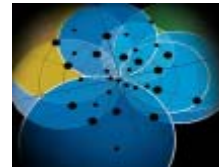


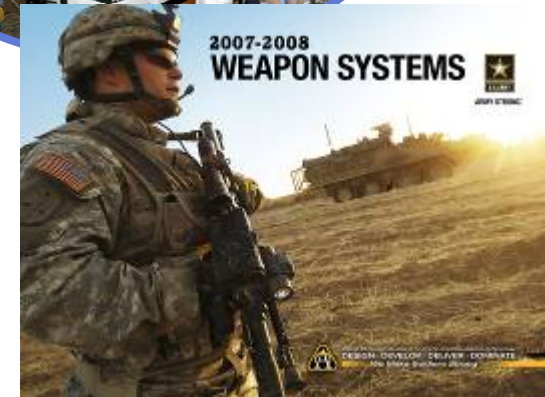


*Enabling Future
Technology
Ultra-Large-Scale Systems
in the Army*

**SMART Ultra-Large-Scale
System Forum**
Carnegie Mellon University
Pittsburgh, PA



6 Mar 2008



Dr. Thomas H. Killion
Deputy Assistant Secretary
for Research and Technology/
Chief Scientist

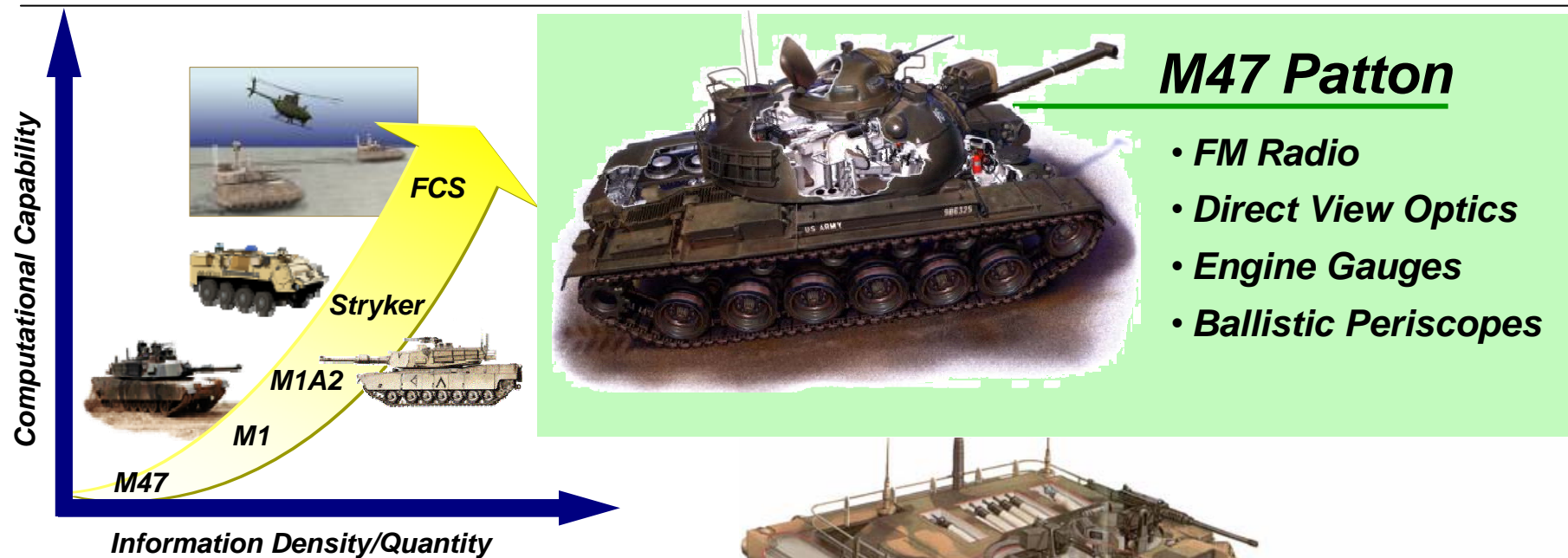


Overview

- ***Today's Environment***
- ***Systems Evolution***
- ***Network Centric Operations***
- ***Game Changing Technologies***
- ***High Performance Computing***
- ***Predicting the Future***



