Advanced Tech Engineering
Where Technical Performance & Integrity Matters

DARPA Phase II SBIR
"Highly Integrated Silicon (Si)-based RF Electronics for Emerging MIMO Radar"

Contract: W91CRB-10-C-0078

Small Business Prime Contractor

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Advanced Tech Engineering
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What problem is being addressed?

- Airborne radars have been transitioning from passive array or reflector based architectures to active phased-arrays based architectures to improve radar performance and capabilities
  - To attain today's operational performance requirements, AESA T/R modules are placed immediately behind each radiating element of an array.
- Looking forward, the ability to design revolutionary approaches that address future bandwidth and power requirements is constrained by inherent limitations of III-V semiconductor technology:
  - Implementation requires many discrete components, each requiring its own peripheral circuitry
  - Phase shifting is accomplished with analog RFICs, with phase shifters and attenuators behind each element in order to calibrate gain differences between each TX and RX path.
  - Other trends include the use of higher transmit power, and operation over wider bandwidths. Both increase the complexity of module design, as well as the need for exotic mechanical thermal cooling schemes.
  - Given operational constraints, the ability to implement advanced radar concepts using III-V technology has reached an evolutionary plateau. Fortunately, there are alternatives.
- ATEI is pursuing innovative radar concepts, techniques, architectures, and highly integrated silicon based RF technology to make dramatic improvements to CSW&P, capability and performance over traditional active phased array based radar and related systems

Revolutionary, not just evolutionary, new approaches are required

Highly Integrated Silicon Based RF Electronics

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Operational Need/Requirement, Gov't Program Manager/PoC:

Multiple (See transition targets below)

Brief Description of Technology

Highly integrated Silicon Based RF Electronics - 8HP SiGe (BiCMOS) process has been selected for this project. MIMO radar architecture relies on highly linear RF front-ends and extremely complex DSP algorithms for target detection and separation. Executing complex DSP algorithms at low-power and low form-factor is one of the major advantages of SiGe technology. Additionally, with the f_T and f_{max} of SiGe technology improving every year , it will soon supersede III-V technology in these metrics. Even with existing SiGe technology nodes (130-nm, 90-nm and 65-nm), significant research is underway in developing circuits operating in V- and W-bands for Gbps WPAN (IEEE 802.15.3c), automotive radar and passive imaging applications. These advantages make SiGe one of the most promising candidates for MIMO radar integration.

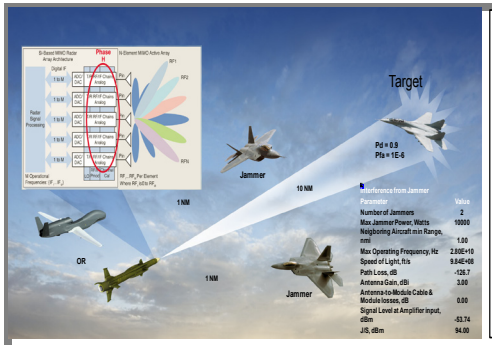
Phase II/II+ Deliverable, TRL, MRL (current status if complete)

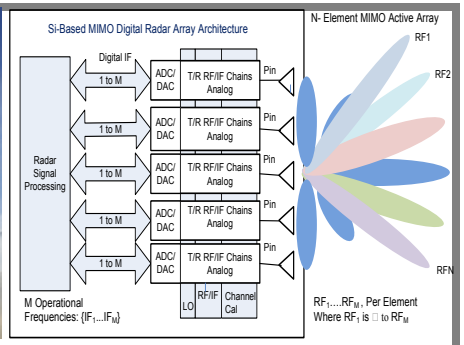
At the end of PII, prototype RFIC chip to validate system performance predicts, RF architecture and circuit level parameters (TRL 3-4)

Transition Targets: (System, Platform or Program)

Advanced RF Seekers: Standard Missile (SM) II, SM VI, SM III block 2/b (LPD/LPI Comms), Tomahawk, Extended Range Sea Sparrow; **Advanced Low Cost RF Seekers:** Small Diameter Bomb; CMTS, JAGM; **Other opportunities:** Navy Analysis Of Alternatives (AOA) for Weapon Family of Solutions – HRR Seeker, UAS RF radar payloads, UAS Sense and avoid radar, LPD/LPI data links, Airborne & Ground Based Radars

Project End Date: 27 June 2012 | ***Transition Ready Date:*** August 2013 (est)





Specify planned transition milestones, timing, cost, & funding source:

See attached

Is Project Aligned With System, Platform or Program Technology Roadmap? ____ Yes ___ No__X__In Process

Project Risk Factors:

Cost – At the end of Phase II, ATEI will develop and fabricate key transmit and receive circuit blocks. External funding is necessary to design and fabricate a complete RFIC front end (RFIC FE) prototype.

Advantages/Benefits over Current or Competing Solutions (e.g. cost, performance, reliability, and new capability):

- Elimination of numerous analog components and interfaces → >10X reduction of Size, Weight, Power and Cost
- Wideband/MIMO radar architecture*
  - Insertion of new radar modes and simultaneous multi-mode (GMTI, SAR, etc.) operation
  - Cognitive radar support → Improved target detection
  - Adaptive digital beam forming & steering -> Improved multi-target separation and angular accuracy
- Simultaneous Transmit and Receive (STAR) Techniques*
  - Techniques reduces or eliminates the current trend and need for higher and higher power RF front GaN MIMC PAs and complex cooling design
  - Exploits target RCS and fast aspect dependent fluxuating targets
  - Inherent LPD/LPI and Jam resistant architecture
  - Dynamic transmit and receive frequency/waveform selection and control

**** Key enabler of Si- based technology for radar applications***

Other: