ASAP: Where to From Here?

10th Annual Conference on Adaptive Sensor Array Processing Workshop
Keynote Address

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Chief Scientist, Signal Processing
Defense Advanced Research Projects Agency
With the Help of

- Jim Anderson, Lincoln Lab
- Ed Baranoski, Lincoln Lab
- Rob Fetterolf, DARPA/SRS
- David Perrine, DARPA/SRS
- Vince Premus, Lincoln Lab
- James Ward, Lincoln Lab
- Michael Zatman, Lincoln Lab
Previous Keynotes

- 1993 Ralph Compton
- 1994 Lloyd Griffiths
- 1995 Jim McClellan
- 1996 Irving Reed
- 1997 Norman Owsley
- 1998 Thomas Miller
- 1999 Henry Cox
- 2000 Delores Etter
- 2001 Don Tufts
Where Are We?

What Is the Purpose of ASAP?

- Not a Primary “Home” for Its Participants
- Not a Venue for “Speciation”
- Not a “Vetted” Peer Review Outlet
- Are We Relevant for the Future?
- No “Entrenched Bureaucracy”:
- Our Future Is for Us to Define
10 Years of ASAP
   - What Have We Been Doing Here?
   - Has It Made a Difference?

10 Years of Geopolitical / Technological Transformation
   - How Has Technology Changed?
   - How Has Our World Changed?

ASAP: The Next 10 Years
   - New Application Domains Need Exploring
   - The Past Is NOT Prelude!
   - Need to Leverage Our Talents, Will Exploring New Turf
What IS Engineering Anyway?

The Glory of Engineering: Salience
- What Survives the Corrosive, Non-ideal unpredictable, Mismodeled, and downright Nasty Effects of the Real World
- Determined By:
  - Testbeds, Architectures, CONOPS,
  - User Dialogue
  - Salience Makes for Good Research

Countervailing View:
- Research As “Poetry”
- Speciation As Objective
- Peer Review Ultimate Adjudication

Unique Approach of ASAP Community:
- Testbed, User Dialogue Early: Before the Ink Is Dry!
- Mixture of “Miners”, “Blacksmiths”, and “Buyers”

Proposition:
Salience Is Responsibility of Research Community
ASAP Prototype for Future Research Funding / Dissemination
Research Community Should Foster Disruptive Tech: Be Dangerous!
We Are Dangerous!

Be Afraid Oh Dish, Be Very Afraid!
Major Systems Planned System Procurements Rely on ASAP Success

Unprecedented “Time to Market”

``Build It and They Will Come” Is Not the Future Paradigm
The ASAP Community

System Focused Algorithms and Architecture Research Building Upon and Adapting to the Explosive Technology Growth

We Have Achieved Extraordinary Technology Transitions Serving National Security

Unique Opportunities and Challenges Present Themselves As We Face the Future
Adaptive Array Testbeds

Data From Numerous Testbeds and Data Collection Assets Have Been Shown at ASAP Over the Past 10 Years
### ASAP Technical Venue

*Good Mix Of Theory / Testbeds*

#### Key:
- **Theory**
- **Application**
- **Experimental Data**

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*Wideband Array Calibration*
Outline

► 10 Years of ASAP
► 10 Years of Geopolitics / Technology
  ► Technology
  ► Geopolitics
► The Next 10 Years
Digital Channelizers: ASAP Lifeblood

- 1 ft-1 m resolution: no swath loss for IMINT
- Huge gains: ($$-perf)
  - 33 dB on A/D
  - 20 dB on TR modules

Sampling Rate (MSPS) vs. Year
- 8-bit
- 10-bit
- 12-bit
- 14-bit
- 16-bit
- 24-bit

- $50, 100 kHz
- $17
Post Channelizing: How Many OPS Available?

20dB throughput gain with COTS: Moore’s law confirmed
Current Threat Events

- Cold War Ended
- Threats Persist
  - More Diffuse, More Uncertain
- Need for Unambiguous Targeting

- Rangers Battle Warlord – Somalia
- Tokyo Subway Gassed
- Embassies Destroyed - Kenya, Tanzania
- Chinese Embassy Bombed – Belgrade
- USS Cole Hit – Yemen
- Pentagon & WTC Struck By Terrorists
- Commercial Airliner Lost – Siberia
- Enduring Freedom Begins

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<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<td>’93</td>
<td>Cold War Ended</td>
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<td>Tokyo Subway Gassed</td>
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<td>Commercial Airliner Lost – Siberia</td>
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<td>’01</td>
<td>Enduring Freedom Begins</td>
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### Current Procurement Events

#### Major Uncertainty in Large Programs
- Reduced IRAD, Risk Acceptance

#### Space Losses Foster Further Conservatism
- Airborne Near Term Growth

#### Merger Began / Terminated
- Stability Ahead

#### SIs Given Unprecedented Latitude
- Opportunity for Fast Transition

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<th>Year</th>
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<td>'93</td>
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<td>'95</td>
<td>$39.4B ↓1.2</td>
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<td>'96</td>
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<tr>
<td>'97</td>
<td>$40.0B ↑1.0</td>
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<tr>
<td>'98</td>
<td>$40.0B ↓0.0</td>
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<td>'99</td>
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<td>$42.7B ↑1.9</td>
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<td>'02</td>
<td>$48.4B ↑5.7</td>
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</table>

- **A-12 Avenger ATA Lawsuit Decision**
- **Discoverer II Begins**  
- **Discoverer II Ended**
- **Titan 4 Explodes**
- **Industry blocked**
- **Future Combat Systems Begins**
- **Iridium restructured**
- **JSF Contract Award**  
- **EHF Satcom restructured**
Merger Mania

- Fewer Vendors Will Accelerate Transition
- Less “Boutique” Programs
- Personal Relationships Increasingly Important
- Must Understand SI Mindset

Lockheed $14.7 B
Boeing $13.3 B
Northrop $5.2 B
Raytheon $5.6 B

GE
General Dynamics
Martin
Loral
Rockwell International
McDonnell Douglas
Hughes

Grumman
Norden
Westinghouse
Logicon
Litton
TRW?

