

Basic & Applied Research Opportunities & Advances

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Naval S&T Strategic Plan



- Cascades from National, DoD and SECNAV/CNO/CMC Guidance
- Vetted by Fleet/Forces Stakeholders
- Approved by DoN S&T Corporate Board

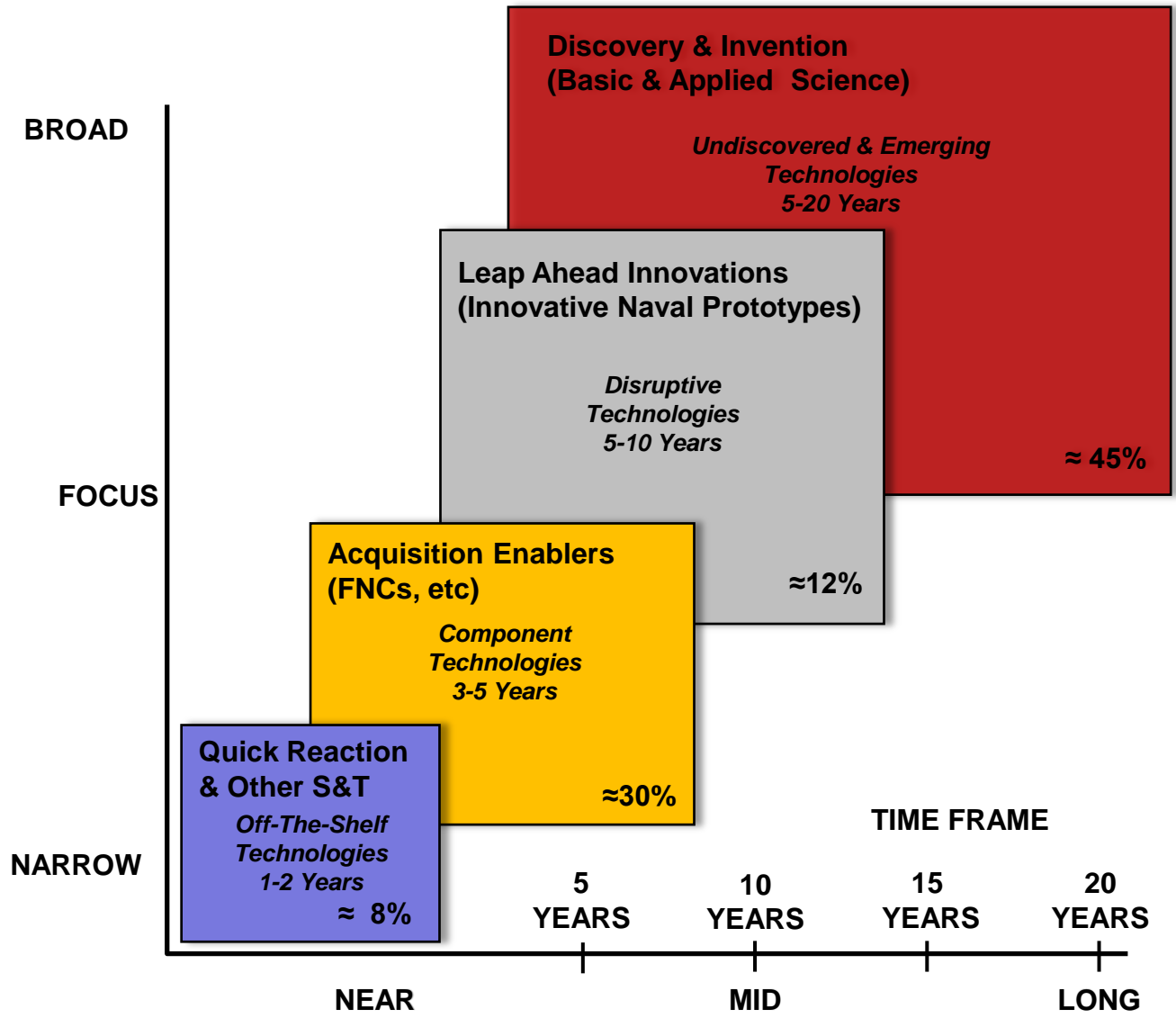
S&T Plan Focus Areas:

- Assure Access to Maritime Battlespace
- Autonomy & Unmanned Systems
- Expeditionary & Irregular Warfare
- Power Projection/Integrated Defense
- Information Dominance
- Power & Energy
- Platform Design & Survivability
- Total Ownership Cost
- Warfighter Performance





