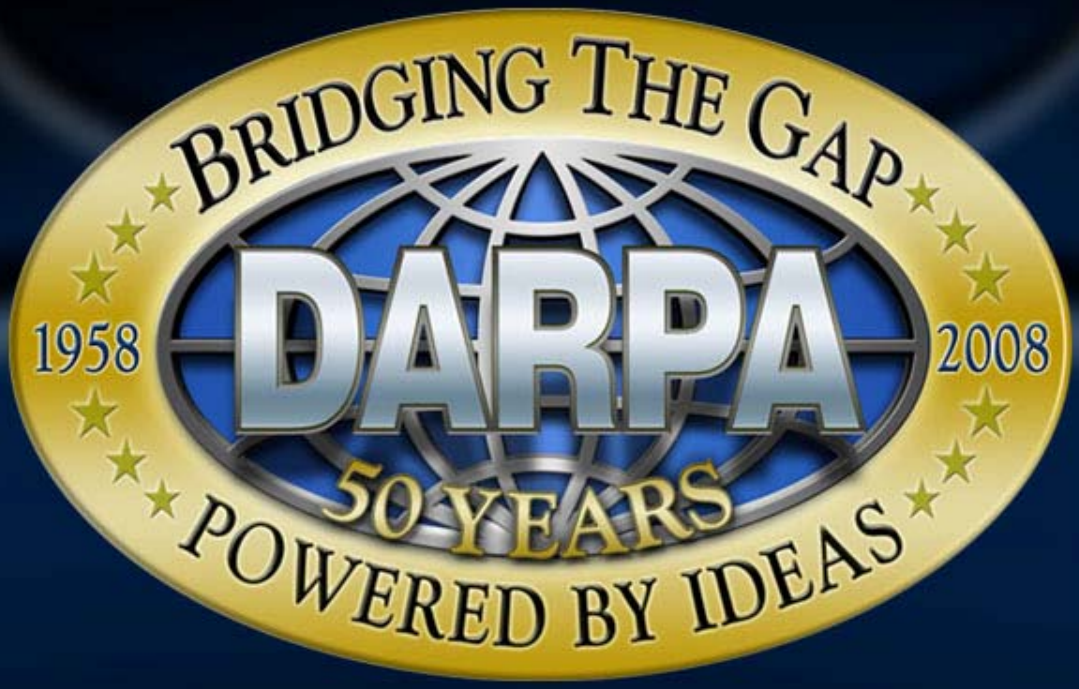


Defense Advanced Research Projects Agency

Dr. Anthony J. Tether
DARPA Director

DARPA Organization

Director, Tony Tether
Deputy Director, Bob Leheny

Tactical Technology
Steve Welby
Steve Walker

Air/Space/Land/Sea Platforms
Unmanned Systems
Space Operations
Laser Systems
Precision Strike

Information Exploitation
Bob Tenney
Mark Davis

Sensors
Exploitation Systems
Command & Control

Strategic Technology
Dave Honey
Larry Stotts/Brian Pierce

Space Sensors/Structures
Strategic & Tactical Networks
Information Assurance
Underground Facility Detection & Characterization
Chem/Bio Defense
Maritime Operations

Defense Sciences
Brett Giroir
Barbara McQuiston

Physical Sciences
Materials
Biology
Mathematics
Human Effectiveness
Bio Warfare Defense

