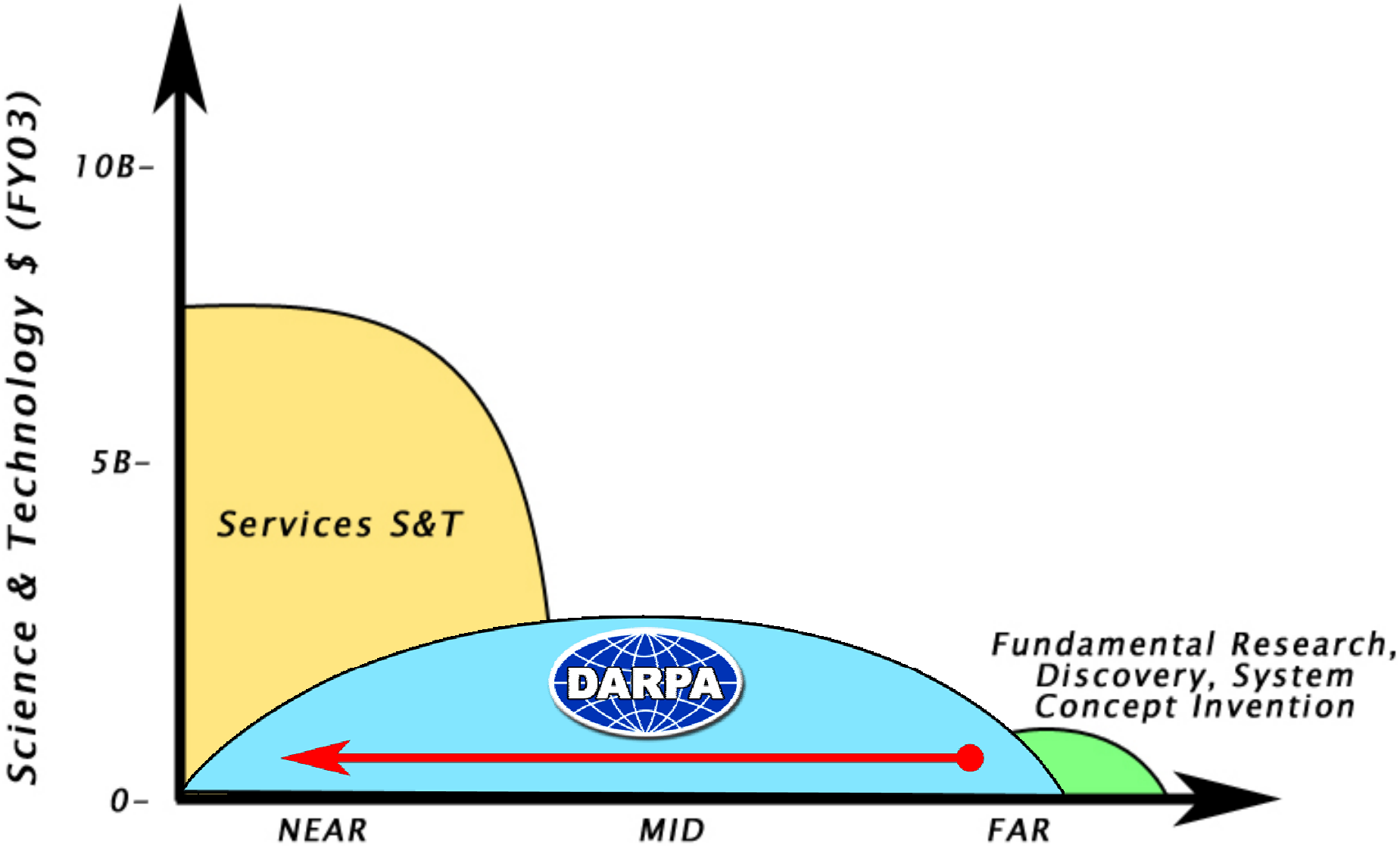
Microsystems Technology Office Overview: Background Info for PM Candidates

Dr. Greg Kovacs, Director MTO
Dr. Dean R. Collins, Deputy Director MTO

2008

MICROSYSTEMS TECHNOLOGY OFFICE

DARPA's Role in Science and Technology



MTO Mission

Exploit breakthroughs in materials, devices, circuits, and mathematics to develop beyond leading edge components with revolutionary performance and functionality to enable new platform capability for the Department of Defense.

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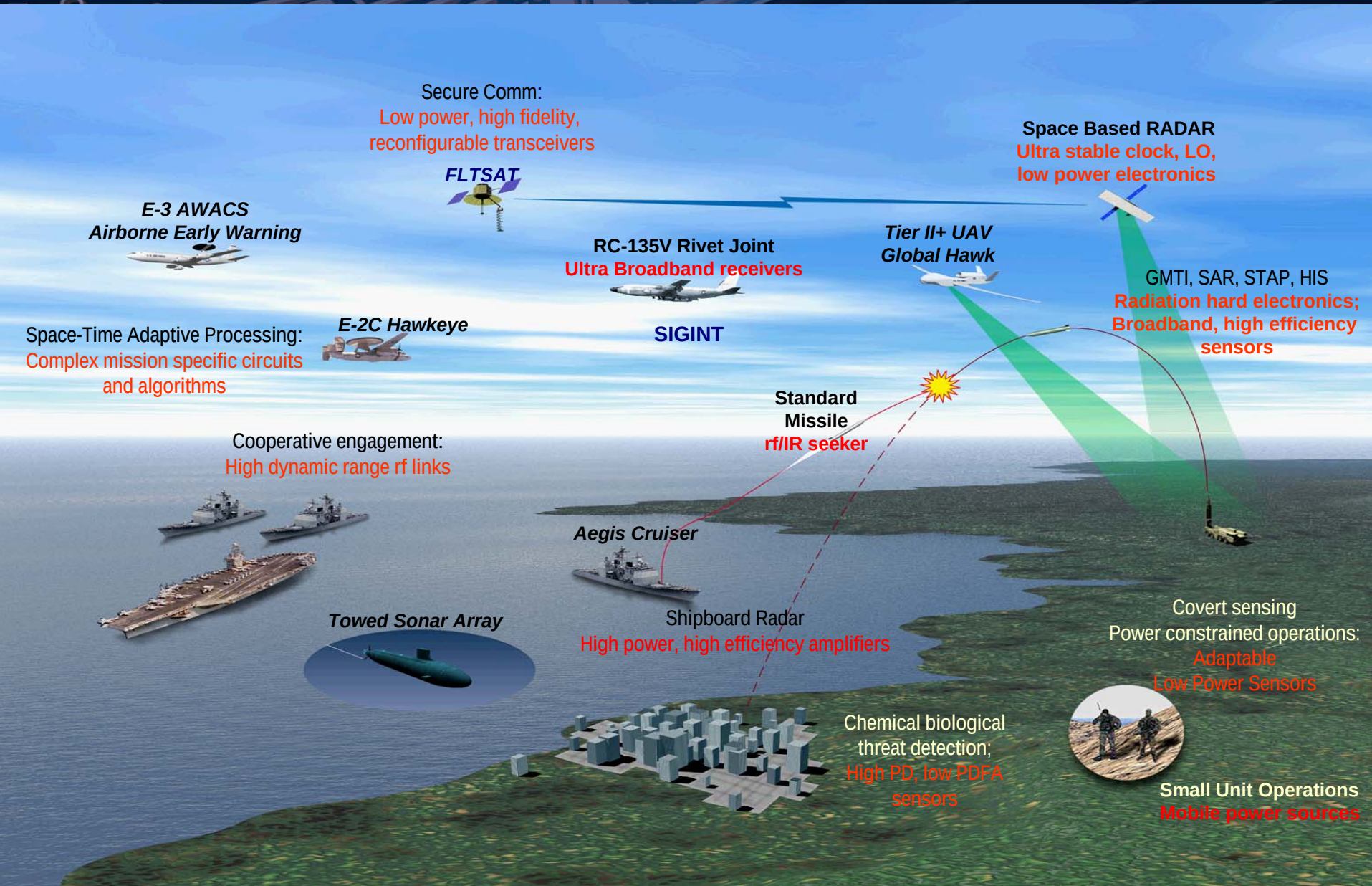
Microsystems in the Current Fight

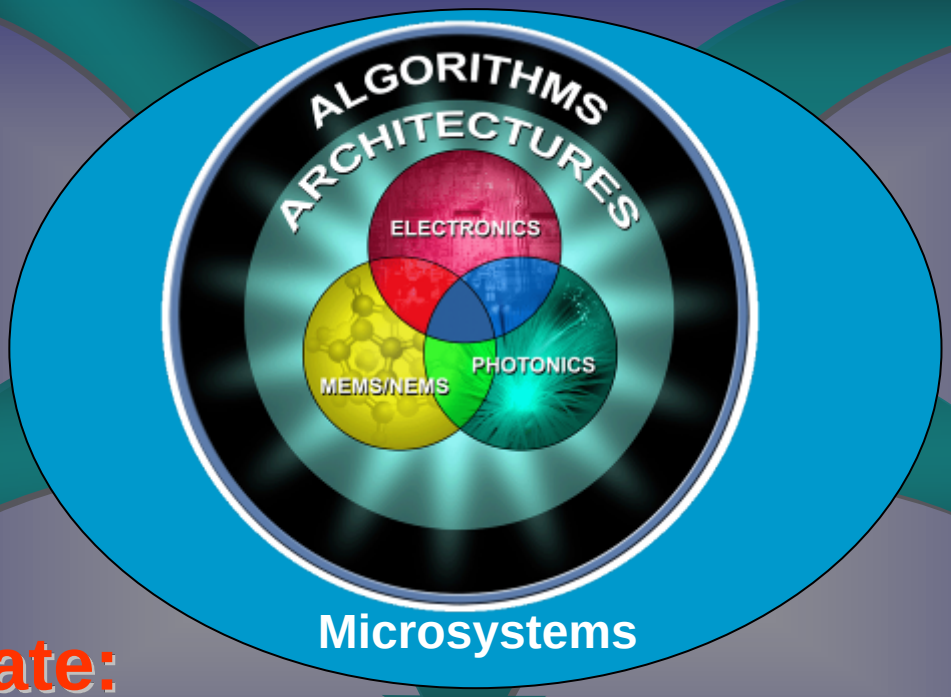
Microsystems Components Driving Platform Innovation



Microsystems Enabling Future System Capability

Sense:
EO/IR/Visible/UV
RF/mm-wave/THz
Chemical
Biological
Trust/Protect

Process:
Digital
Analog
Memory
Quantum
Biological
Trust/Protect



Communicate:
Optical
Analog/digital
Wireless RF/mm-wave

Energize:
Convert
Generate
Directed

Actuate:
Mechanical
Electrical
Optical
Chemical

Classes of Microsystems

Increasing Capability

- **<u>Intelligent:</u> High level of autonomy with the ability to reason and learn with time**

- **<u>Adaptable:</u> Some degree of autonomy to self optimize, test, or monitor. Able to change mode of operation.**

- **<u>Reconfigurable:</u> Predefined, deterministic set of operating parameters that can be selected externally.**

- **<u>Static:</u> Fabricated to design specifications with fixed performance.**

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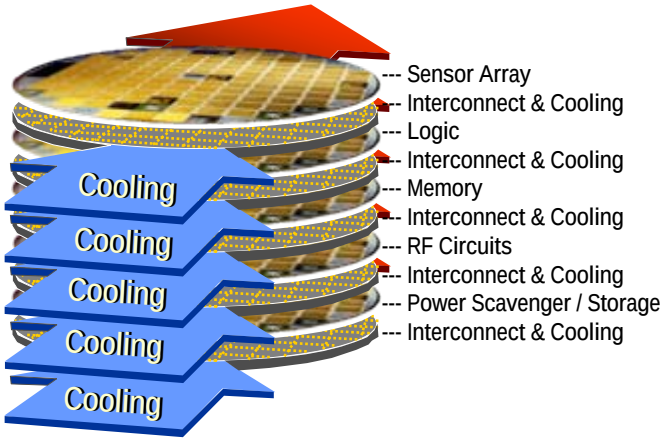
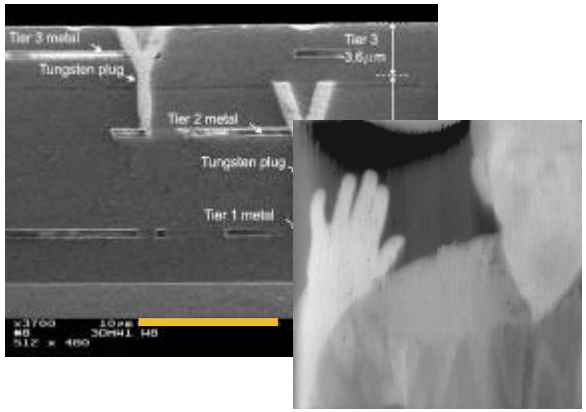
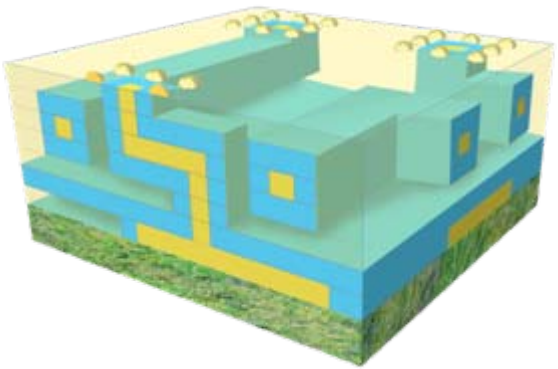
Exploiting the 3rd Dimension



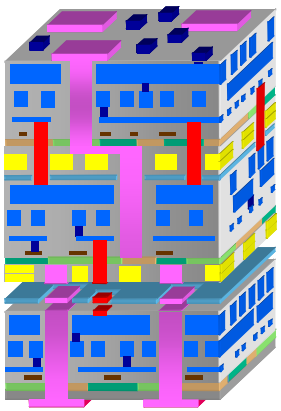
3D Electronics

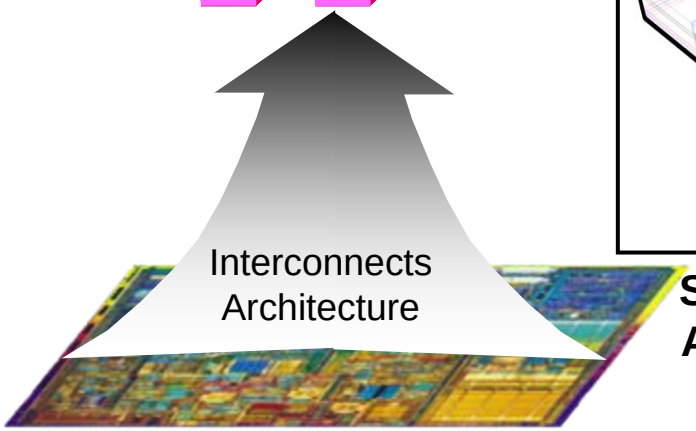


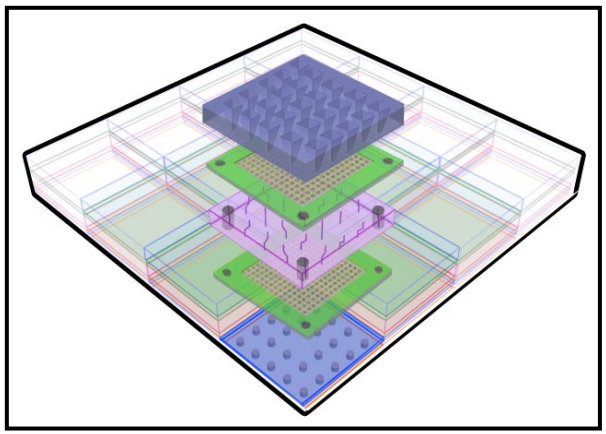
Vertically Interconnected Sensor Arrays (VISA)