Ground Combat Vehicle Evolution



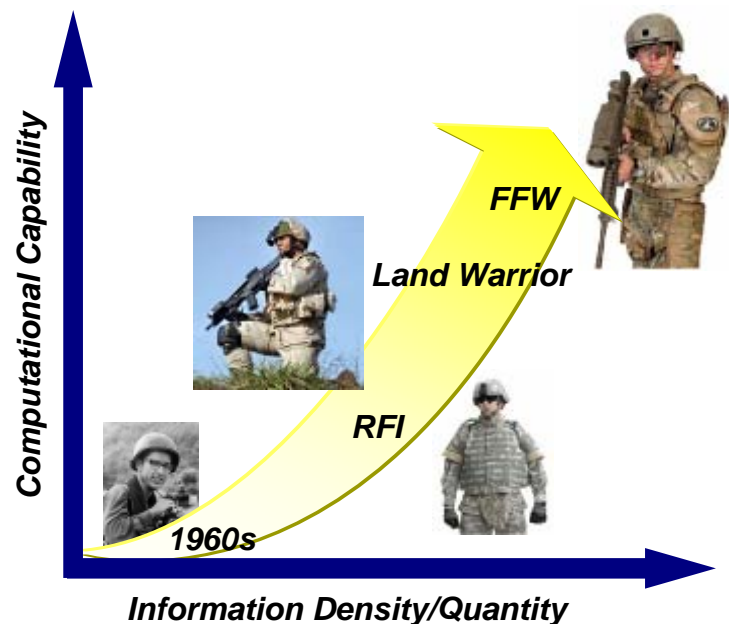
M1A2 Abrams

- Secure data/voice radio
- Thermal Viewer
- FBCB2 Digital Battle Command
- Digital Fire Control
- 1 Color/3 Monochromatic Displays





Soldier as System Evolution



Late 1960s Soldier

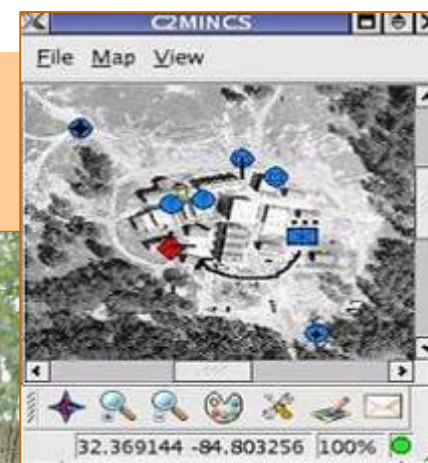
- FM radio
- Early P^2 devices
- Binoculars
- M-16 with daylight scope

Future Force Warrior (FFW)

- Integrated body armor & equipment carriage suite
- Helmet mounted thermal imaging
- Radio digitally linked to unit communications network displaying individual locations
- Laser aided weapon precision fire control
- Embedded training

