



Army Transformation to the Future Force...A Race for Speed and Precision

***7th Annual High Performance Embedded Computing Workshop
Lincoln Lab/MIT***



***Dr. John Parmentola
Director for Research
and Laboratory Management***

September 23, 2003



Purpose

- *Describe Army's vision of the Future Force*
- *Address Army needs and challenges in High Performance Embedded Computing (HPEC) to enable Transformation to the Future Force*



Future Force for Full Spectrum of Missions

Environmental Complexity

High
Urban



Open
rolling
terrain



Low

Stability and Support
Operations

Small Scale
Contingencies

Major Theater War

Spectrum of Conflict

Increased strategic responsiveness

- ✦ Brigade in 96 hrs;
Division in 120 hrs;
Five Divisions in 30 days
- ✦ Fight immediately upon arrival
- ✦ Simultaneous air and sea lift

Render Previous Ways of Warfighting Obsolete

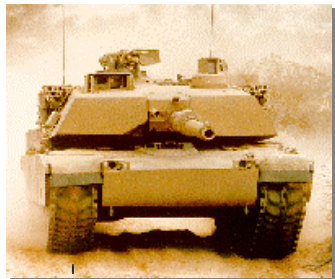


Seeking A Revolution in Capabilities ... Smaller, Smarter, Lighter & Faster

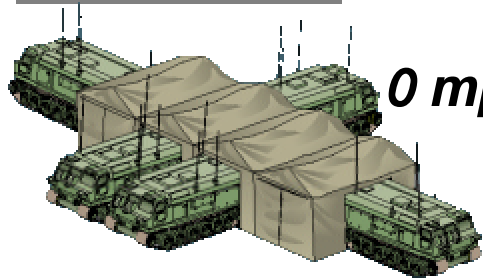
Today



~100 lb.
load

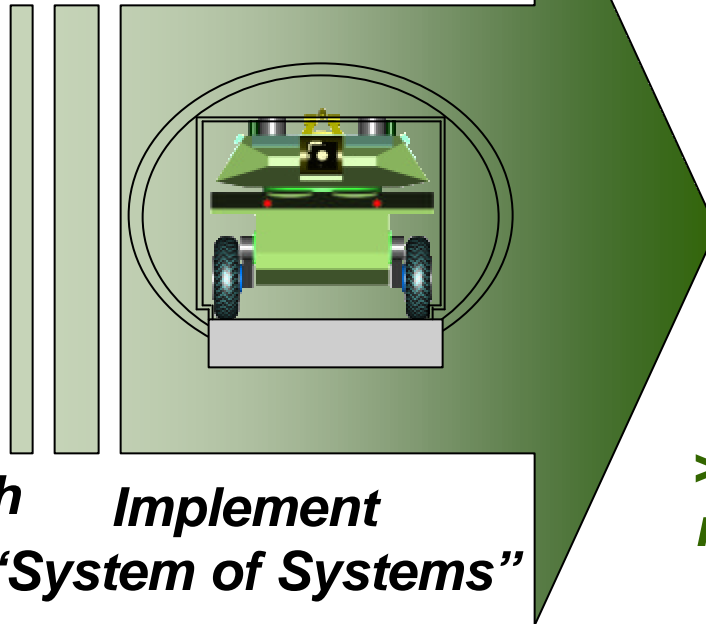


70+
tons



0 mph

Fit the C-130
"Crucible"



Implement
"System of Systems"