3D Micro-Electromagnetic RF Systems (3D-MERFS)







Scalable Microsystems for Affordable Reconfigurable Transceivers (SMART)

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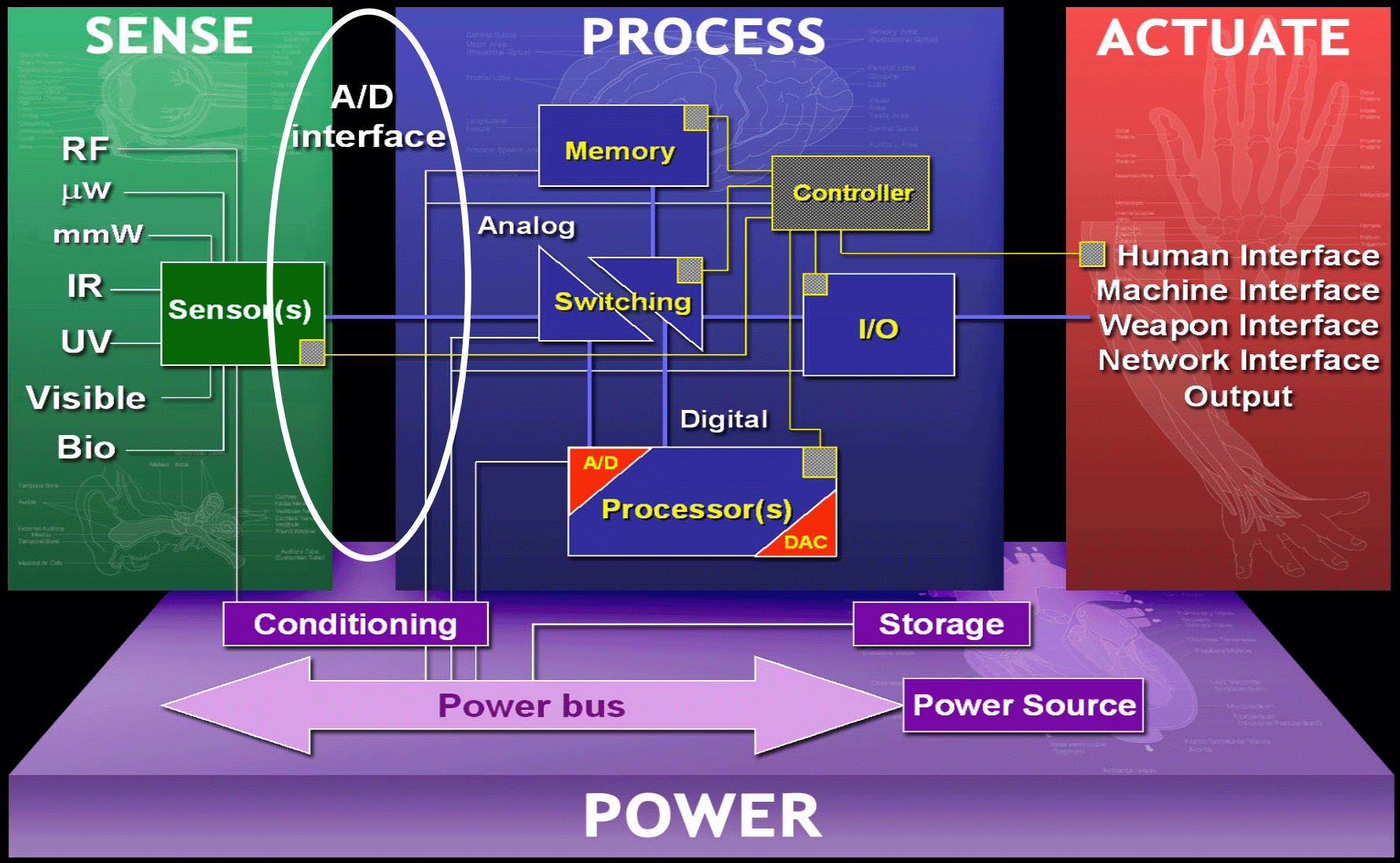
Integrated Microsystem



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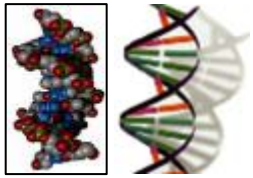
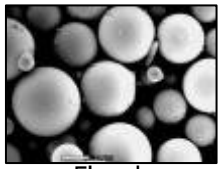
The Micro to Nano World

Things Natural (Carbon Chemistry)