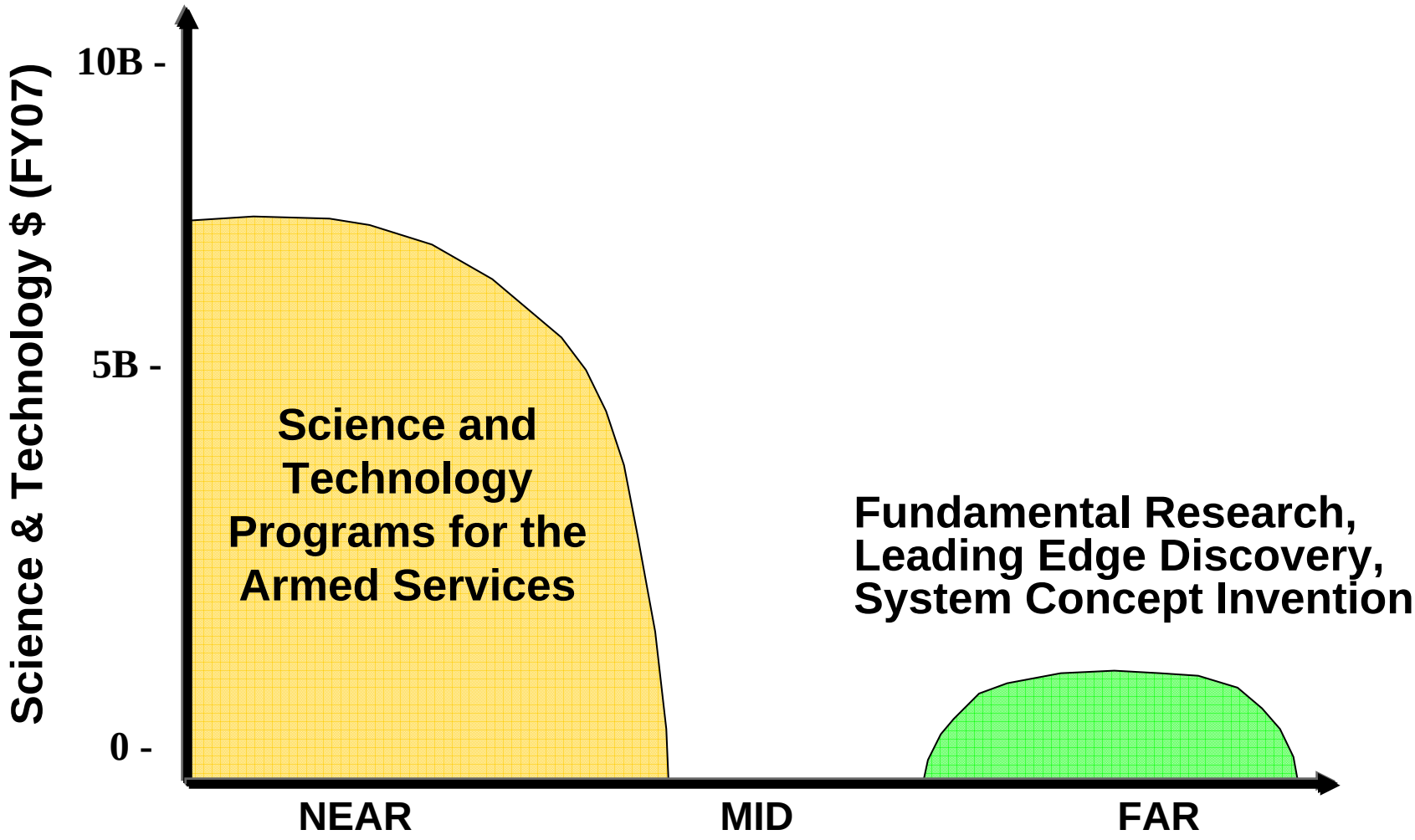
Information Processing Technology
Charlie Holland
Barbara Yoon/Chuck Morefield