Future Force

< 40 lb.
effective
load



< 20
tons



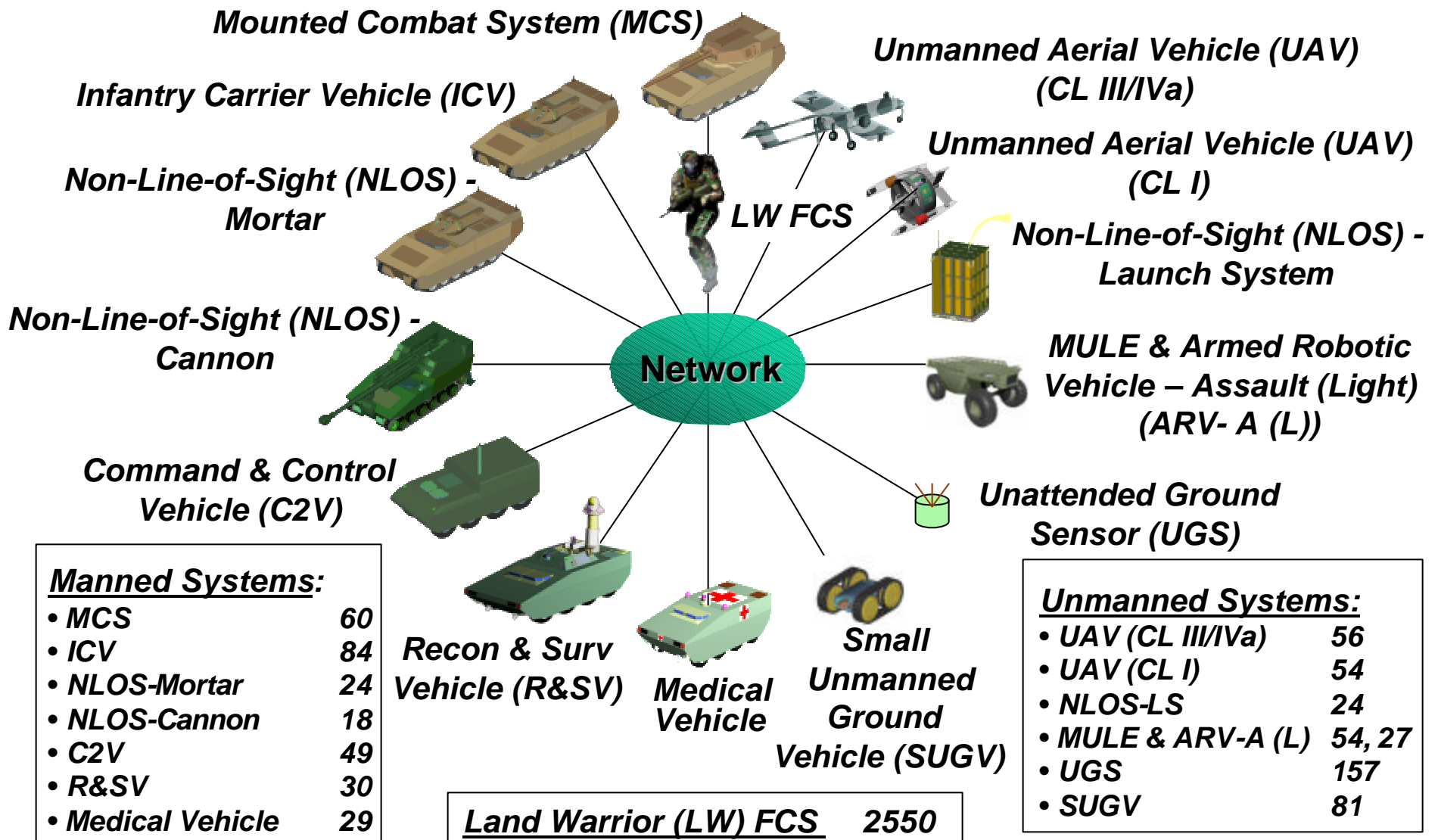
> 40
mph



S&T Mission -- Accelerating the Pace of Army Transformation



Future Combat Systems (FCS) Maneuver Unit of Action (Brigade Equivalent)





Unit of Action Networked Battle Command

- ***Sensors – Information gatherers***
- ***Network Architecture – Information management (processing, routing, dissemination)***
- ***Nodes or platforms (soldiers, ground vehicles, aerial vehicles) – Information receivers, gatherers and users (FCS ~ 3300)***
- ***Shooters – Information receivers and users***

See First, Understand First, Act First, Finish Decisively



FCS Key HPEC Challenges

- ***Network-centric/Collaboration-centric***
 - ***Local HPEC capabilities to manage the complexity of large amounts of data and information***
 - ***HPEC will enable local nodes to perform complex analysis and data management functions with reduced use of bandwidth***
- ***Robotics integrated into force***
 - ***Real time scene understanding for maneuver and threat analysis***
 - ***Real time RISTA from multiple sensors and sensing modalities***
- ***Increased reliance on extended range engagement***
 - ***HPEC crucial for smart munitions – accurate target ID***
 - ***Wide range of distributed sensors, each needing HPEC***
- ***Capable of air-mobile operations - DoD strategic and tactical lift***
 - ***New smaller sized force elements require small embedded processors to meet demanding computing requirements***