DNA
~2-1/2 nm diameter

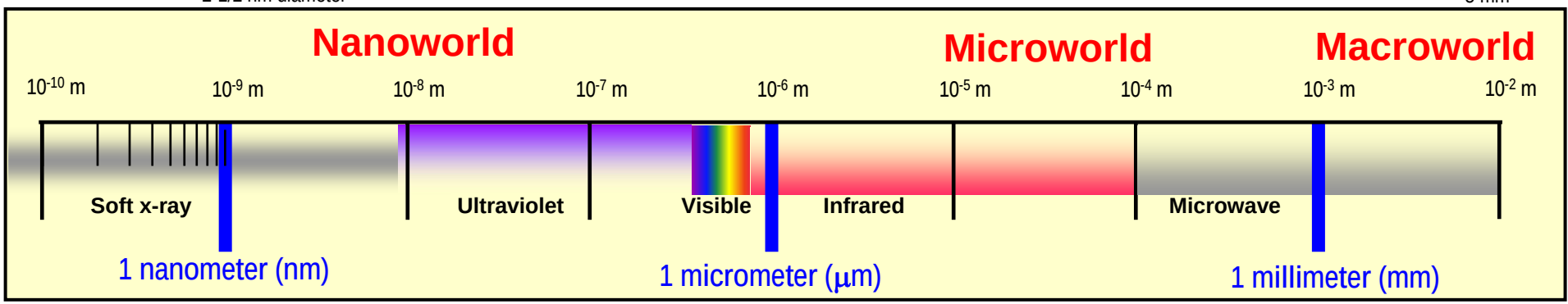


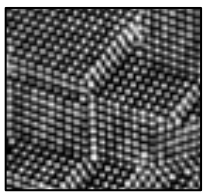
Fly ash
~ 10-20 μm

Human hair
~ 10-50 μm wide

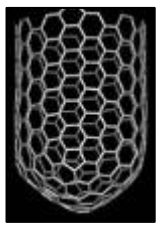
Dust mite
200 μm

Ant
~ 5 mm



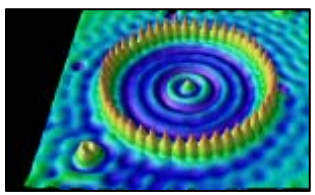


Atoms of silicon
spacing ~tenths of nm



Carbon nanotube
~2 nm diameter

Transistor gate
60 nm



Quantum corral of 48 iron atoms on copper surface positioned one at a time with an STM tip
Corral diameter 14 nm

MicroElectroMechanical devices
10 -100 μm wide

Head of a pin
1-2 mm

Things Manmade (Silicon Chemistry)

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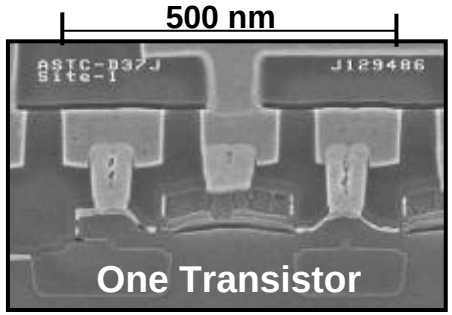
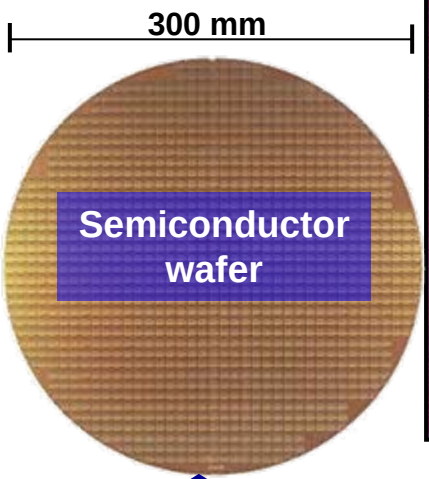
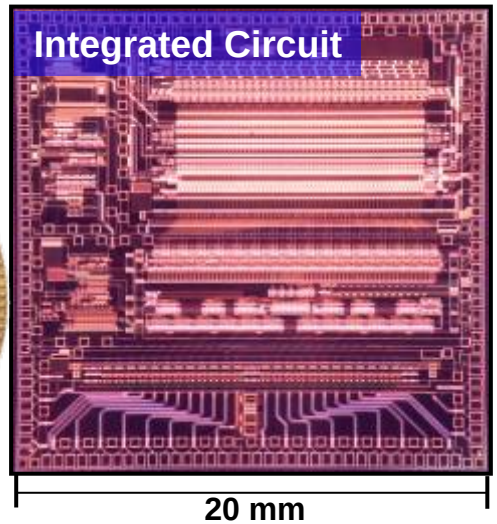
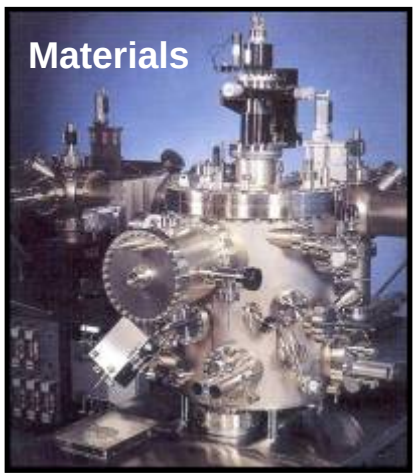
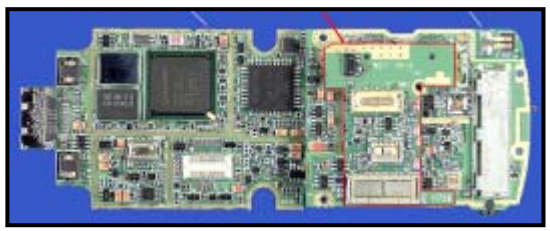
Flow of Technology Innovation