ONR S&T Portfolio Balance



D&I

INPs

FNCs

QR S&T

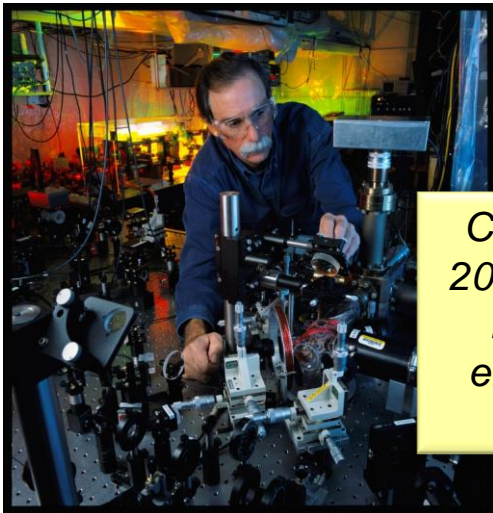


Discovery & Invention S&T

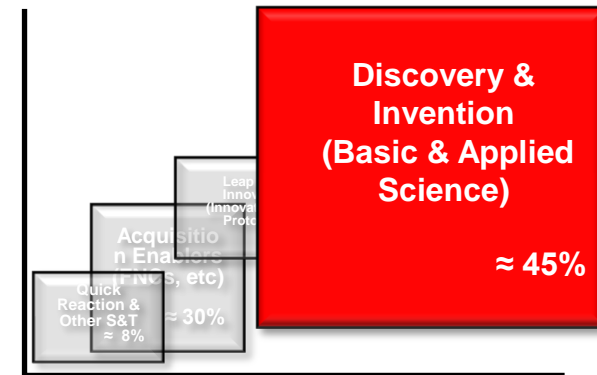


Discovery & Invention (D&I) consists of Basic Research (BA 6.1) and early Applied Research (BA 6.2). It is the essential foundation required for advanced technology

- Focused on 5-20 years out
- $\approx 45\%$ of ONR's budget
- New investments selected through competitive process across warfare areas
- D&I budget includes:
 - ❖ ONR's core research programs
 - ❖ University Research Initiatives (MURI, DURIP, PECASE)
 - ❖ In-House Laboratory Independent Research
 - ❖ STEM



*Congratulations Dr. David J. Wineland!
2012 Nobel Prize in Physics "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems."*



- **Diverse Portfolio**
- **Fosters Innovation**
- **Long-Term**
- **Investment in People:**
60 Nobel Laureates

Precision Time and Timekeeping (PTT):

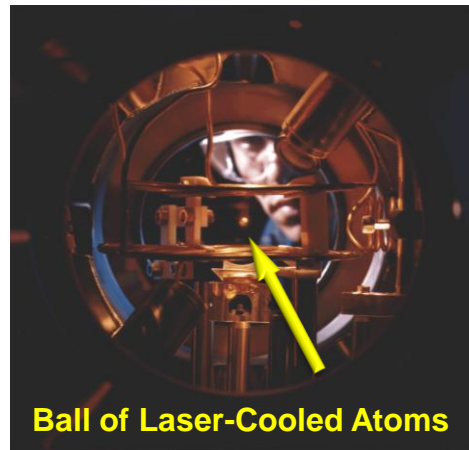
- ONR funding for basic research in atomic clocks has led to significant advances in PTT.
- The US Naval Observatory (USNO) maintains the DoD Master Clock with 60 Cs (Cesium-133) atomic clocks, 20 Hydrogen maser clocks, and two Cesium Fountain atomic clocks.
- The DoD Master Clock is a Critical National Defense Technology (MCTL Section 16).
- ONR funding sustains the Atomic Clock industrial base in U.S.

ONR research support produced:

- Four Nobel Prizes (1997, 2001, 2005, & 2012)
- Six ONR Nobel Laureates
- Two orders of magnitude improvement in Naval Observatory primary clock



1997 – Phillips
2001 – Ketterle / Wieman / Cornell
2005 – Hall
2012 – Wineland



Ball of Laser-Cooled Atoms



Global Positioning Systems (GPS):

The origin of GPS began in 1960 when the Navy launched the Transit satellite constellation for submarine navigation. Today's GPS systems are possible because of ONR sponsored research in precision timekeeping. ONR funding currently sustains the atomic clock industrial base in U.S.