Objective Force Warrior (OFW)

- ***Integrated Combat Suit***
- ***Head Borne Vision Enhancement***
- ***Physiological Status Monitoring***
- ***Personal Navigation***
- ***Robotic Mule***
- ***Situational Awareness***
 - ***Networking Digital Radio***
 - ***Warrior Team collaboration***
 - ***Horizontal data fusion***



**Micro
UAV**



**Robotic
Mule**



OFW Key HPEC Challenges

- ***Real time situational awareness***
 - ***Connection and exploitation of information from FCS network***
 - ***Access to Common Operating Picture***
 - ***Vertical/horizontal position/navigation***
 - ***Status of physiological readiness and vital signs***
 - ***Two-way language translation***
- ***Embedded training***
 - ***Planning and rehearsal of complex missions***
 - ***Immediate access to Tactics, Techniques and Procedures (TTPs)***



Low power HPEC is an essential OFW need




HPEC Challenge: Communication Functions

- ***Network may be source of “surprise” computational problems and system congestion / bottlenecks***
- ***Will be the largest, most ad hoc, dynamic and mobile Unit of Action network ever deployed***
 - ***A ground traffic control system integrated with an air traffic control system that will work in all environments and conditions***
 - ***Mix of SATCOM, platform and soldier radio networks***
 - ***Rapidly formed and broken links rates, i.e., “chaotic network”***
- ***Routing and network management may require:***
 - ***Active network technology***
 - ***Very advanced routing methods – heavy computation***
- ***Demand for fully distributed computing***
- ***Power-aware routing, low power computing***



HPEC Challenge: Communications Security

- **HPEC can assist in data encryption**
- **Process is very complex, i.e., multilevel security, and computationally intensive especially for authentication.**
- **Challenge is striking a balance between security and performance, interoperability, reliability, . . .**
- **Main processing challenge is complexity of decoding encryption techniques used in authentication**

Symmetric Encryption Key Size	ECC Key Size	RSA Key Size	Computational Complexity
56	112	512	 <i>Increases with key size</i>
80	160	1024	
112	224	2048	
128	256	3072	
192	384	7680	
256	512	15360	



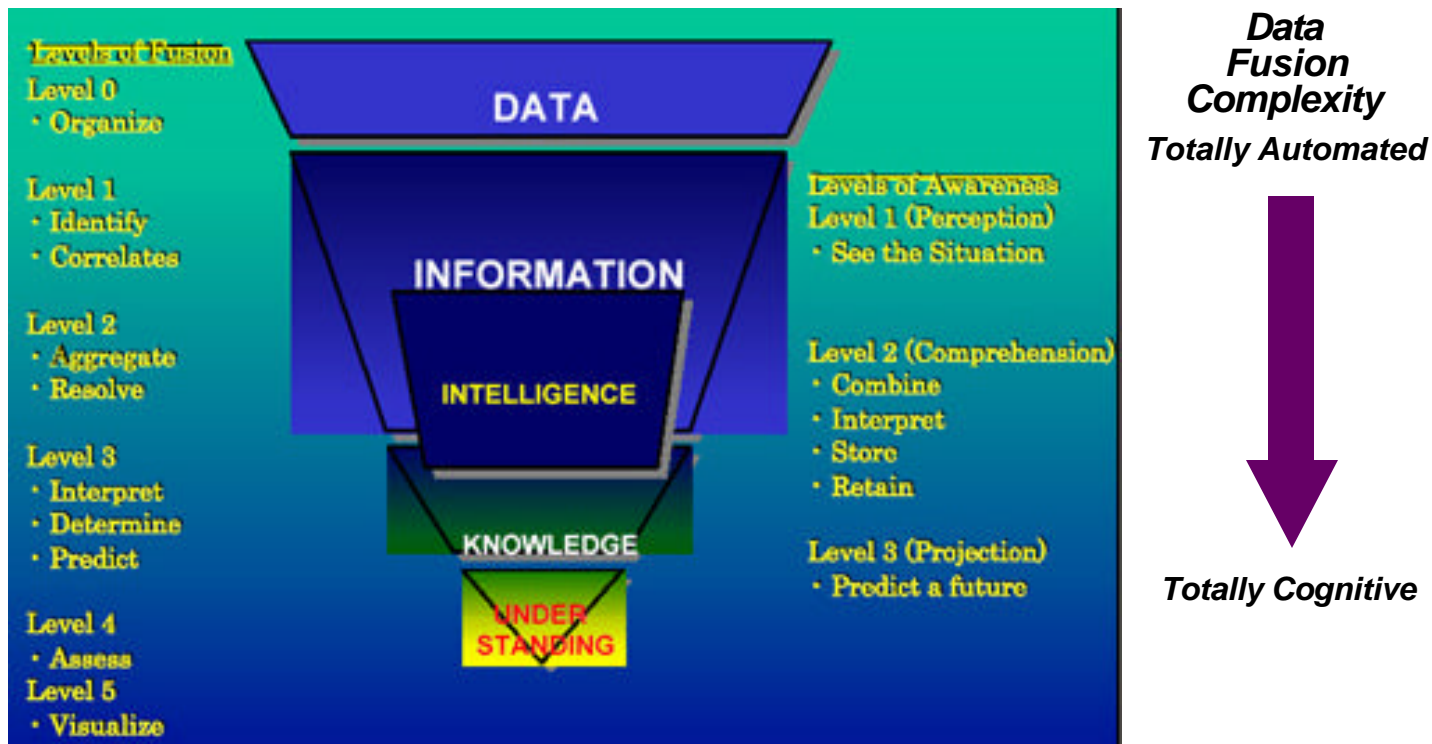
HPEC Challenge: Aided / Automatic Target Recognition