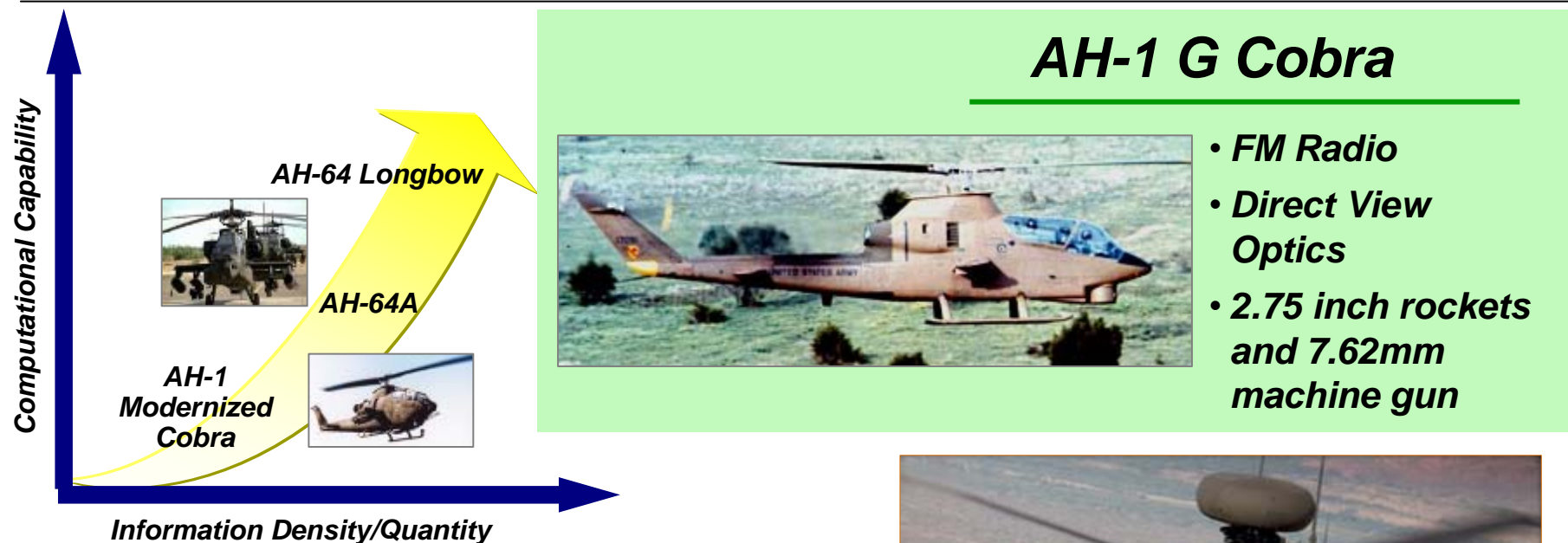


Handheld Soldier Display





Helicopter Evolution



AH-1 G Cobra



- FM Radio
- Direct View Optics
- 2.75 inch rockets and 7.62mm machine gun

AH-64 Apache Longbow

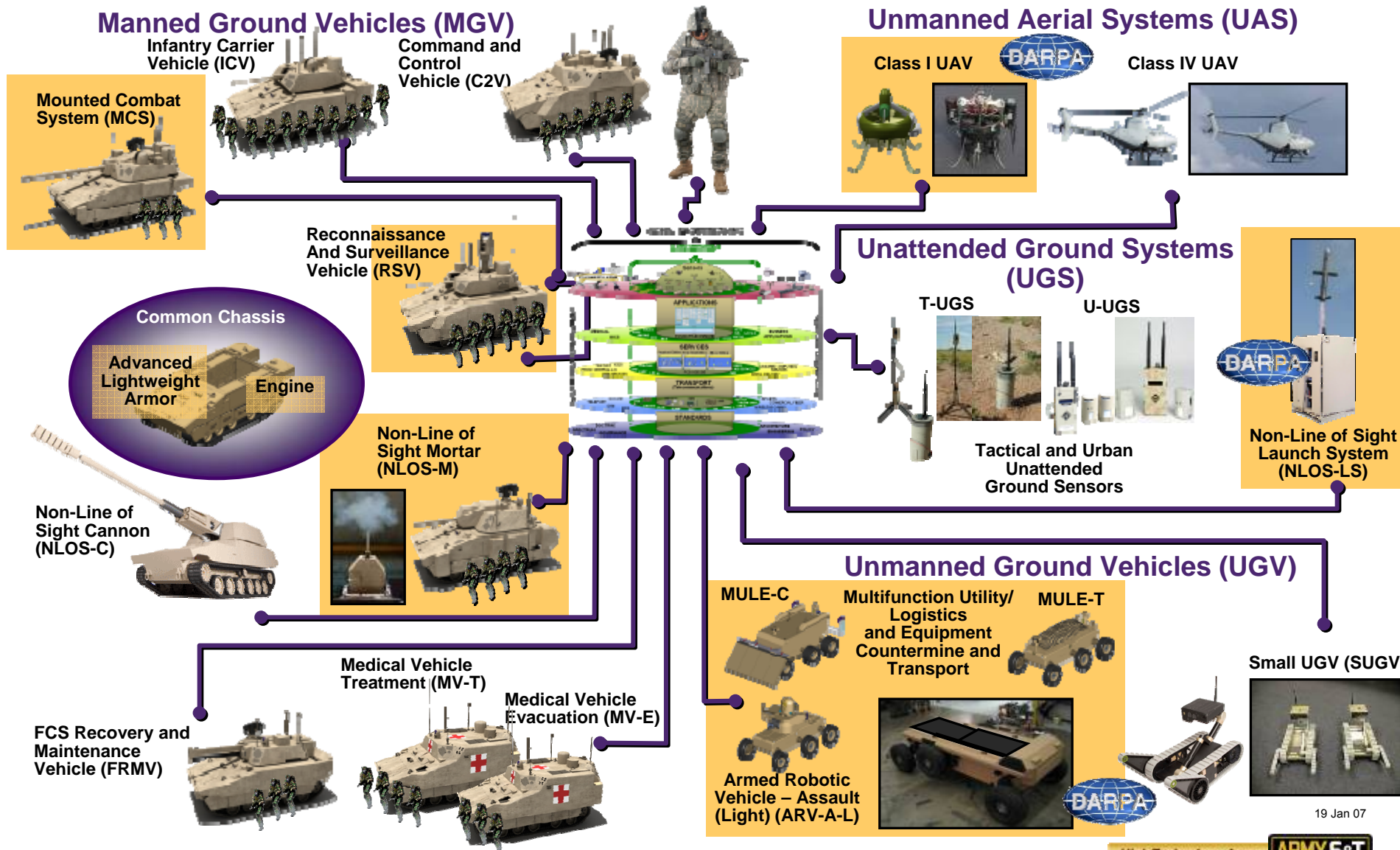
- Secure data/voice radio
- Integrated pilot night vision system
- Digital fire control linking gunners view & weapons systems
- Longbow MMW radar
- Hellfire missiles and 30mm cannon
- Survivable rotors—up to 23mm AA





Future Combat Systems

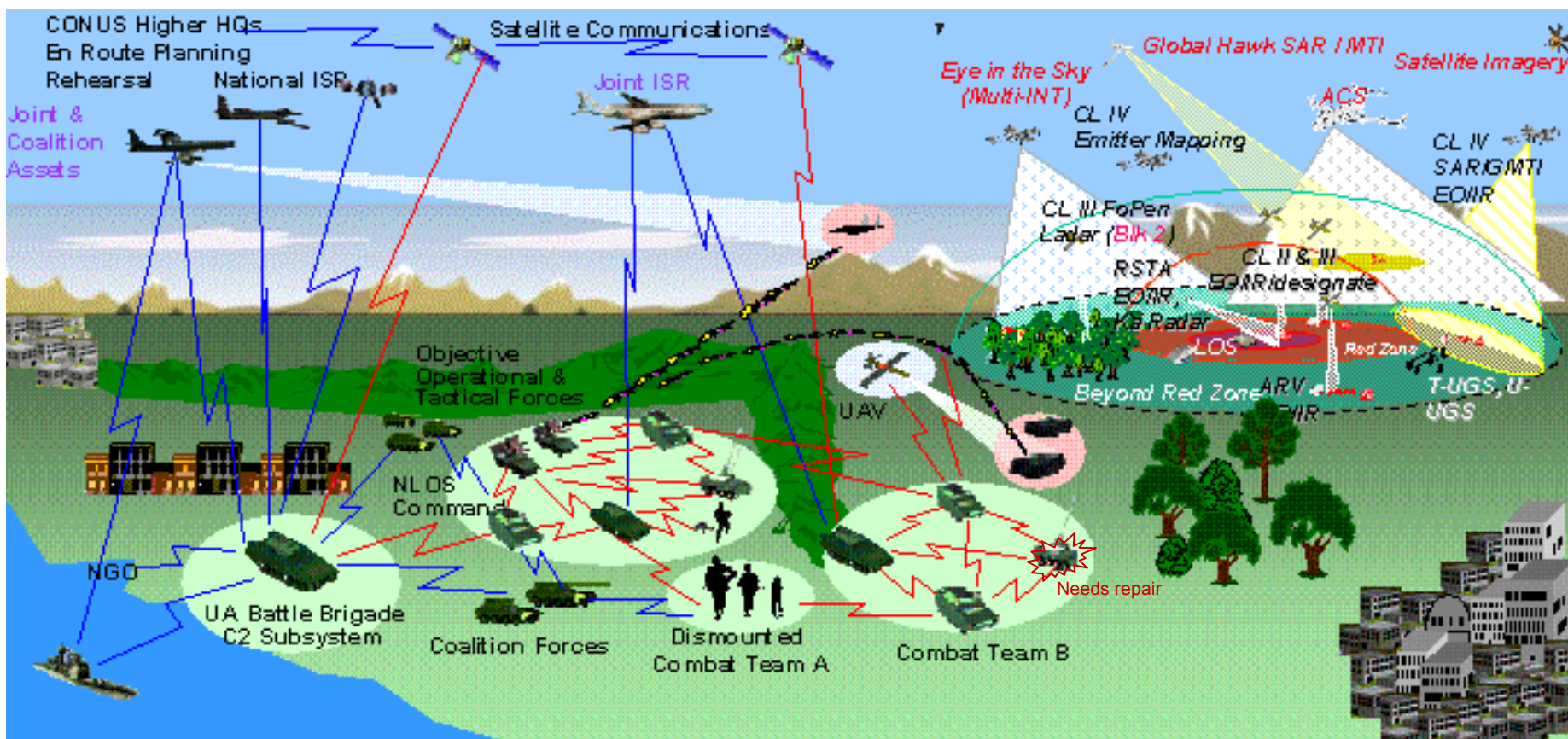
PROGRAM MANAGER
FCS
BRIGADE COMBAT TEAM
One Team - Five Arms - Defense & Industry