Cognitive Systems
High Productivity Computing Systems
Language Translation

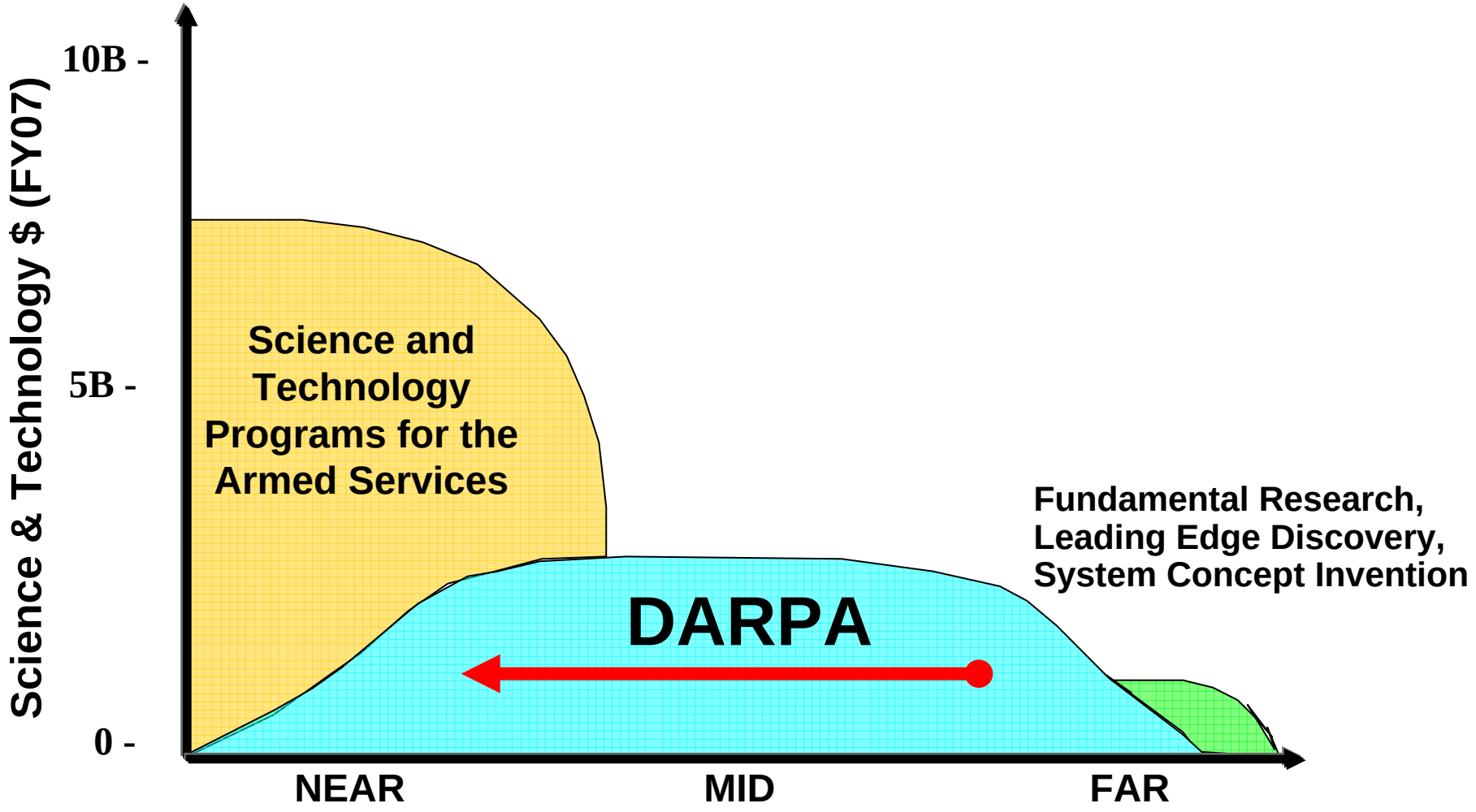
Microsystems Technology
John Zolper
Dean Collins