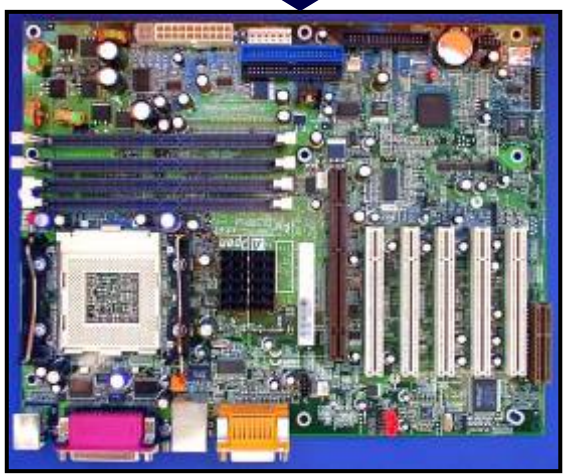












End Applications

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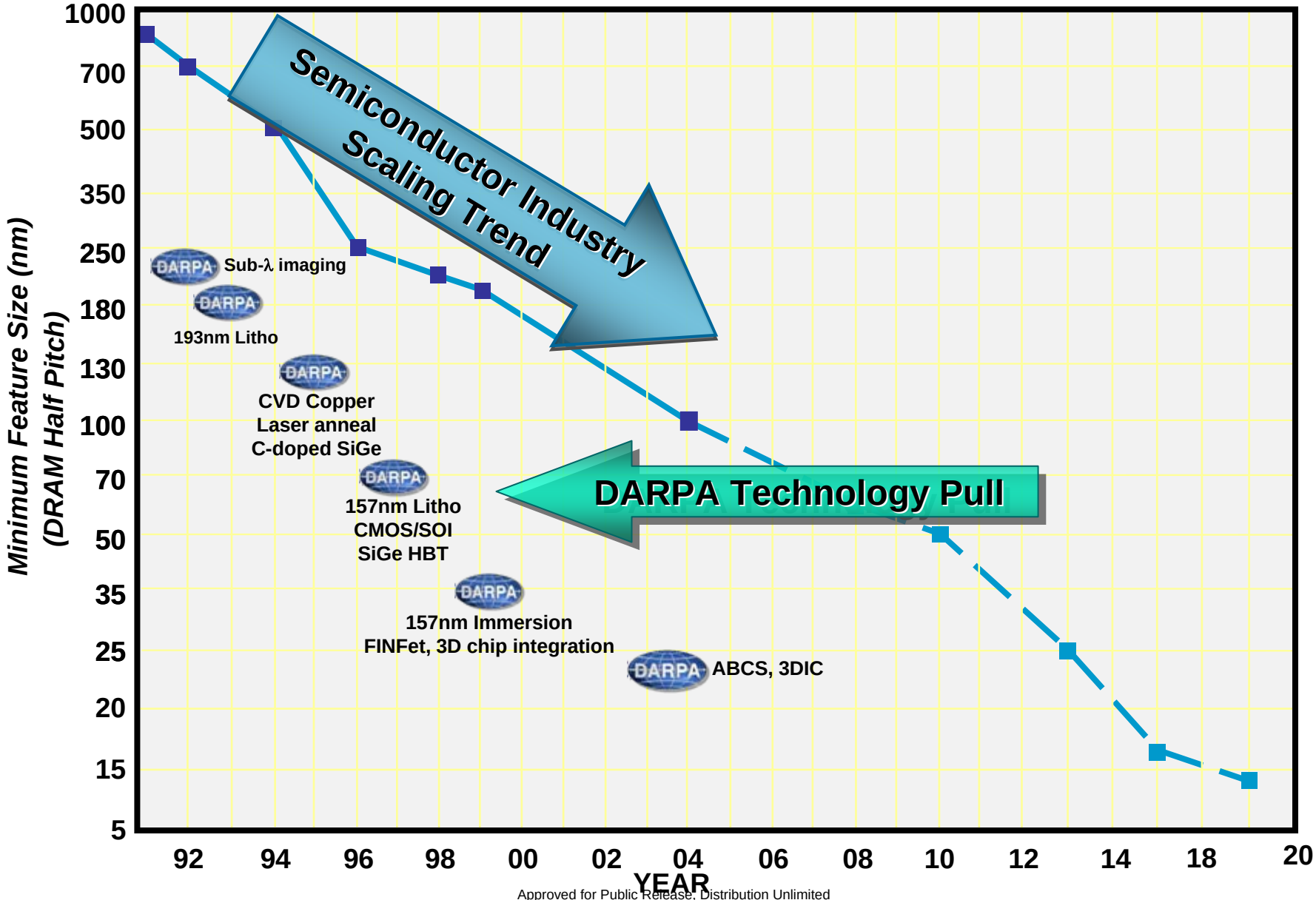
Technology Extension