19 Jan 07



Complexity of Network Centric Operations



Success depends upon C4ISR technologies, networked human behavior, and organizational networks with *joint and coalition interdependency*



Generations of Game Changing Technologies

Decade of the 1950's

Lasers

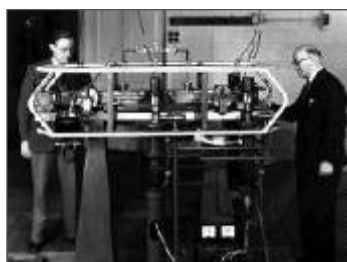
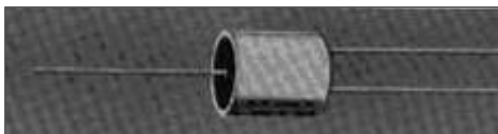


Programmable Systems



**WWII Ballistic Computing/
ENIAC**

Transistor



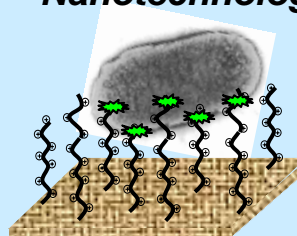
Atomic Clock



DNA

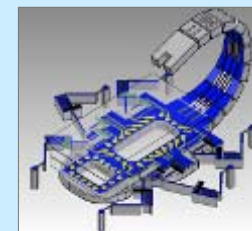
Today for 2020 and beyond...

Nanotechnology



**Institute for Soldier
Nanotechnologies (ISN)**

Micro-robotics

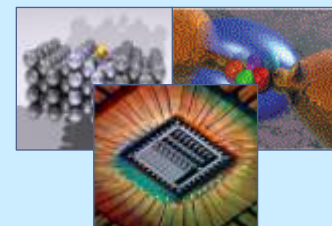


Immersive Environments



**Institute for Creative
Technologies (ICT)**

**High Performance
Computing**



The Network



Flexible Displays

Biotechnology



**Institute for Collaborative
Biotechnologies (ICB)**



Impact of High Performance Computing Past, Present and Future

Compute Capacity Scale (FLOPS)

Peta

Dynamic Hologram



Multi-Disciplinary Analysis and Optimization



Precision Air Drop



Force Protection



Tera

Virtual Wind Tunnel



Smart Munitions



Hardened Structures

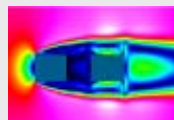


Micro-Autonomous Systems

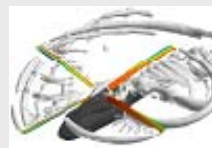


Giga

Multi-Component Projectiles/Missiles (SADARM, BAT)