Electronics
Photonics
MEMS
Algorithms
Integrated Microsystems

DARPA Role in Science and Technology

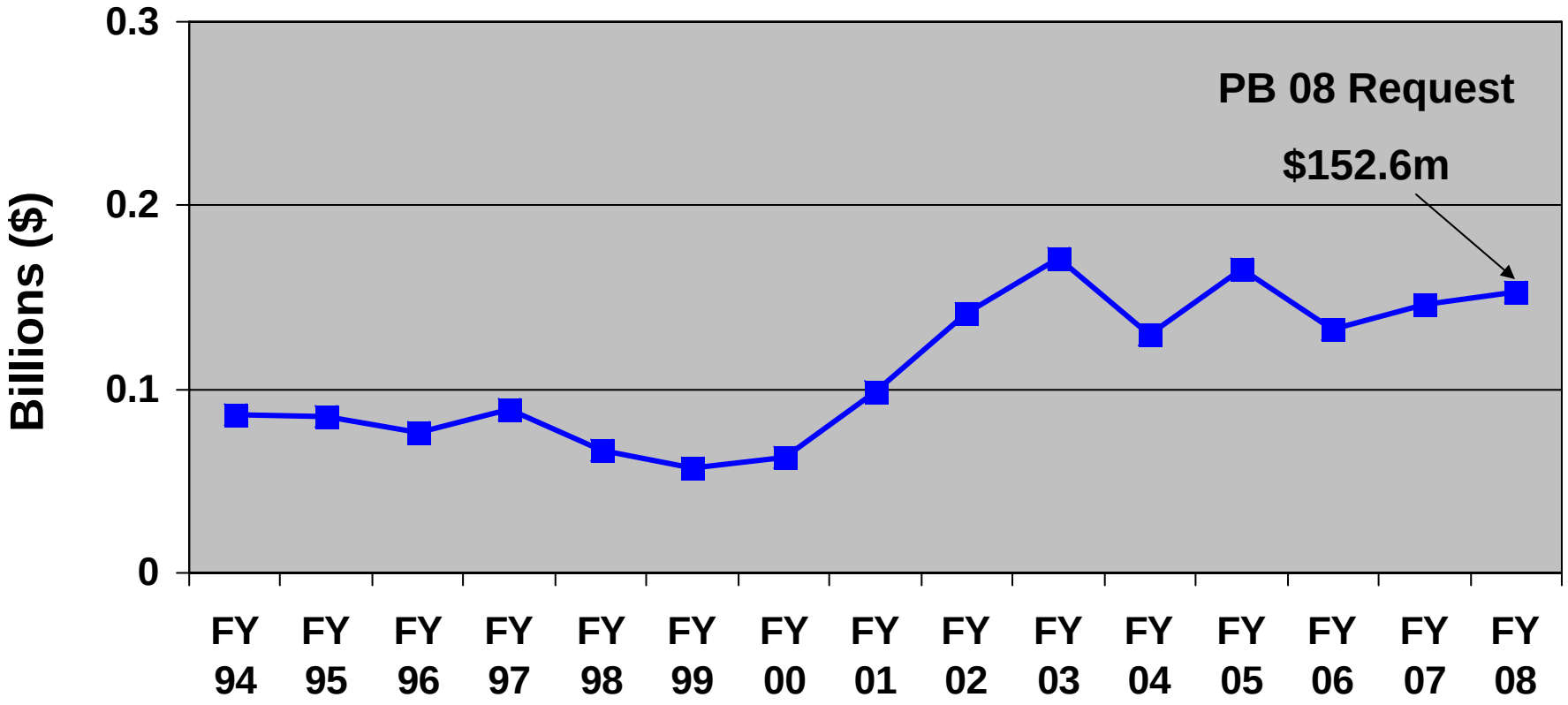


DARPA Role in Science and Technology



DARPA Basic Research Funding ($B)

Budget Activity 6.1 ("University" funding)



Basic Research Examples

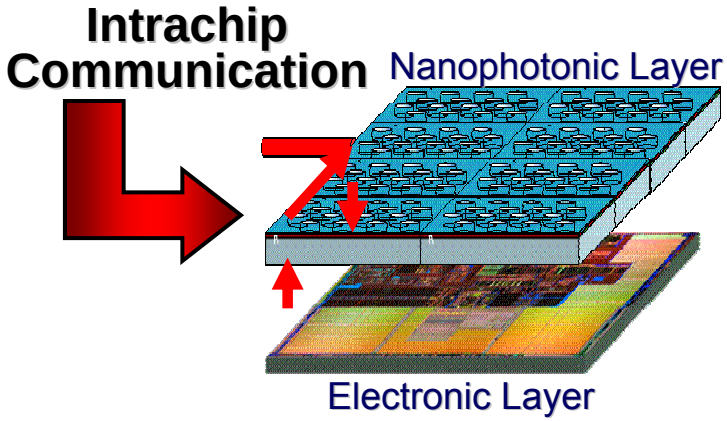
- Defense Science Studies Group
- Computer Science Studies Group
- Computer Sciences Futures Group
- Young Squirrels Awards
- Finding the Fundamental Laws of Biology