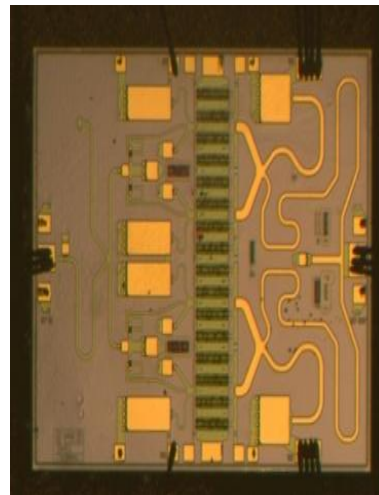
ONR research produced “Wide Bandgap Semiconductors”

- Led to compact, high power RF amplifiers for E-2D
- Is enabling development for high frequency, power amplifiers for Nulka and SEWIP

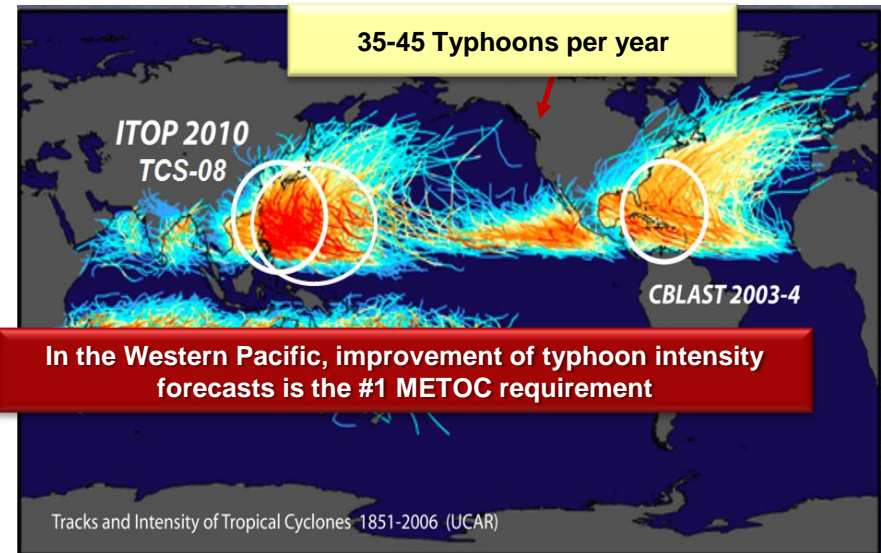
GaN & SiC Components—

ONR funded basic research on Si & GaN components led to the development of the wide bandgap semiconductors.

Breakthrough technology necessary to meet performance parameters within the space and weight constraints of the E-2D surveillance system design specification.



Tropical Cyclone Formation & Intensity Forecasts



Basic Research Efforts —

2004-2012

6.2 Transition: Enhance the Coupled Atmosphere-Wave-Ocean Model for Operational Evaluation.

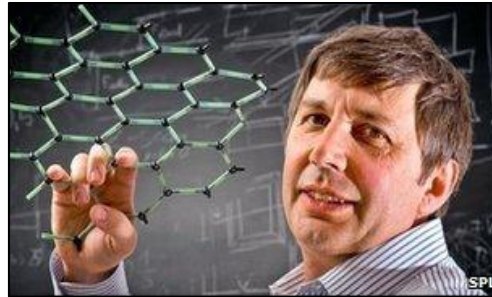
2009-2012

Joint 6.2/6.4 Rapid Transition Program: Collaborate with operational centers to transition research model to full operational status in 3 years for all typhoon, cyclone, and hurricane forecasts for global Fleet support.



Tomorrow

Dr. Andre Geim
Langworthy & Royal Society Research
Professor University of Manchester



Graphene - Graphane

Graphane, a chemical derivative of Graphene

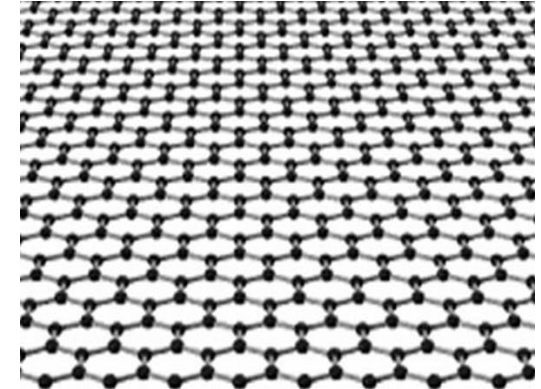
- Formed by attaching a hydrogen atom to each of the carbon atoms in the original graphene sheet
- Hydrogen alternates between above and below the sheet