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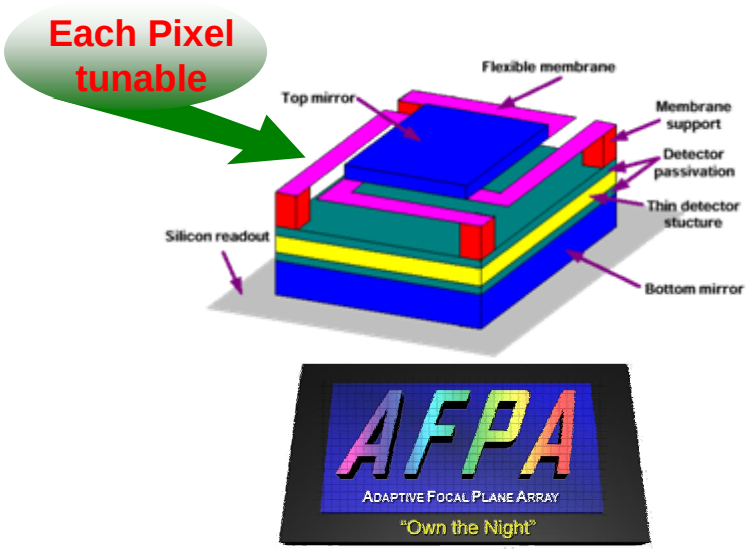
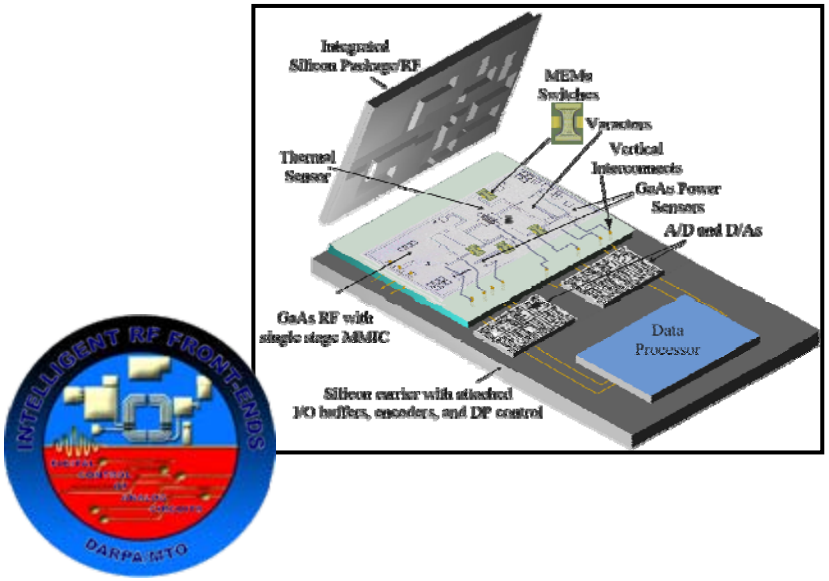
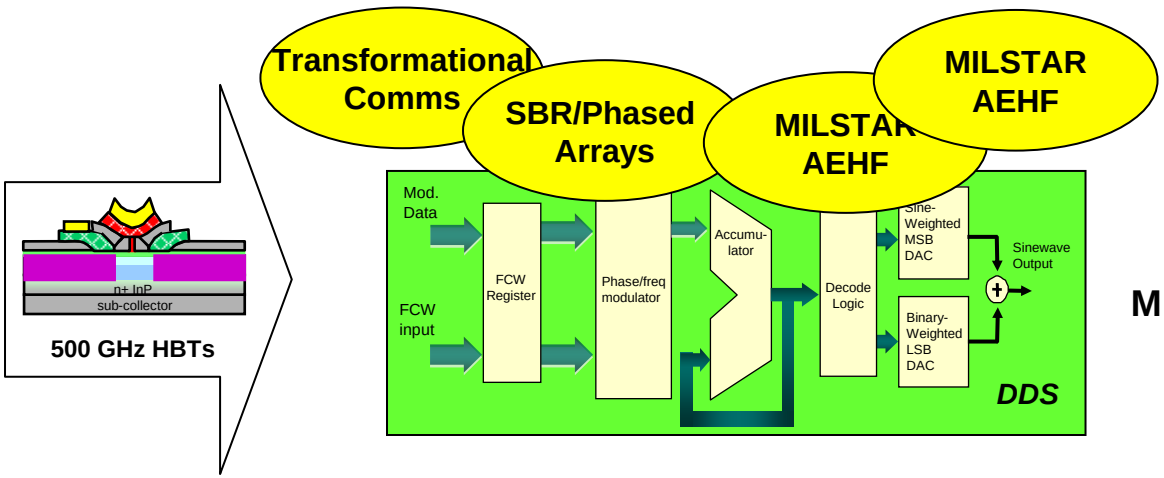
Reconfigurable Microsystems







Microwave Digital Synthesizers: Digitally controlled phase, amplitude, and frequency modulation

