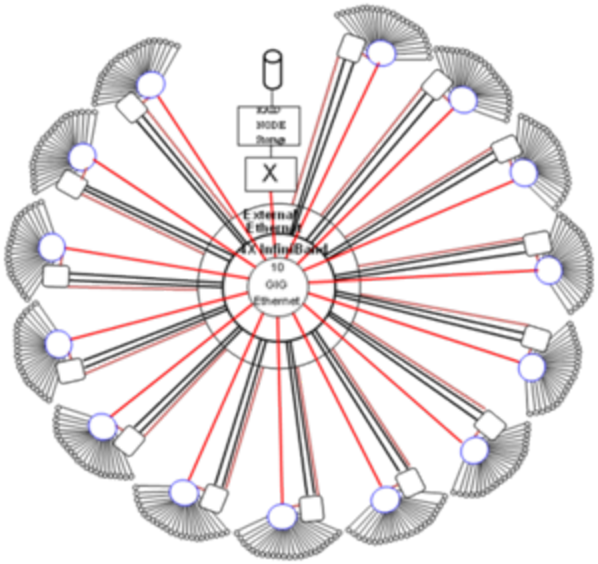
SMDC's SGI Altix 3700

Scalable Single Image / Global Memory Architecture

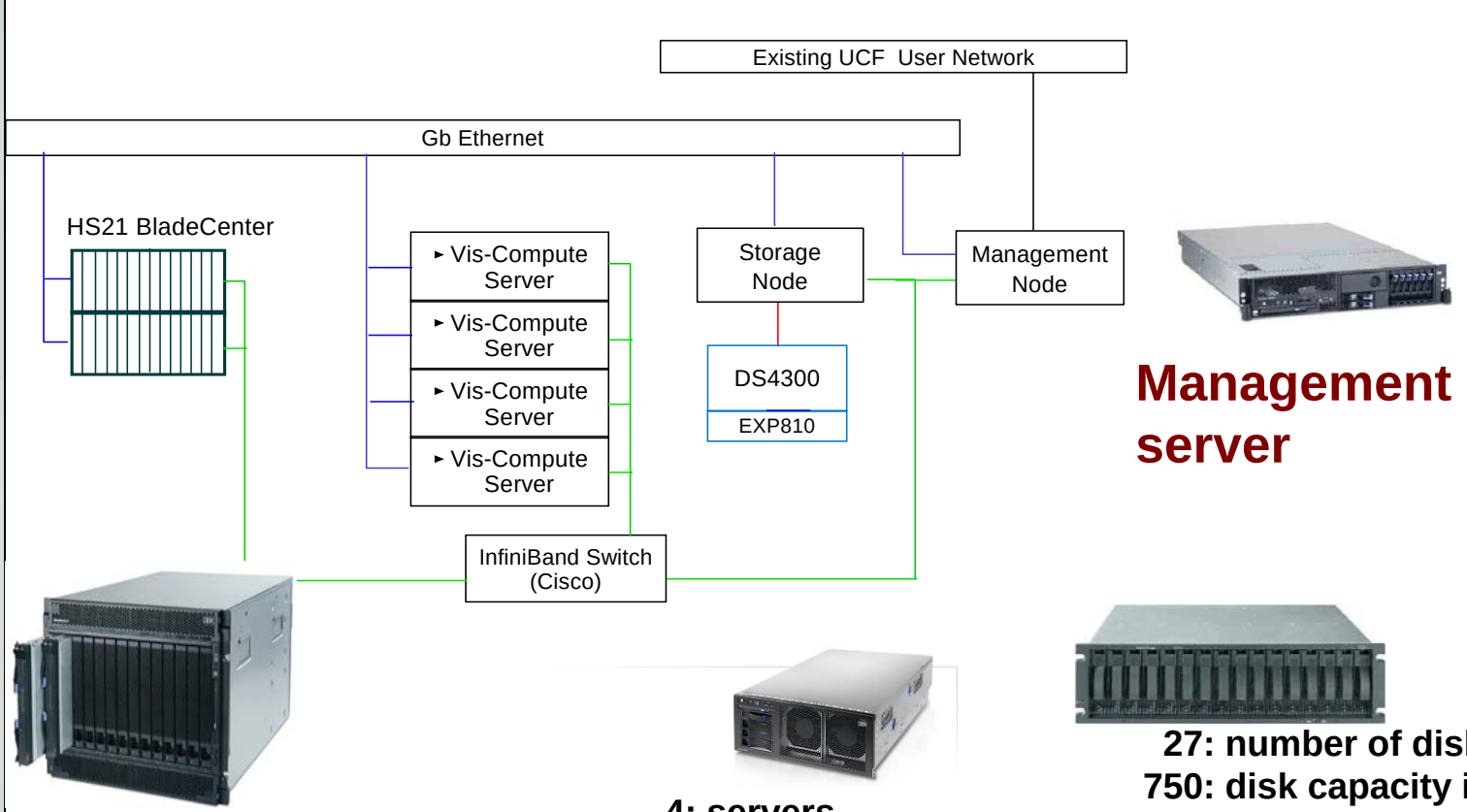
- 128 – 1.6 GHz Processors
  - 6.4 GFLOP Intel Itanium2 CPUs,
    - 820 GFLOP system peak
- 128 GByte Memory
- SuSE Linux
- 5 TByte FiberChannel/SATA Disk
- Gigabit Ethernet network
- HPC Load Sharing Facility (LSF) batch queuing system
- Fortran 90, Fortran 77, C, and C++
- MIPS Pro Auto Parallelization Option
- ProDev Workshop

AFRL's PS3 Cell Cluster

- The Cell Cluster has a peak performance of 51.5 Teraflops from 336 PS3s and additional 1.4 TF from the headnodes on its 14 subclusters.
- Cost: $361K ($257K from HPCMP)
    - PS3s 37% of cost
- Price Performance: 147 TFLOPS/$M
- The 24 PS3s in aggregate contain 6 GB of memory and 960 GB of disk. The dual quad-core Xeon headnodes have 32 GB of DRAM and 4 TB of disk.