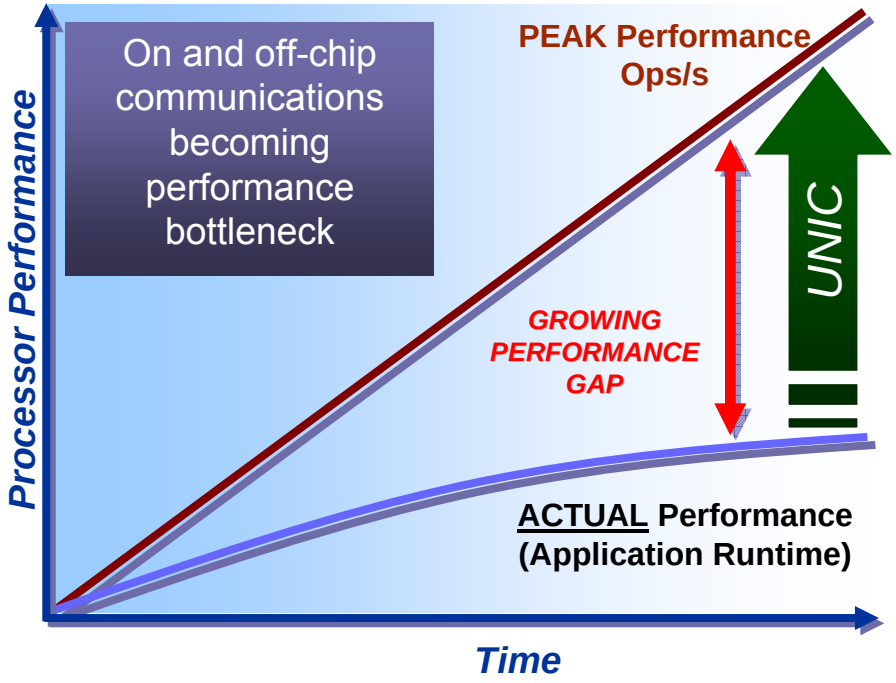
DARPA Accomplishments

Future Icons

- Low-cost titanium to enable routine use ($3.5/lb military grade alloy)
- Accelerate Development & Production of Therapeutics & Vaccines from 12+ years to 16 weeks or less
- Alternative Energy Sources for military operations, such as jet fuel from plants
- Prosthetics to enable a Soldier's return to the unit without loss of capability
- Quantum Information Science for new computational capabilities
- Networks - Self-forming, Robust, Self-defending to enable true network centric operations
- Chip Scale Atomic Clock to replace communication devices' reliance on GPS time signal
- Networked Sensors – Determine, track, and neutralize elusive threats, such as IED factories
- High-productivity computing system – peta scale computer for important DoD applications
- Air Vehicles - Fast Access, long loiter
- High Energy Liquid Laser Area Defense System as a penetration aid to replace stealth
- Submarines – reduce size and cost while maintaining existing capabilites
- Space capabilities to enable global military operations
- Real time language translation to replace linguists (Defense Language Institute, III → IV)
- Solid State for the next generation of systems

Ultraperformance Nanophotonic Intrachip Communication (UNIC)





Vision:

- Create enhanced pathway to high-bandwidth, high-performance and low power intra-chip communication for ultra-dense 2D and 3D systems on a chip

Goal:

- Demonstrate nano-photonic technology using CMOS compatible fabrication processes that would significantly exceed electrical global interconnect performance (and hence total performance) for IC microprocessor chips
- Develop nano-photonic architecture/system design that would enable such performance superiority
- Demonstrate a functional chip with all necessary components working together

Technical Challenges:

- High integration density
- Low power dissipation devices
- High speed devices (Low latency)
- Low loss waveguides and devices
- Small physical size
- Fabrication fully compatible and integrable with mainstream electronics

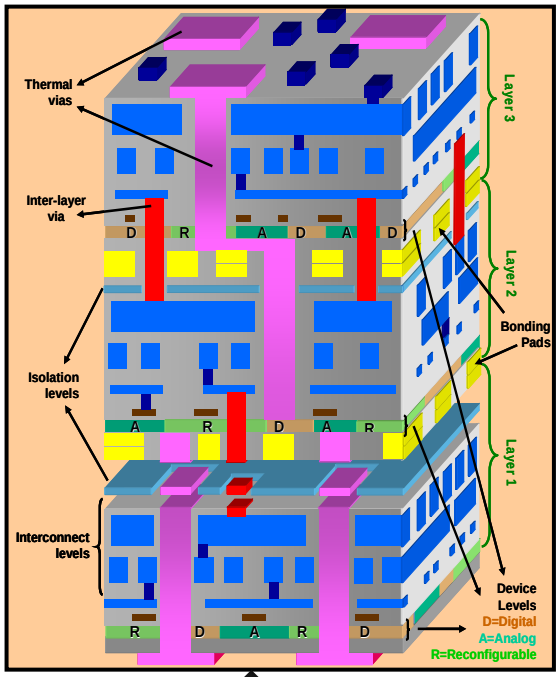
Impact:

- >10X increase in processing performance as a function of power dissipation

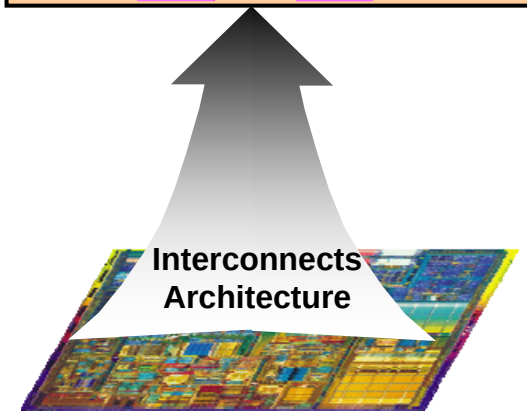
The Ultimate On-Chip Data Link: Eliminating the Interconnect Bottleneck

3-Dimensional Electronic Circuits (3-D IC)

3D



2D



Goal:

- Develop the Design and Process Technology for True 3D Integrated Circuits (multiple active layers)

Challenges:

- Achieve dense 3D Interconnections of Multi-layer Circuits
- Design Tools that Optimize Place & Route of Circuit Blocks, Synthesis of 3D circuits with Electro-Thermal Analysis
- Thermal mitigation

Key Accomplishments:

- 3D-IC technology development based on thin layer wafer transfer methods.
- High density 3D vias demonstrated.
- Through wafer vias in development for mm-wave applications.
- 3D Supercomputer chip designed.

Impact:

- Higher speed/lower power system-scale circuits
- Larger chip effective area, more transistors/unit volume. Improved computational density.

The Next Revolution in Digital Electronics

DEFENSE SCIENCES OFFICE

Slow Light

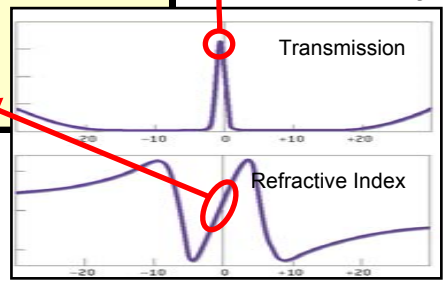
Exploring the limits and applications of slowing, storing, and manipulating light in various media (Slow light $n_{group} << C$)

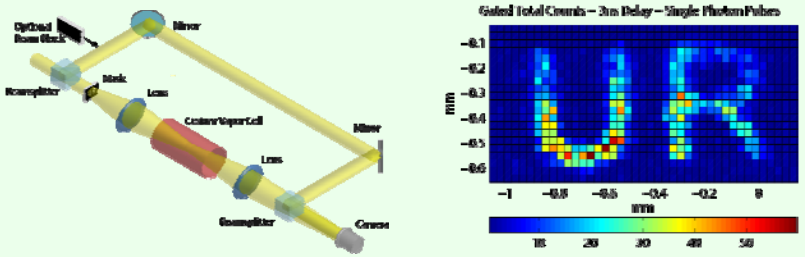
Group velocity – velocity at which a pulse of light propagates through a material

$$v_{group} = \frac{c}{n + \omega \frac{dn}{d\omega}}$$

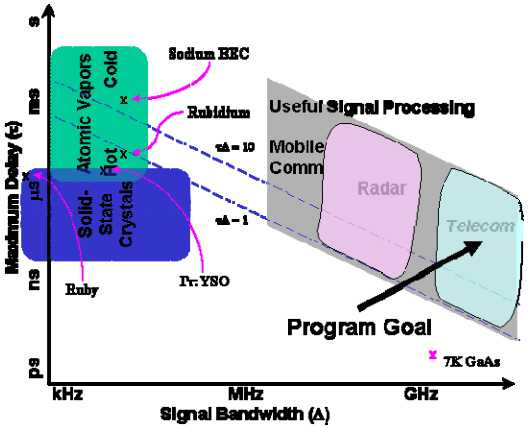
High transmission with large effective nonlinearity

Ultra-slow group velocity



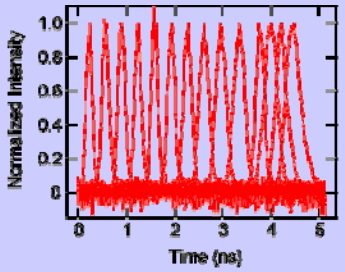


All optical delay of images using slow light
(left) 3ns delay of 2-d image, 0.8 photons per pulse and (right) 2d image propagating through air, 0.8 photons per pulse.