- ***Typical ATR systems analyze a digital representation of a scene and locate/identify objects of interest***
- ***While conceptually simple, ATR has extremely demanding I/O and computational requirements***
- ***Image data are large, can be generated in real-time, and must be processed quickly so that results remain relevant in a dynamic environment***
- ***Future Force ATR will incorporate more than one sensor and use more data from other sources***



HPEC Challenge: Data Fusion

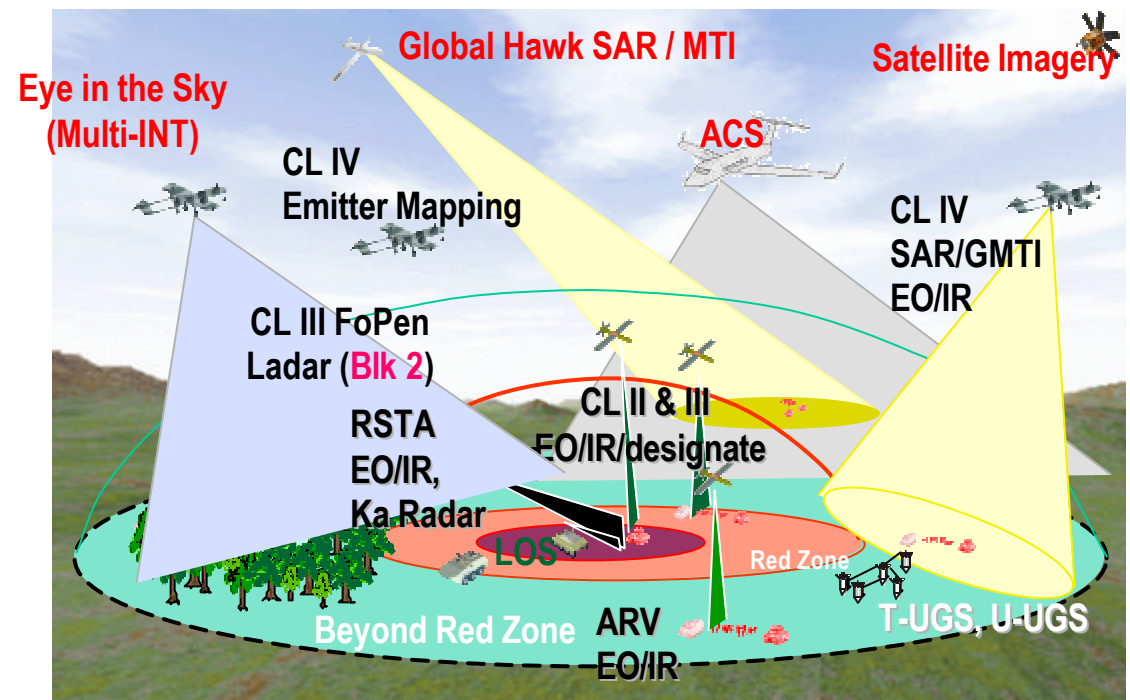
- **Functions needed for multi-source fusion**
- **Distributed, real time fusion is needed to minimize command center message inundation**
- **FCS will increase the volume and complexity of data – more local fusion is needed**





