MIT Lincoln Laboratory Overview

SENEDIA Tech Talk

Israel Soibelman

7 November 2017
## 65 Years of Technical Achievement

<table>
<thead>
<tr>
<th>Category</th>
<th>Event</th>
<th>Details</th>
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<tr>
<td>First Continental Air Defense System</td>
<td>Protected US from Soviet nuclear attack for 20 years</td>
<td>ALCOR radar located at Kwajalein</td>
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<tr>
<td>Digital Signal Processing &amp; Error-Correcting Codes</td>
<td>Inventions of recursive digital filters and Reed-Solomon codes</td>
<td>Spawned commercial mini-computer industry</td>
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<td>First Fully-Transisterized Real-Time Computer</td>
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<td>Birth of nonvolatile memory</td>
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<td>Coincident Core Memory</td>
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<td>First Transmission of Packetized Speech</td>
<td>Forerunner of voice over internet protocol (VoIP)</td>
<td>Installed on all planes with &gt;19 passenger seats</td>
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<td>Airborne Collision Avoidance System</td>
<td>Instructs the optimal avoidance direction based on radio waves received from the other aircraft</td>
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<td>First Prototypes for All Military Comm. Satellites</td>
<td>DSCS, MILSTAR, WGS, AEHF, MUOS</td>
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<td>First RADAR-based Satellite Imaging</td>
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<td>First Television Picture Transmission via Satellite</td>
<td>Used NASA’S Echo I Satellite</td>
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<td>Air Defense of the National Capital Region</td>
<td>Rapid deployment post 9/11</td>
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<td>3-D Laser Imaging</td>
<td>Permits airborne 3D imaging through trees</td>
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<td>193nm Optical Lithography</td>
<td>Leap ahead in integrated circuit technology</td>
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<td>NASA Chandra X-Ray Observatory</td>
<td>Advanced CCD imaging spectrometer</td>
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<td>First Laser Communications from Lunar Orbit</td>
<td>622 Mbps downlink for 30 days with zero bit errors</td>
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MIT Lincoln Laboratory
Department of Defense (DoD) Federally Funded R&D Center

Mission: Technology in Support of National Security

Key Roles: System architecture engineering
Long-term technology development
System prototyping and demonstration

Mission Areas:
- Air, Missile & Maritime Defense
- Homeland Protection
- Advanced Technology
- Space Control
- Air Traffic Control
- ISR Systems and Technology
- Communication Systems
- Tactical Systems
- Cyber Security
- Engineering
Major Federally-Funded Research and Development Centers

- **Department of Energy**
  - National Laboratories: Los Alamos, Sandia, Lawrence Livermore, Lawrence Berkeley, Oak Ridge, Argonne, Idaho, Pacific Northwest, Savannah River and Brookhaven

- **Department of Defense**
  - Aerospace, RAND, Institute for Defense Analysis, Center for Naval Analysis, MITRE, MIT Lincoln Laboratory, and Carnegie Mellon University Software Engineering Institute

- **NASA**: Caltech Jet Propulsion Laboratory
MIT Lincoln Laboratory FFRDC Roles

• Giving open/unbiased support to government
• Developing noncompetitive relationships with industry
• Maintaining/developing strong technical expertise
• Establishing long-term system and technology awareness
• Promoting cross-Service technology awareness
• Promoting technology transfer to industry
• Enabling rapid assessment and prototyping

Technology in Support of National Security
Technology Development and Transition

Development Approach

- Analysis & Architectures
- Technology Awareness and Development
- "Prototyping" • Components; Subsystems • Evaluation Systems
- Production Industrial Base
- User Experience
- Testing

Recent Technology Transitions

- Ground Forces Sensing Technology
- Transportable AEHF Communications Terminals
- Cyber Security Software
- Curved CCDs for Space Surveillance
- Biological Agent Identification Sensor
- Dual-Band Pacific Testing Radar
- Photodiode Arrays for Ladar Sensing
Lincoln Laboratory R&D Facility

- Many specialized facilities for advanced research, technology development, and prototyping
  - Microelectronics Laboratory
  - Lincoln Space Surveillance Complex
  - Airborne Test Bed Facility
  - RF System Test Facility
  - Rapid Hardware Integration Facility
  - Polymer Laboratory
  - Environmental Test Laboratory
  - Machine Shops and Additive Manufacturing
  - Optical Systems Test Facility
  - High Bay Integration
  - Interactive Supercomputer (1.75 Petaflops)
  - ISR Processing and Exploitation Laboratory
  - Lincoln Research Network Operations Center
Composition of Technical Population

Degrees

- Master's: 33%
- Bachelor's: 41%
- Doctorate: 23%
- No Degree: 3%

Academic Disciplines

- Physics: 35%
- Electrical Engineering: 17%
- Mechanical Engineering: 14%
- Computer Science: 10%
- Aerospace, Astronautics: 8%
- Computer Engineering, Biology, Chemistry, Meteorology, Materials Science: 6%
- Mathematics: 5%
- Other: 2%
- No Degree: 3%
Range of Laboratory Programs

**Advanced Technologies**
- Cryogenic Yb:YAG Lasers
- Advanced Focal Planes
- APD Arrays
- Quantum Bits
- Miniature Low-Power Transceivers
- Decision Architectures

**System Prototypes**
- Space Surveillance Telescope
- HUSIR W-Band
- Lunar Laser Comm. Demo
- XTR-1 Radar
- Rapid Agent Aerosol Detector
- ALIRT 3-D Imaging
The Need for Space Situational Awareness

Widespread emergence of microsatellite technology and space debris places more demanding requirements on capability of systems to detect and track space objects.

Public concerns over space mission assurance

Example small satellite payloads prepared for launch

Locations of currently tracked space debris

Image credit: NASA
Space Surveillance Telescope (SST)

Telescope Subsystem (L3-Brashear)

Control and Data Processing Subsystem (MIT LL)

Sensor Subsystem (MIT LL)
  - Wide Field-of-View Camera (GL Scientific)
  - Curve Focal Surface
  - High-Speed Shutter

First Light!

Ribbon Cutting – 12 October 2011
In 2014, SST provided data collected on all or part of 59 nights
- 2.2 million asteroid observations
- 2nd-largest in the world for 2014

In 2015, SST provided the largest number of asteroid observations ever submitted to the MPC by a single site in one year
- Over 7.2 million asteroid observations

In 2016, SST provided data from Jan-Sep
- Over 2.8 million asteroid observations
MIT Lincoln Laboratory Beaver Works
300 Technology Square, Kendall Square, Cambridge, MA

Lincoln Beaver Works Activities

- Lincoln Beaver Works capstone projects (Lincoln funding and/or mentors)
  - STOL seaplane (16.62/16.82)
  - Maritime power system for STOL seaplane (2.013/2.014)
  - Mobile tactical power systems (2.013/2.014)
  - KitCube Design for NASA CubeQuest (16.83/16.89)
  - Unmanned marine vehicle autonomy, sensing and communications (2.680)
- Lincoln – campus joint research projects
  - Firefly high speed micro UAV
  - Microwave Radiometer Technology Acceleration (MiRaTA)
  - Center for Engaging Supercomputing projects (3 projects, $8.9M, FY15-17)
  - Cyber security evaluation and prototyping
- Nine Lincoln IAP courses
- Other activities
  - Cyber Capture the Flag (university teams)
  - Cyber Patriot Teams (high school teams)
  - Beaver Works Humanitarian Initiative
  - Assistive Technologies Hackathon

Opening Ceremony
November 12, 2013

Prototyping lab, classrooms, and research area (~5,000 sqft)
Recent Press Related to MIT LL Micro-UAV Efforts

- CBS 60 Minutes special January 8, 2017
  - “The Coming Swarm”
- Focus on emerging military autonomous systems
  - MIT LL Perdix Micro-UAV system featured
- More video available on cbsnews.com
Air Launched Micro UAV Concept

1. Deploy from tactical aircraft
2. Slow with drogue chute
3. Release vehicle from canister
4. Unfold wings
5. Stabilize
6. Navigate
7. Communicate & Coordinate

Micro-UAV capable of deployment from tactical aircraft and coordinated autonomous operations
MIT Campus Concept Development

MIT Aero/Astro Department Capstone Course: 16.82

- High-altitude deployment for atmospheric monitoring
  - Fit into standard flare dispenser
  - Deploy at 30,000 ft
  - Persistent operations for 30+ minutes
  - Station keeping under typical head winds

  - Open architecture payload
    - 15 g, max range configuration
    - 100 g with reduced flight time
    - Multiband communications
    - Integrated GPS, INS and autopilot

  - Low unit production cost ( < $2,000)

- Fall 2010 design: 26 undergraduate, 5 graduate, 3 faculty
- Spring 2011 build: 6 undergraduate, 2 graduate, 3 faculty
Perdix Micro UAV in Flight
Current Micro UAV System
Summary

• Lincoln Laboratory is a DoD Federally Funded Research and Development Center operated by MIT

• Key mission areas:
  Air Defense        Communication Systems
  Missile Defense    Space Control
  ISR and Tactical Systems Advanced Electronics
  Air Traffic Control Cyber Security
  Tactical Systems   Homeland Protection