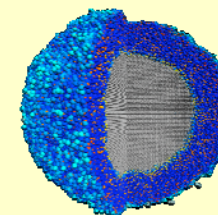
Proof-of Concept



Advanced Armors

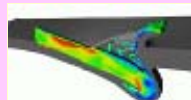


New Materials

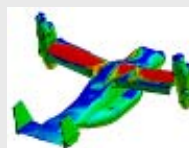


Mega

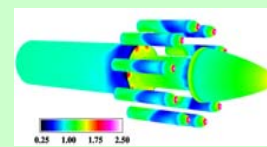
3D Armor Penetration



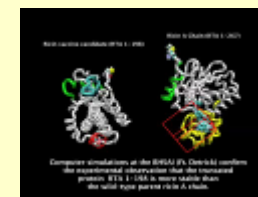
Physics Performance of Fielded Vehicles



Multi-Function Munitions



Vaccines



Kilo

M > 1
- Loads
- Noise
2D airfoils
Num. Meth. Development

1975

1985

1995

2005

High Technology Army

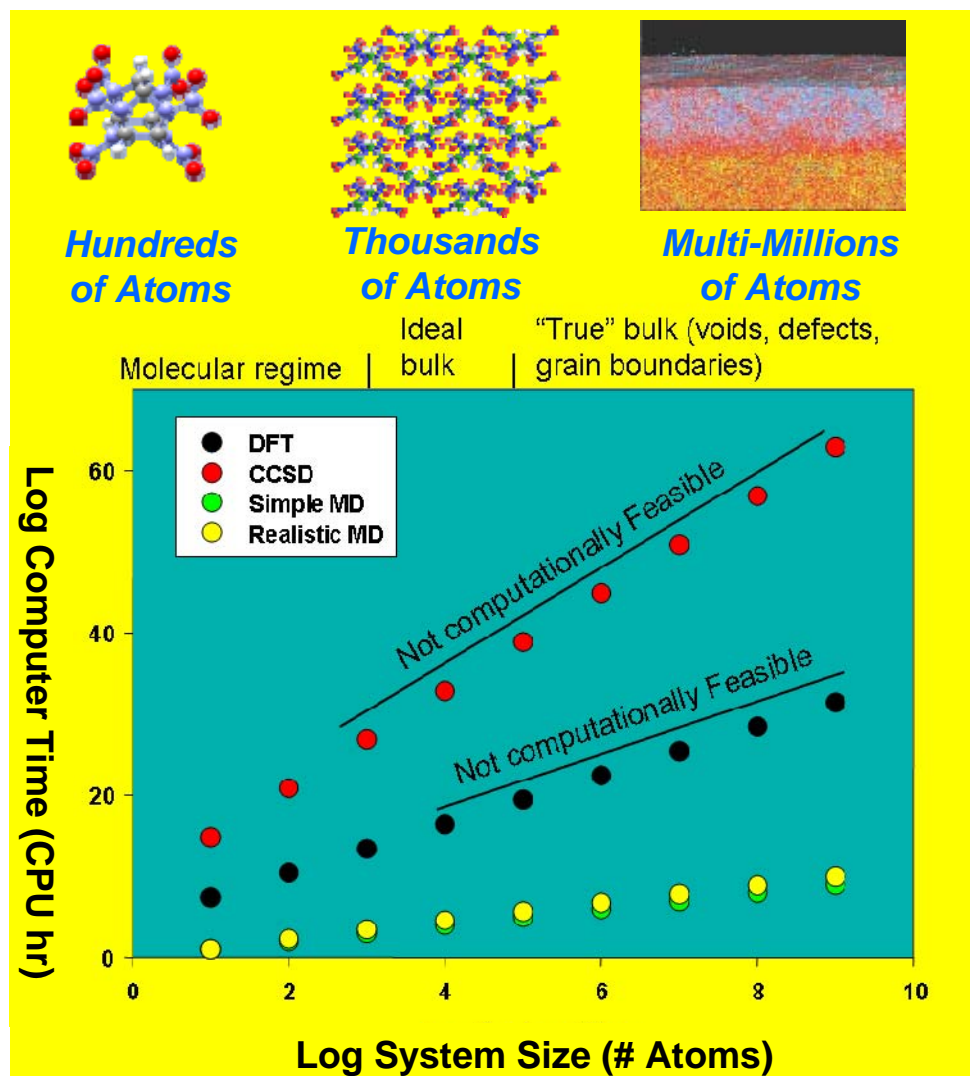


10



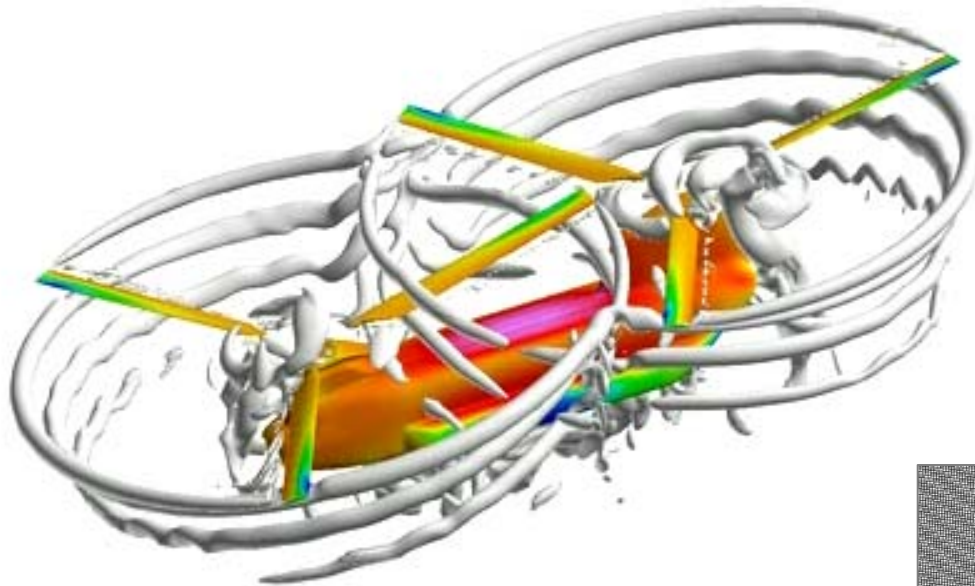
High-Performance Computing Needs to Support Energetic Materials Quantum Mechanics (QM) & Molecular Dynamics (MD)

- **Density Functional Theory (DFT) is currently state-of-the art Quantum Method for Solid State:**
 - Limited to ~1000 atoms
 - Does not sufficiently or accurately predict conventional CHNO explosives (lacks description of key component of interactions in organic crystals)