Army S&T Program That Uses HPEC “Eye in the Sky”

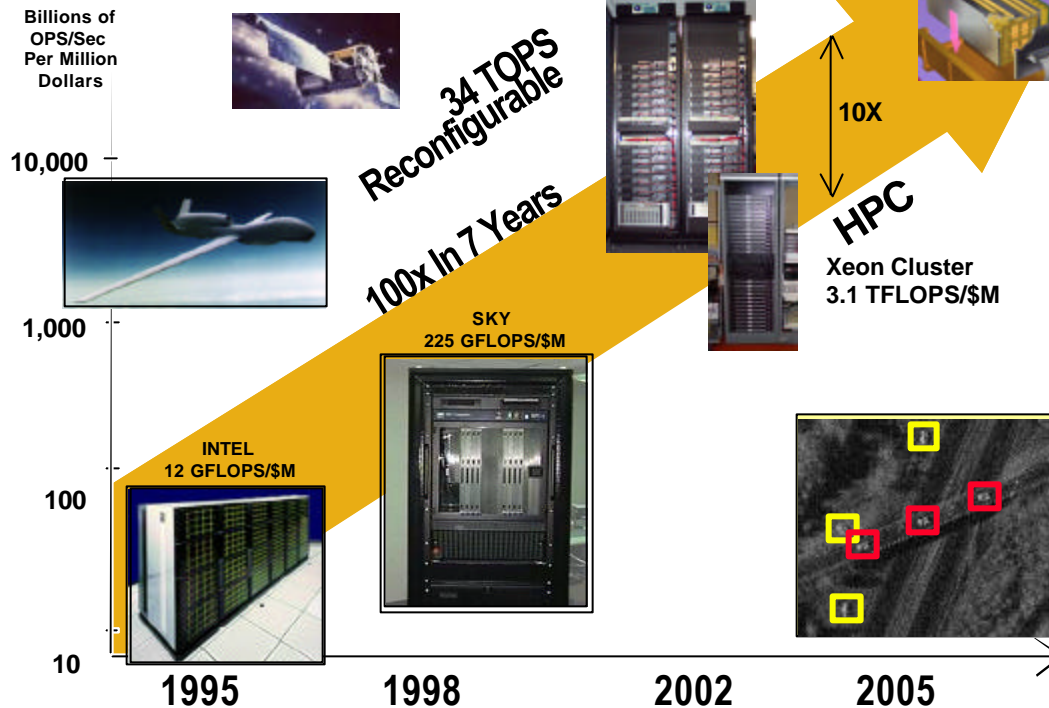
- **Demonstrate onboard automated payload management functions to facilitate tasking and cross-cueing of sensors**
- **Onboard, autonomous sensor management and data fusion**
- **Software to integrate RF Tags SA data into the COP for Blue Force tracking**
- **Multiple Sensors**
 - Radars (GMTI, SAR, GPEN, FOPEN)
 - EO/IR
 - Hyper-Spectral
 - Electronic Support Measures
 - LADAR
- **Integrated on a Class IVA UAV**





HPEC Challenge: Affordability

**Exponentially Improving HPEC
Affordability Transitioned to DoD Users**



CHALLENGE

- **Develop and incorporate the most affordable embedded information technology available**

APPROACH

- **Leverage commercial investments in computer architectures**
- **Develop portable embedded DoD applications using middleware standards**
- **Leverage DARPA and other DoD efforts in emerging architectures**