Graphene and Graphane have drastically different electronic properties

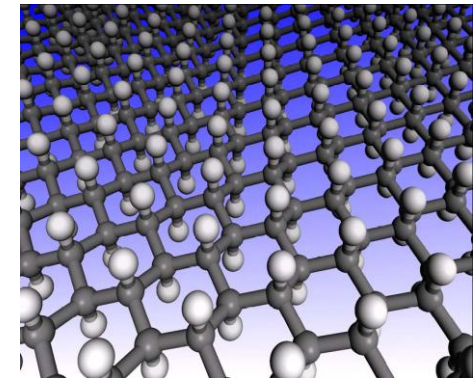
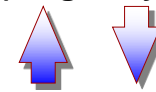
- Graphene is the best conductor known to man (at room temperature)
- Graphane is an electrical insulator

Graphene-Graphane reaction is entirely reversible

ONR Researchers, Geim & Novoselov, Awarded 2010 Nobel Prize in Physics



GRAPHENE (Single-layer 2D Carbon)



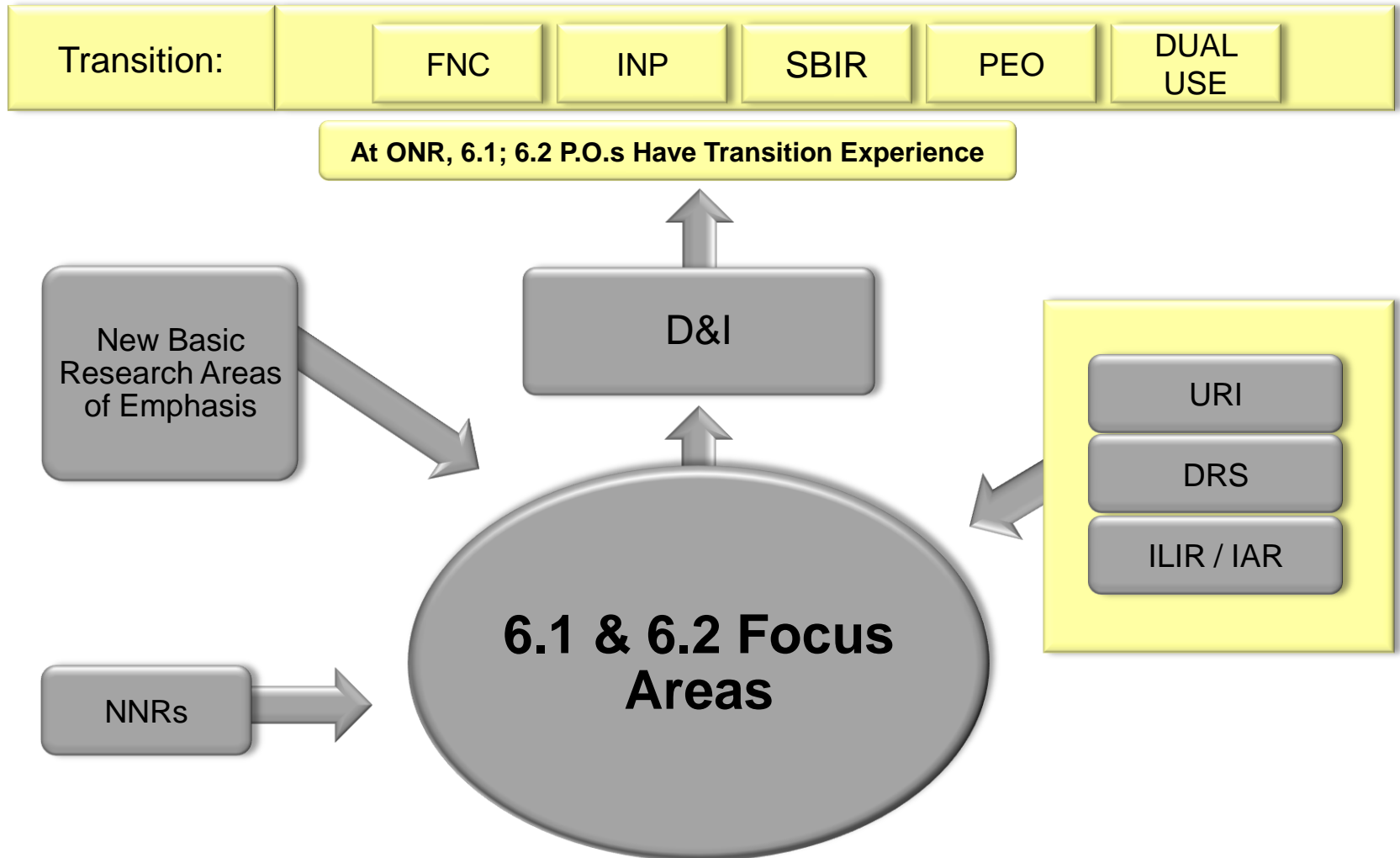
GRAPHANE (Single-layer 2D Hydro-Carbon)