Team Orlando HPC "Stokes"



Management server

2: chassis
12: blades in each chassis
8: cores in each blade
192: total number of cores

Bladecenter Cluster

4: servers
8: cores in each server
32: total number of cores

Visualization & Compute Servers

27: number of disk drives
750: disk capacity in GB
20250: total capacity in GB

Storage Subsystem

IBM HS21 Bladecenter Cluster

	Installed in Each Blade
Intel Xeon Processor	2 quad-core E5450 (Harpertown) 8 cores @ 3.0 GHz
L2 Cache	2 X 2 X 6144 KiB
Memory	8 GB, 667 MHz, DDR2
Front Side Bus	1333 MT/s
internal disk	73 GB, 10K RPM SAS
Power	80 W
Ethernet	1 Gb Ethernet
InfiniBand	Single-port 4X DDR IB PCI-E HCA (Cisco)
Linux OS	Red Hat V5
Compilers	GCC Intel Fortran V10.1 Intel C++ V10.1 PGI V7

Orlando HPC: ~~24 Blades, 192 cores~~

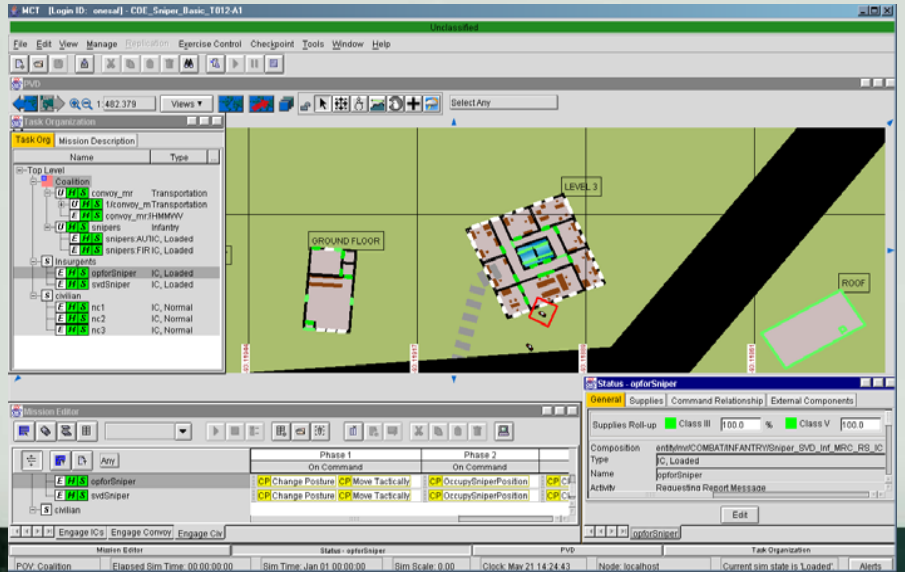
Upgrade: 85 Blades, 680 cores

Predecessor Experiments

- WARSIM Port
  - HPCMO, SAIC
- Physics-based Environment for Urban Operations using OneSAF
  - HPCMO, STRI, SAIC
- Millennium Challenge Exercise Clutter using JointSAF
  - JFCOM, Maui SCC, Alion
- PEO-C3T C4ISR On-the-Move (OTM) program includes OneSAF
  - CERDEC, HPTi, SAIC, HPCMO

OneSAF Porting

- HPCMO Funded
- Team Orlando Coordination
  - STRI, STTC, HPCMO, SAIC, UCF IST
- Porting OneSAF to UCF Stokes HPC
  - IBM x-series machine running Red Hat Enterprise



OneSAF HPC Research Problems

- Porting
  - Host OneSAF Sim Core and MCT on HPC
- Computational Distribution
  - Efficiency of thread distribution in HPC environment
  - Function of JVM, Node/Process/Core availability
- MCT Interface
  - Internal to HPC with VNC video exported
  - External with efficient network comms
- Light Interface
  - Operate via light GUI interface outside of HPC (e.g. Browser interface)
- Infiniband Network
  - Multiple instances using Infiniband vs. Ethernet to communicate

MITRE IRAD FY09

- Ernie Page, Emmet Beeker
- Extend CombatCloud to use other HPC assets
  - UCF Stokes and CERDEC Halle
- Wrap OneSAF as cloud application
  - Identify relevant OneSAF components (core simulation, scenario generation tool(s), after-action review tool(s), etc.), their ancillary support utilities, and other software elements, and identify preferred approach for wrapping as Condor/Stork jobs.
- Support mobility of OneSAF elements in the cloud
  - Define and implement load balancing strategies.
- Evaluate the performance of cloud-based OneSAF
  - Define performance metrics (with focus on scalability, throughput, reliability, ease of use/access). Conduct experiments.

WARSIM Potential

- Dr. Blake is interested in tackling a challenging problem
- Start with WARSIM, move to JLCCTC
- Beyond multiple core workstations

Team Orlando Efforts

- PEO-STRI, STTC, UCF IST, Industry
- $1M & $2.4M Congressional Money
- $100K HPCMO
- $60K JTIEC
- Supercomputing 2007 & 2008 Conference Panel
- TechNet 2009 Tutorial

Conclusion

- Reduce operational costs for hardware, shipping, set-up time, travel, staffing
- Increase soldier/unit access to training systems
- Increase exercise reliability and availability
- Increase model fidelity
- Increase model synchronization