Projection:
2007: 60 trillion flops/\$M
2010: 360 trillion flops/\$M

Source: Dr. Rich Linderman, RADC



Trend in Computer Size

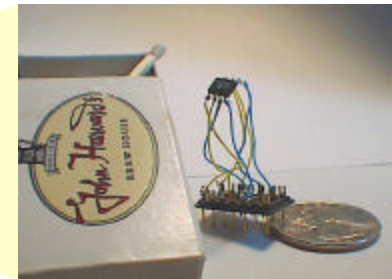
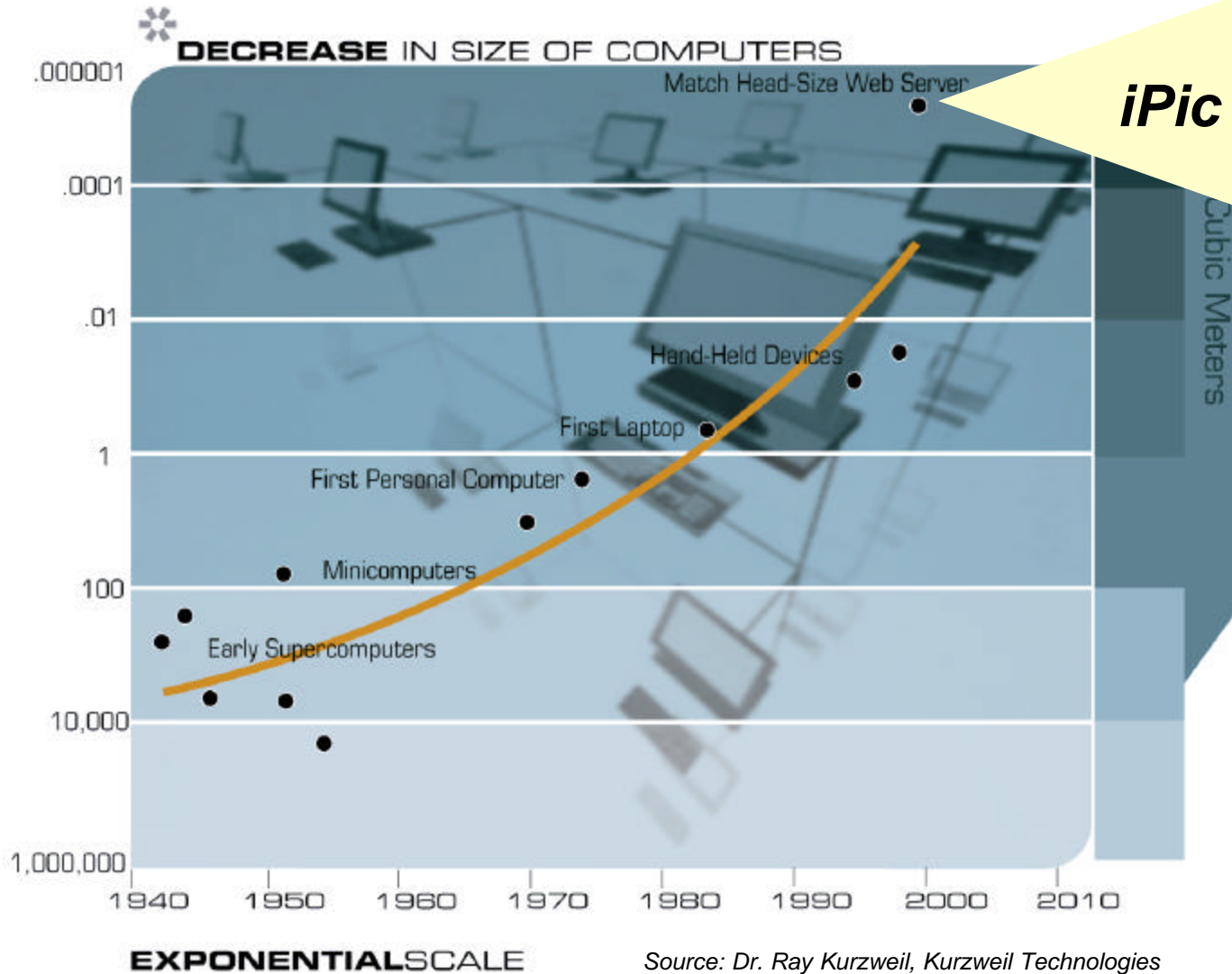
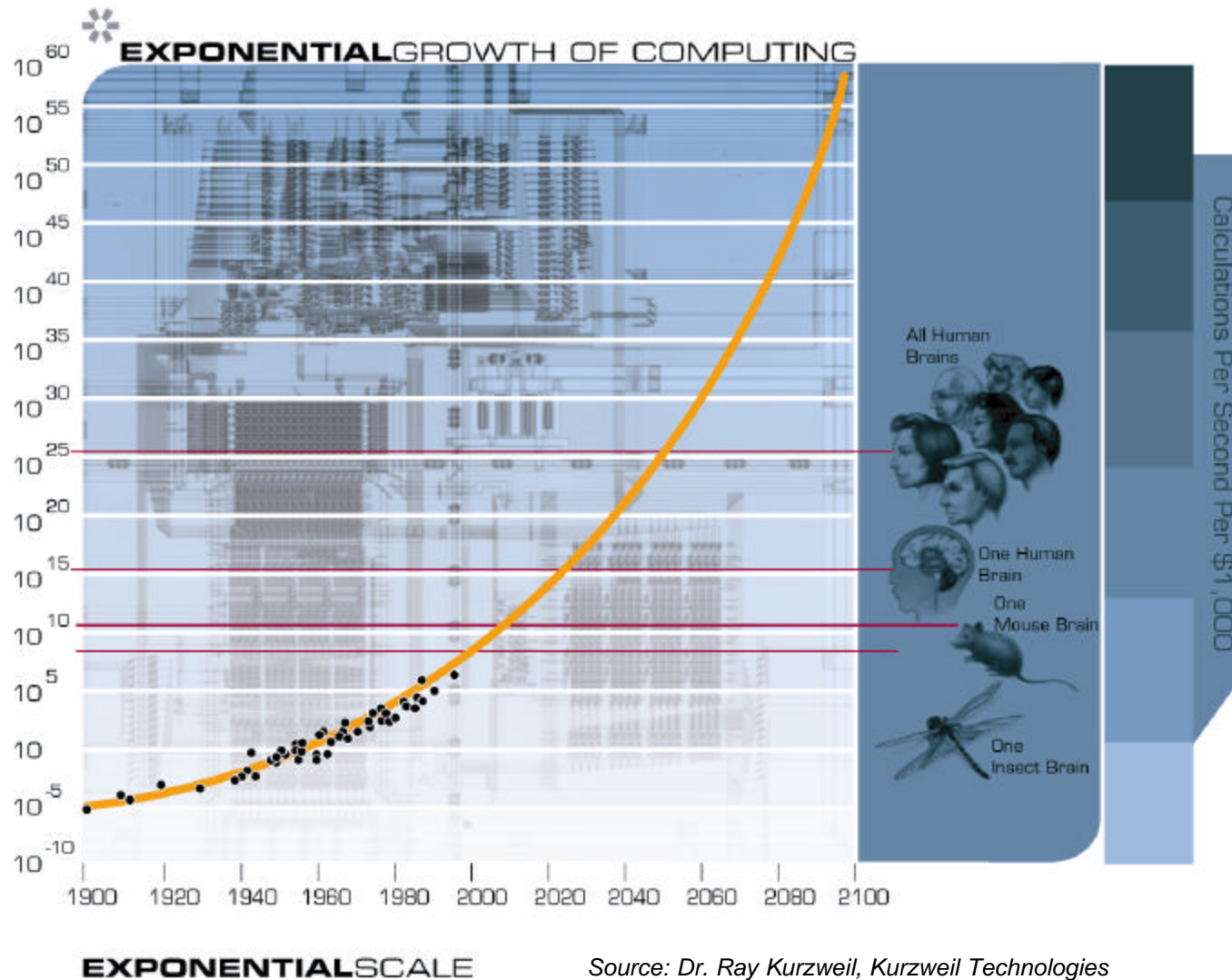


Photo courtesy of Cris Pedregal-Martin
<http://www-ccs.cs.umass.edu/~shri/iPic.html>

Source: Dr. Ray Kurzweil, Kurzweil Technologies



Trend in Growth of Computing





Summary

- ***The Army's Future Force will have a critical need for HPEC technologies throughout its system of systems***
 - ***Autonomous sensing and sensor fusion***
 - ***Complex communications tasks***
- ***The acute Army challenges for HPEC are cost, power consumption and physical size***
- ***The Army is looking to academia and industry for advances in HPEC to enable its vision of the Future Force***

Army Transformation...A Race for Speed and Precision