 - Limited to very small-time dynamics calculations; typically used for calculating static properties (i.e. structures)
- **CCSD (Coupled Cluster Single & Double [excitations]) is current most accurate Quantum Method—only feasible for extremely small systems, single point energies (no dynamics)**
- **MD simulations can treat 10 million atoms readily at this time—need to exceed this by orders of magnitude to treat “true bulk”**
- **Simple MD does not include reactive models**
- **More complex descriptions substantially increase computational requirements**





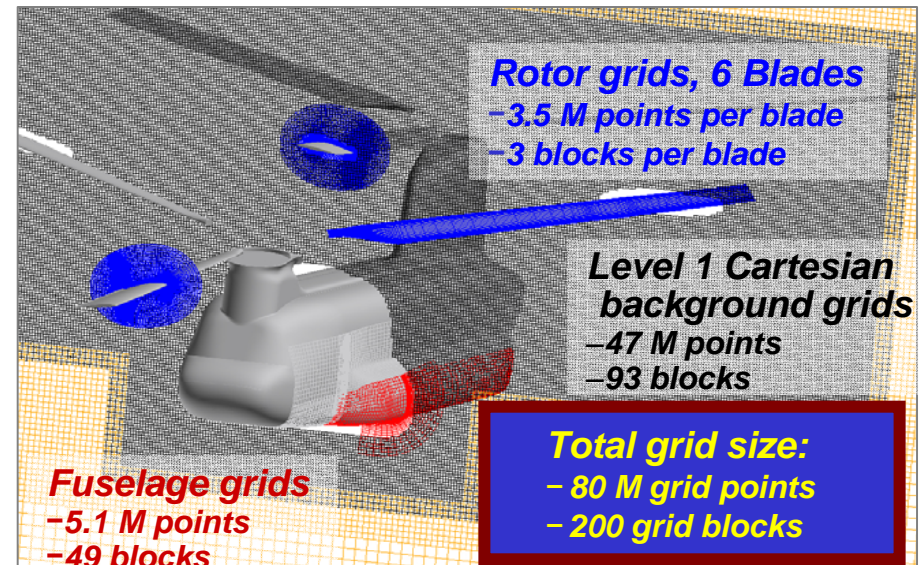
High Performance Computing CH-47 CFD/CSD Hover Application



**State-of-the-art tools
for design and analysis**

CFD=Computational Fluid Dynamics
CSD=Computational Structural Dynamics

- **Joint work between AMRDEC (Army Aeroflight Dynamics Directorate) and Boeing Co.**
- **15 total rotor revolutions**
 - About 150 hours on 256 processors of an IBM-P5
- **Computed rotor performance closely matches flight test data**