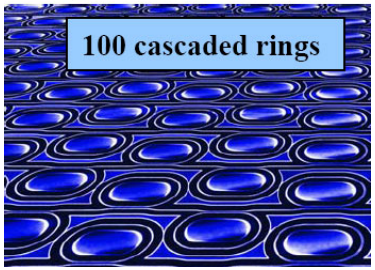
Delays shown at many different bandwidths and material systems open range of applications

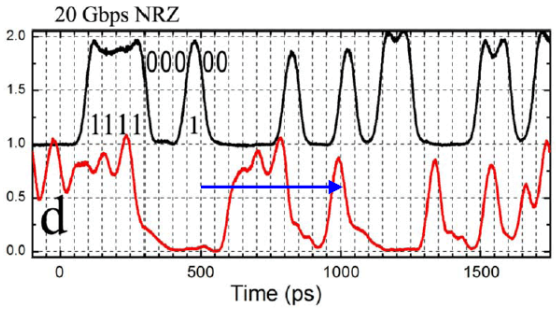
Demonstrated fiber-based technique to produce delays > 1200 pulse widths.



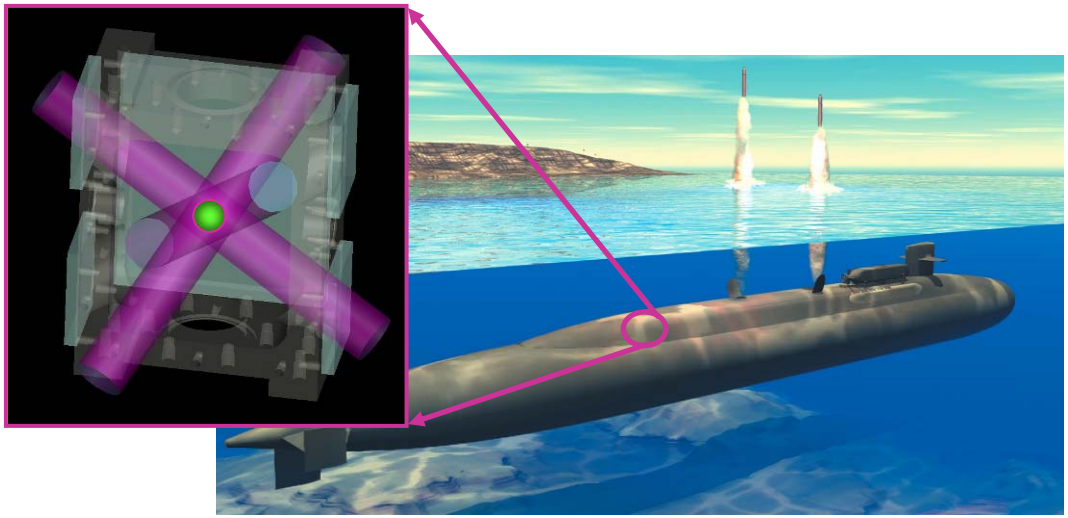
Demonstrated 10 bit buffering at 20 Gbps using 10μm ring resonators