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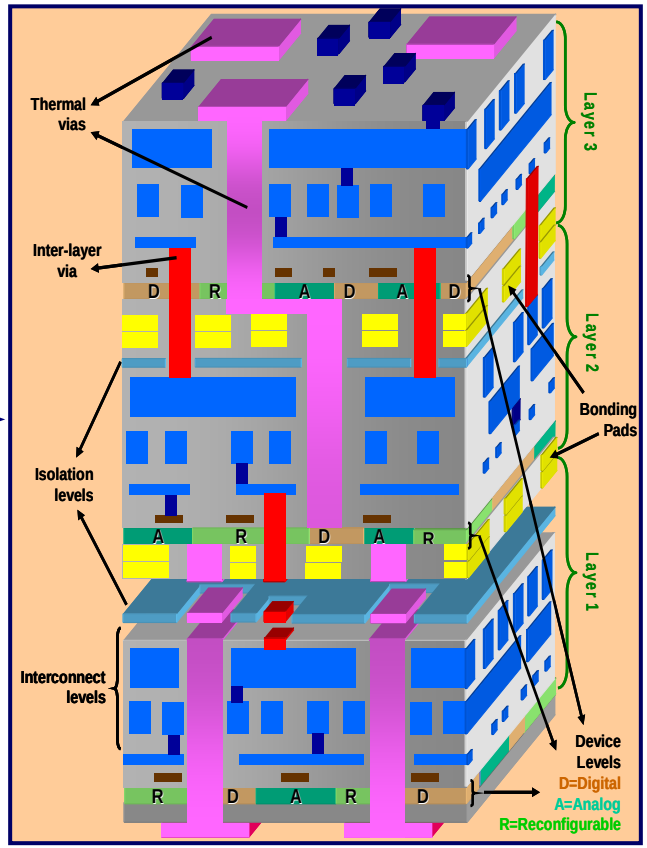
DARPA Revolution in 3D Integrated Microsystems

Conventional 2D Scaling

Performance limited by:

- **Global interconnects**
- **2D architecture**



3D Scaling: A platform for Functional Scaling

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Review Current MTO Programs at:

http://www.darpa.mil/mto/

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Responding to Changing Threats

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What Makes a DARPA PM

- **Idea Generator**
- **Technical Expert**
- **Entrepreneur**
- **Passion for Drive Leading Edge Technology**
- **National Service**

~*~DARPA Hires Program Managers for their Program Ideas ~*~

… if you have interest, formulate your program ideas along the lines of the following charts and contact the Director at:
Gregory.Kovacs@darpa.mil

The Following Slides are a template for your briefing to MTO.
These will be a helpful guideline for the construction of your presentation.

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Program Name

Name

Contact info

MICROSYSTEMS TECHNOLOGY OFFICE

Resume (1 chart)

- Who are you?
- What is your technical background?
- What key work have you done in the field?
- Recognition within the technical community
- Key awards

The Idea (1 chart)

- What are you trying to accomplish?
- A diagram of what you plan on doing.
- Develop a performance trade space (e.g. power versus speed; MOPS/cm^2 versus watts) and show current SOA and where your program will take it

Topic/project/effort description

[PROJECT-NAME] ACHIEVEMENT

STATUS QUO

Relationship to New Start Topic

(DELETE THIS BOX OF TEXT AND INSERT DIAGRAM(S)

- *What new start topic is this seedling supporting?*
- *What is the problem the new start is seeking to solve?*
- *How is this problem addressed today?*
- *Projected date for new start briefing?*

NEW INSIGHTS

How does this effort establish new insights or data to support the new start development?

(REPLACETHIS BOX AND INSERT DIAGRAM(S))

First key insight. Add more text as necessary.

Second key insight. Add more text as necessary.

- Add other points as necessary

MAIN ACHIEVEMENT:

Placeholder explanatory text. Replace with text and diagrams as necessary.

HOW IT WORKS:

Placeholder explanatory text paragraph. Replace with text and diagrams as necessary.

ASSUMPTIONS AND LIMITATIONS:

- Limitation or assumption
- Another limitation or assumption

EXPECTED PERFORMER:

REQUESTED BUDGET AND SCHEDULE:

DELIVERABLES AND DATE:

QUANTITATIVE IMPACT

CHARACTERIZE THE QUANTITATIVE IMPACT

(DELETE THIS BOX OF TEXT AND INSERT TABLE, GRAPH, OR OTHER SUITABLE VISUALIZATION)

Identify the technical issues that will be addressed.

What is the expected outcome of the seedling effort (be quantitative)?

END-OF-PHASE GOAL

Define the projected impact of the new start program this seedling will support.

(REPLACE WITH DIAGRAM/TEXT/THRESHOLD CRITERIA)

Primary answer here. Add more text as necessary.

- *First key point*
- *Additional as necessary*

Draft

A sentence why it is important/useful

Technical Approach

- How do you plan to accomplish the new capability
- What new results suggest this is possible
- Analysis of required performance

Technical Challenges

- Breakdown the end product into key technical challenges that need to be overcome
- Quantify current performance and the final performance required to meet the complete program goals
- Include visuals or graphics where possible

Impact

- If this is successful, what difference will it make
- How will this new technology impact system performance (quantify this)
- Who in the DoD will care?
- Are there commercial applications?

Program Plan and Metrics

- Estimate how long it will take
- Break the overall program into phases with key performance metrics at the end of each phase

Review:
A good program plan should answer the questions below

Heilmeier's Catechism

PRIMARY

- **What are you trying to accomplish?**
- **How is it done now, and with what limitations?**
- **What is truly new in your approach which will remove current limitations and improve performance? How much will performance improve?**
- **If successful, what difference will it make?**
- **What are the mid-term, final exams or full scale applications required to prove your hypothesis? When will they be done?**

SECONDARY

- **How could this transition to the end user? (usually DoD)**
- **How much will it cost?**