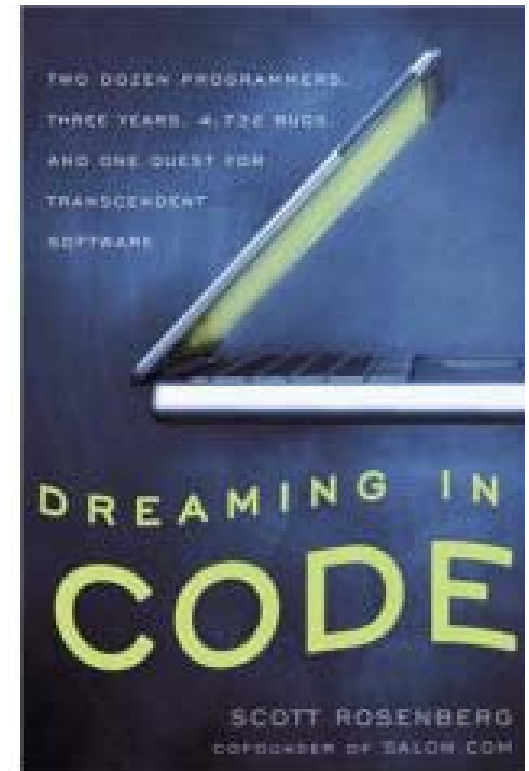


Dreaming in Code

Our civilization runs on software. Yet the art of creating it continues to be a dark mystery, even to the experts, and the greater our ambitions, the more spectacularly we seem to fail.

Big software projects regularly crash and burn—just ask the FBI and the IRS, the Pentagon and the FAA, or any decent-size corporation.

The latest version of Microsoft Windows took years longer than planned, and it will still have mountains of bugs. Never in history have we depended so completely on a product that so few know how to make well.



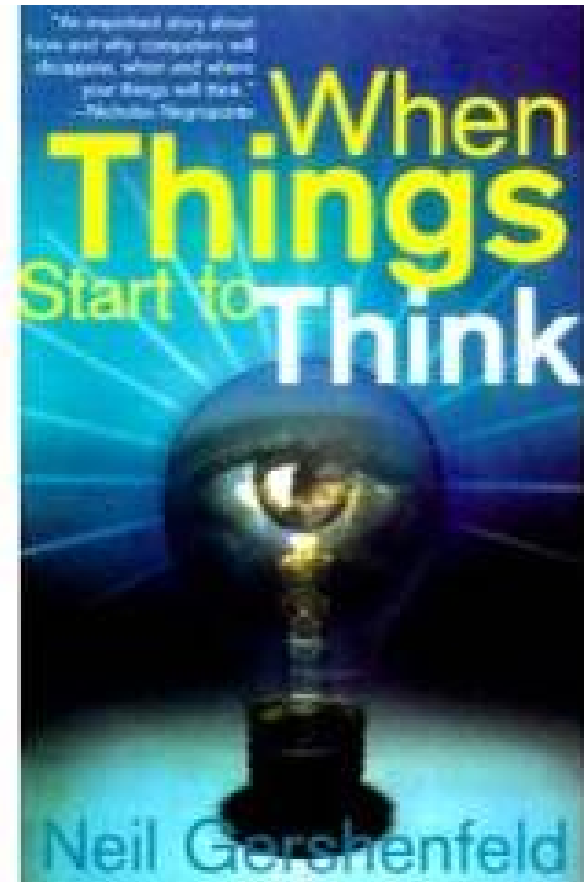
***Two Dozen Programmers, Three Years, 4,732 bugs,
and One Quest for Transcendent Software***



The “Real” Computer Revolution?

An Associated Press report from Issaquah, Wash., in 1997 told of a man who pulled a gun and shot his personal computer several times. The police took him off for mental evaluation. According to Gershenfeld, “(T)hey should have instead checked the computer for irrational and antisocial behavior.”

“There is a disconnect between the breathless pronouncements of cybergurus and the experience of ordinary people left perpetually upgrading hardware to meet the demands of new software, or wondering where their files have gone, or trying to understand why they can't connect to the network.”



“The [digital] revolution so far has been for the computers, not the people.” – Neil Gershenfeld



Predicting the Future

It's tough to make predictions, especially about the future. Some famous technology predictions include:

- ***“Heavier-than-air flying machines are impossible.”***
 - Lord Kelvin, 1895
- ***“Airplanes are ...of no military value.”***
 - Marshal Ferdinand Foch, 1911
- ***"Who ... wants to hear actors talk ?"***
 - H. M. Warner, 1927
- ***"... (T)here is world market for maybe five computers."***
 - T. Watson, IBM Chairman, 1943
- ***"640k (RAM) ought to be enough for anybody."***
 - Bill Gates, 1981



Army S&T... Engine of Transformation