GE
General Dynamics
ESystems
Hughes
TI

‘93 ‘94 ‘95 ‘96 ‘97 ‘98 ‘99 ‘00 ‘01 ‘02
### Telecommunications Timeline

<table>
<thead>
<tr>
<th>Year</th>
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<tr>
<td>‘93</td>
<td>First US Web Page</td>
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<tr>
<td>‘94</td>
<td>First Web Cam</td>
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<tr>
<td>‘95</td>
<td>Iridium First Operational</td>
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<td>‘96</td>
<td>cable modems</td>
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<td>‘97</td>
<td>DVD Standard Agreed</td>
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<td>‘98</td>
<td>First 2-Way Pager in Telecom</td>
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<td>‘99</td>
<td>First US HDTV Broadcast</td>
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<td>‘00</td>
<td>2D Wireless CDMA</td>
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<td>‘01</td>
<td>2D Wireless GSM</td>
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<td>‘02</td>
<td>Digital Expands To Video</td>
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<td>Internet Becomes “Sensor Web”</td>
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<td>Wireless Coms: Commodity</td>
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<td>Network Centric Warfare: Familiarity Facilitates Transformation</td>
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</tbody>
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- First US Web Page
- First Web Cam
- Iridium First Operational
- Cable Modems
- DVD Standard Agreed
- First 2-Way Pager in Telecom
- First US HDTV Broadcast
Predator UAV

- DARPA Success
- Affordable, Tactical ISR
- Very Low Flight Qualification Cost
- First Robotic Weapon
  - UCAV, UCAR, OAV Followon

1993
- Contract Award
- First Flight
- Radar Installed
- 1st Operation
- UCAV Contract Award
- UCAV-N Award
- Fired Weapons in Combat

1994
- Predator lost
- 1st Fired Hellfire-C Missile
- OAV First Test Flight

1995

1996

1997

1998

1999

2000

2001

2002
STAP Radar transition: Global Hawk

- First Flight: 12k Mile Flight to Australia Begins
- First Radar Flight: STAP
- First Op – Afghanistan
- Low platform costs, fast acquisition, Enhance radar X-ition
- Production Deliveries Due

Timeline:
- ‘93: DARPA Success
- ‘94: Affordable, StandOff ISR
- ‘95: First STAP Transition
- ‘96: Common JSTARS Radar Upgrade
- ‘97: Phase I Contract Award
- ‘98:
- ‘99:
- ‘00:
- ‘01:
- ‘02:
10 Years of ASAP
10 Years of Geopolitics / Technology
  Technology
  Geopolitics
The Next 10 Years
  Grass Roots Adaptive Sensor Processing
  SVD for heterogeneous fusion
  Brain in the Loop ASAP

Media Reports Indicate That “a U.S. Customs Agent” Inspected Ahmed’s Vehicle Because He “Looked Suspicious”.

This Single Event Saved the Lives of Hundred’s of Innocent Civilians

Todd Beamer, a 32-year-old Sunday School Teacher Saved the Lives of Hundred’s With the Famous Word’s “Let’s Roll”

National Security Has Become a Grass Roots Matter
-INS -Border Guards –Local Law Enforcement -Even Private Citizens

Technologists MUST Augment Human Efforts at Deterrence

Sensor’s Are Key Enabling Technology

ASAP Has Proper Talent and Organizational Model, Salience, Testbeds, User Input
SVD Provides Excellent Stationarity Assessment

- **E2C Image**
- **E2C^2 Image**
- **Stationary^2 Image**

- Local Stationarity Key for ASAP Detection
- Image Segmentation Not for Virtual Arrays
- SVD Modal Analysis Segments Data
- SVD Nonlinear Mapping Elucidates Segments

**Conclusion:**
- SVD May Be a Space Time Segmentation For Virtual Arrays

10 Eigenvalues Suffices for Tail Section
ASAP Future: “Brain in the Loop”
Vice Human in the Loop

- Human Perceptions Replace / Augment “CFAR”
- Neural Nets Trained Automatically Based on Brain Response
- Intelligence Analysts Perceptions Replace Tedious Subjective Reporting
Example of Breakthrough Cognition Sensors

- U. Penn 8 Channel Laser Photo-Diode Array
- No ASAP at Present
- Wearable, Low Cost, $10K, Robust

- Significant Transient During Deception by DARPA PM!
- Detects “Aha!” Moment
- 4,000 SAT Database
Conclusions

► Now Is NOT a Time to Be Timid!
► Huge Changes Lie Ahead, Technologically Geopolitically
► The ASAP Community Is Uniquely Situated to Make a Difference

Let’s Roll!