New ways of constructing 2D
Electron Devices and Circuits

- ONR first in US to fund basic research; initial work general in nature, e.g. entire circuit perspective
- ONR & AFOSR work closely via the MURI process
- DARPA exploring RF applications



Transition of D&I







Science, Technology, Engineering, & Mathematics (STEM)




“...The need is clear – large numbers of Naval STEM professionals will be retiring over the next few years, and fewer American students are graduating with the preparation and interest needed to pursue STEM careers...” – SECNAV 2011



SECURING OUR FUTURE:
The Naval Science, Technology, Engineering, and Mathematics (STEM) Workforce

 A Strategic Approach
June 2011




INSPIRE
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ENGAGE

EDUCATE

EMPLOY




MESSAGE FROM THE SECRETARY OF THE NAVY



The Department of the Navy currently enjoys a high level of technological superiority across the full spectrum of its missions. To maintain this technological superiority, we must nurture a world-class Science, Technology, Engineering and Mathematics (STEM) workforce able to contribute to, and support, a culture of innovation. I am committed to the Department's aggressive leadership role in STEM education, to improve the quality and the quantity of the future STEM workforce, from which we will draw future Sailors, Marines, Engineers and Scientists.


The need is clear – large numbers of Naval STEM professionals will be retiring over the next few years, and fewer American students are graduating with the preparation and interest needed to pursue STEM careers.

In FY 2010, the Navy portfolio included over \$54 million in direct investments as well as an additional \$20 million from the Department of Defense spread across 180 STEM programs nation-wide. An additional \$108 million was invested annually to support domestic graduate students and research assistants under research grants to academic institutions. These investments are significant but not sufficient. As a result, I have committed to doubling the Department of the Navy's direct investment in STEM over five years, to more than \$100 million dollars.



This Strategic Roadmap presents a path forward for the Navy and Marine Corps – a way to increase our impact on STEM education. This plan provides strategies to address gaps and weaknesses in the current Naval STEM portfolio, and includes exciting new programs that will help increase participation by students and teachers. As the Naval STEM Executive, the Chief of Naval Research will continue to align service-wide STEM education and outreach efforts using this Roadmap as a guide.

I challenge each of you to enter the discussion and consider how you can take bold steps to partner with us to expand, enhance and increase the effectiveness of the nation's investments in STEM education. More importantly, I challenge you to remember what first excited you about STEM subjects and to consider how the experiences and technologies of tomorrow can inspire the same excitement in our future scientists and engineers.



The Honorable Ray Mabus
Secretary of the Navy

Page 1 - Securing Our Future: The Naval STEM Workforce



STEM Landscape



\$18.3 M

\$50.4 M

\$14.9 M

Elementary

Middle

High School

Undergraduate

Masters

PhD

Faculty Research, Teacher Training & Professional Development

Programs

Underrepresented
Family Science
Science Fairs
iApps

Internships
Digital Tutors
Robotics
Camps

Internships
Scholarships
Competitions
Cohorts

Internships
Scholarships
Fellowships

Scholarships
Fellowships

Young Investigator
Summer faculty



Levers

- Fun
- Interesting
- Hands-on
- Real-world
- Family Involvement
- Use of Near-Peers

- Exciting / Relevant
- Competition
- Mentoring
- Social Networking
- Funding / Support
- Real-world Experience

- Employment/Stability
- Prestige
- Relevance
- Compelling Research
- Opportunity to Publish

Metrics

Inspire ➔

Engage ➔

Educate ➔

Employ

Questions to consider...

How much “Discovery and Invention” funding does
Industry receive?

How large is a typical D&I program?

Who selects the programs? How do I meet them?

Where does ONR tell people what they want to fund?

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