Optical Buffer

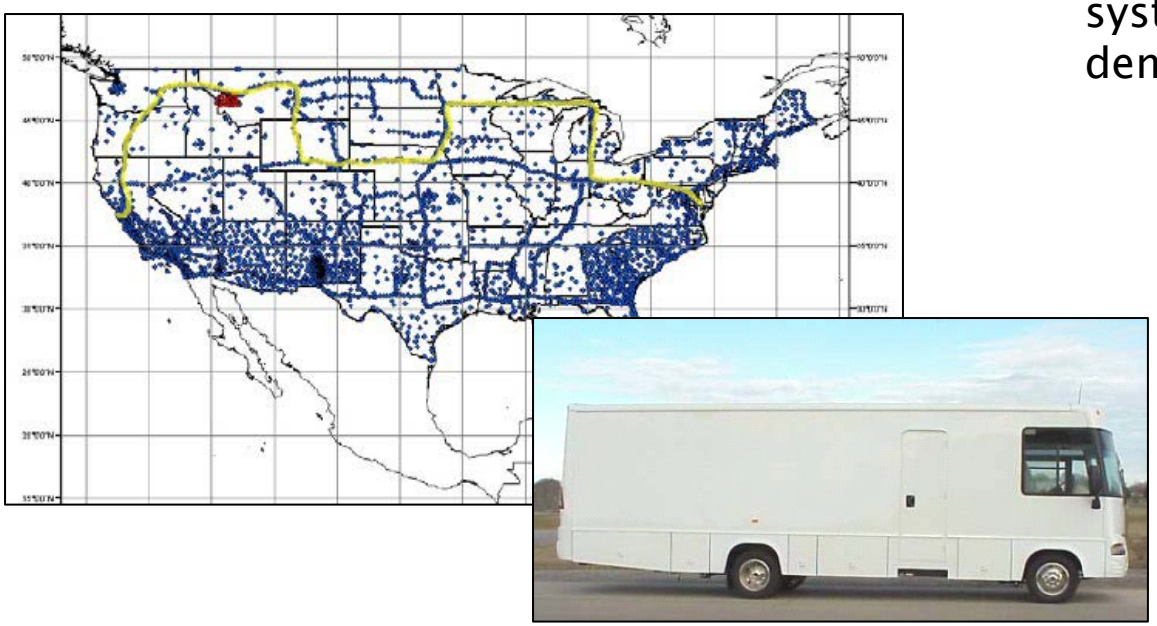


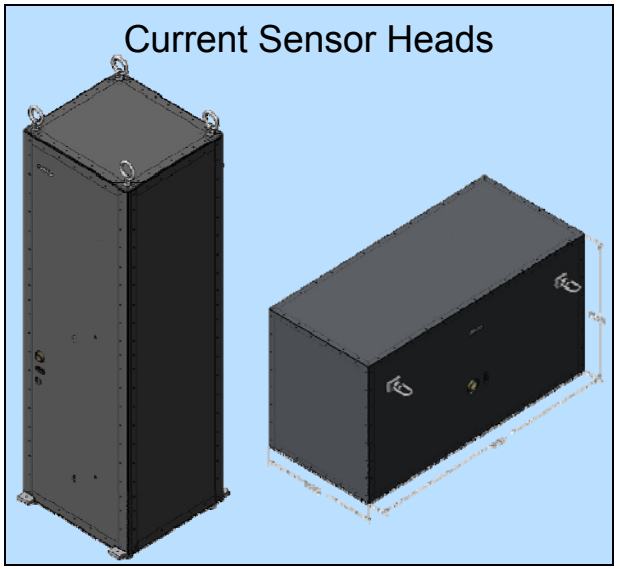


Precision Inertial Navigation Systems: Ultra-cold Atom-based Inertial Measurements



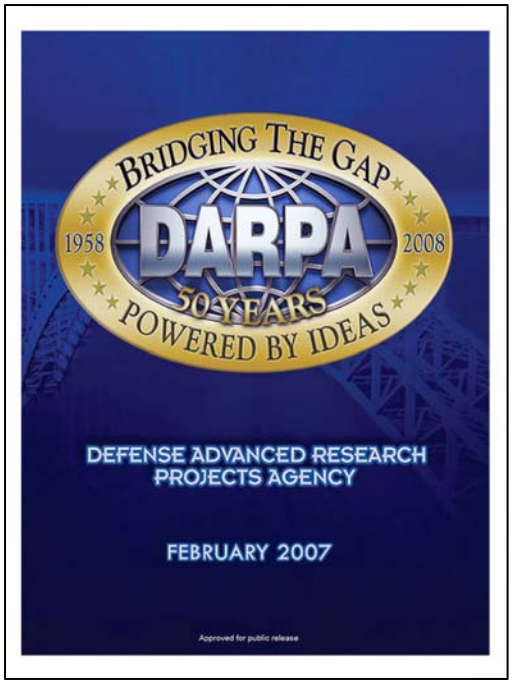
- Ultracold atom navigation relies on precise measurements of forces acting on atom cloud
  - Platform motion decoupled from acceleration, rotation measurements
  - System measures gravity to compensate for local variations in gravity vector
- <u>Available regardless of geography, jamming, etc.</u>
- Will drive atom-based navigation system across country to demonstrate system performance





The Future

- DARPA Always Interested in Innovative Ideas
  - Solicitations: **www.darpa.mil**
  - Talk to DARPA Program Managers
  - Become a DARPA Program Manager
- Upcoming Events
  - 25th DARPA Systems & Technology Symposium (DARPATech 2007) August 7 - 9 2007, Anaheim, California
  - Urban Challenge, November 3, 2007
  - 50th Anniversary Conference / Dinner
    - April 10, 2008 – Washington, D.C.



DARPA Strategic Plan

www.darpa.mil/body/mission.html


BRIDGING THE GAP
DARPA
1958
2008
50 YEARS
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