• Main program roles:
  Architectures     Ranges and Test Infrastructure
  Signal Processing  Test and Evaluation
  Networks          Technology
  Intelligence      System Prototypes

• Significant emphasis on rapid prototyping and technology transfer
MIT Lincoln Laboratory Small Business Program

SENEDIA Tech Talk

Dave Pronchick

7 November 2017
Overview

• Small Business Program Objectives
• Small Business Office Functions
• Direct Support for Programs (Subcontracting) for MIT LL
• CRADA Opportunities
• Small Business Partnerships
• What MIT LL Buys
• Vendor Visit Program
• Upcoming Initiatives
• Recommendations
MIT LL Small Business Program Objectives

- Promote Maximum Practicable Opportunities for Small Business
- Comply with Contract Requirements
- Meet or Exceed Contract Goals
- Maintain High Quality Small Business Outreach Program
What does the Small Business Office (SBO) Do?

- Hosts weekly Vendor Visits
- Maintains Small Business Vendor Database
- Assists with SAM registration
- Nominates Small Business Vendor for SBA Annual award
- Hosts Annual MIT LL Small Business Award Ceremony
- Participates in Matchmaking Events
- Coordinates Subcontractor/Vendor Export Compliance Confirmation
- Complies with Small Business Subcontracting Plan
  - Reports SB Results to Govt.
Subcontracting Over $522M in FY17

• **FY17 R&D Procurements**
  – $130M and 191 Purchase Orders issued
  – “Competition to maximum extent practicable”
  – Market research: capabilities to meet specific technical need
  – Past performance with Government or FFRDCs a plus

• **Typical R&D Procurement Cycle Times:**
  – Less than $150K: 30 Days or less
  – Greater than $150K: 90 - 120 Days

• $215M subcontracting dollars awarded to small businesses in FY17
Cooperative Research and Development Agreements (CRADA)

- Collaborative vehicle utilized by MIT LL
  - Provide access to MIT LL’s unique technologies, capabilities, expertise, and facilities

- Funded entirely by private sector partner
  - Private sector funding covers MIT LL’s internal operating and outside procurement expenses
  - Funding can be in-kind (i.e., personnel, equipment, supplies, and capital equipment)

- Additional Types of CRADAs
  - Umbrella: multiparty collaborative effort; long term
  - No Cost: where each entity funds its own effort
  - Facilities: untested but available

Questions: Contact Technology & Contracts Office at CRADA@ll.mit.edu
Federally Funded Collaborations

- **Small Business Innovation Research Program (SBIR) & Small Business Technology Transfer Program (STTR)**
  - Three phased approach designed to fund and assist early stage research and development (R&D) performed by small companies
  - LL is available to partner with Small Business on Phase I and Phase II
    - May also partner after an award has been issued to small business
  - Combine strength of both Small Business and LL resources

![Current STTR/SBIR Funding](image1)

![FY17 Proposals Submitted](image2)
What MIT LL Buys

- Engineering/Technical Services
- Software Development & Maintenance
- Fabrication Services
- Operations & Maintenance Services
- Office Support Services
- Laboratory Equipment
- Test Equipment
- Optical Equipment
- IT Hardware & Software
- General Hardware
- Chemicals
- Aircraft Parts
- Innovative Technology

Commercial Suppliers may be invited to join MIT LL’s reverse auction system. For additional information, please contact SBLO@ll.mit.edu.
MIT LL’s Small Business Vendor Visit Program

- Vendor Visits allow a *single* vendor to set up a table in MIT LL’s main cafeteria to showcase their services and capabilities
- Occurs every Thursday from 11am – 2pm
- SBO sends notification emails of upcoming visit to pertinent Groups and Departments identified by the vendor
- Must be a U.S. citizen or permanent legal resident
- Vendor Visits do *not* guarantee personal connections or business/contracts with the Laboratory
MIT LL’s Business Opportunities Portal

- Pilot Program will post RFP’s to MIT LL’s external website
- Initial RFP postings will be >$150k
- Planned launch date is EOY 2017

SBIR/STTR Partnership Matchmaking

- Developing internal process to identify appropriate Groups within Lab for these partnership opportunities
- Please contact SBLO@ll.mit.edu if there is a SBIR/STTR of interest
  - Provide a brief description of the work to be performed by small business and MIT LL
Summary/Final Recommendations

• Contact the SBO for a Small Business Introductory Package at SBLO@ll.mit.edu
  – Schedule a Vendor Visit
  – Join MIT LL’s Small Business Database

• If you are a Commercial Supplier, inquire about MIT LL’s new platform for reverse auctions (hosted by Jaggaer)

• Watch for new MIT LL external web site (spring 2018)