Radio Frequency Stealth Transmit/Receive Modules (RF STORM)

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Problem

- Battlefield operations require timely access to mission-critical sensor data.
- Operational scenarios require low-power, low-cost, small form-factor RF tagging solutions.
- Examples ...
  - Blue Force Tracking
  - friend-or-foe identification
  - image registration
  - data exfiltration, e.g., unattended ground sensors

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Background

- Existing solutions for RF tagging are not appropriate for applications requiring large numbers of distributed tags.
  - Short-range (few meters), limited number of tags in view, limited data
- These missions require lightweight hardware and large stand-off distances.
- Radar-responsive tags utilize the radar return to send data with low transmit power.
- RF Stealth Transmit/Receive Modules (RF STORM) meet these requirements by applying system-on-a-chip (SoC) technologies to a radar-responsive tag.

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Objective

- Design and develop RF STORM tag technology applicable across various missions by applying state-of-art process technologies and SoC design methods
- Develop SoC design process and explore SoC technology boundaries to increase MITRE microelectronics design capability
- Apply this SoC technology by developing an RF tag to demonstrate FOPEN SAR (foliage penetrating synthetic aperture radar) image registration utility

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Activities

- FOPEN SAR Image Registration Technology Development
  - Develop and demonstrate FOPEN tag waveform using application-specific digital RF memory (DRFM) module in laboratory
  - Develop application-specific requirements for FOPEN radar digital tag
  - Simulate top-level performance of FOPEN-tag system
  - Investigate analog versus digital tag technology tradeoffs applicable to FOPEN SAR
- SoC Technology Development
  - Evaluate RF CMOS test chip for risk reduction and insight into process
  - Develop design requirements for FOPEN ASIC digital tag in 0.18μm CMOS technology

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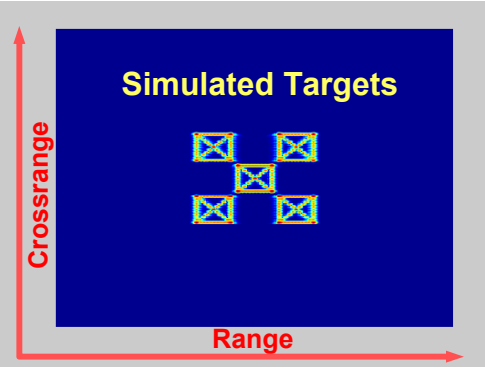
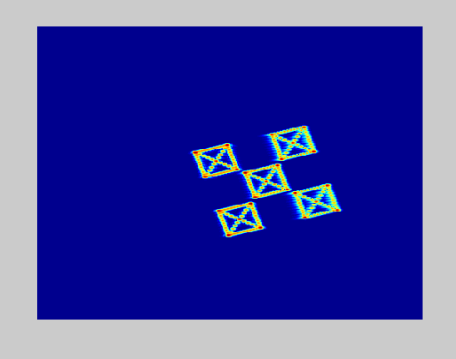
Highlight

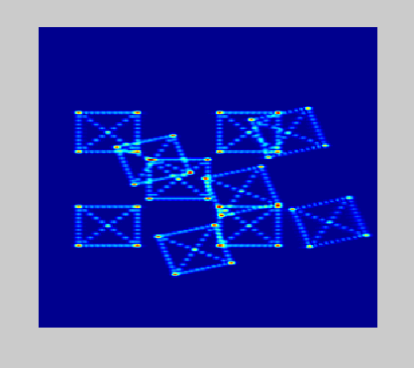
Tags for FOPEN SAR Image Registration



Pass 1 - Scene Broadside



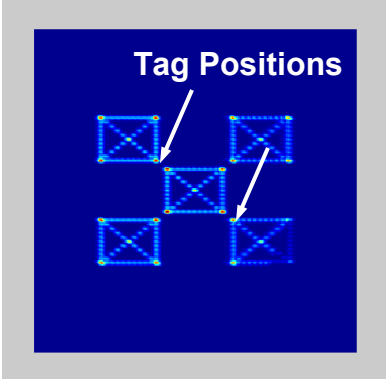
Pass 2 - Scene Rotated and Translated



Uncorrected Overlay of Two Scenes

Scenes from Two Passes Must Be Accurately Registered for Proper Target Detection.

Tag Points Improve Image Alignment.



Alignment Enhanced by Two Tag Points

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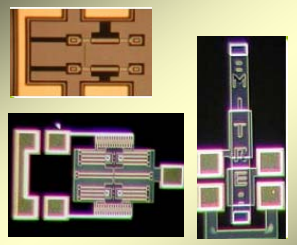
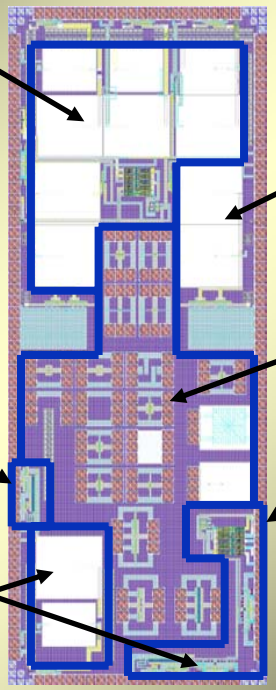
Highlight

- MITRE's vision of system on a chip integrates RF and analog functions with digital signal processing to
  - Increase performance, reduce cost, lower power, reduce size
- Standard CMOS not suitable for high performance analog design
- RF CMOS augments standard CMOS with low-loss passives
- RF/MEMs creates low-loss passives through micromachining structures



Polysilicon MEMs



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Impacts

- Next-generation RF STORM tags promise to greatly improve FOPEN radar change detection through precise image registration.
- Higher integration and greater power efficiency technology lead to smaller battery requirements and longer duration for all tag missions.
- This contributes to industry-wide efforts in the leading-edge development of SoC.
  - Enabling lower-cost, lower-power, mixed-signal ICs for the military

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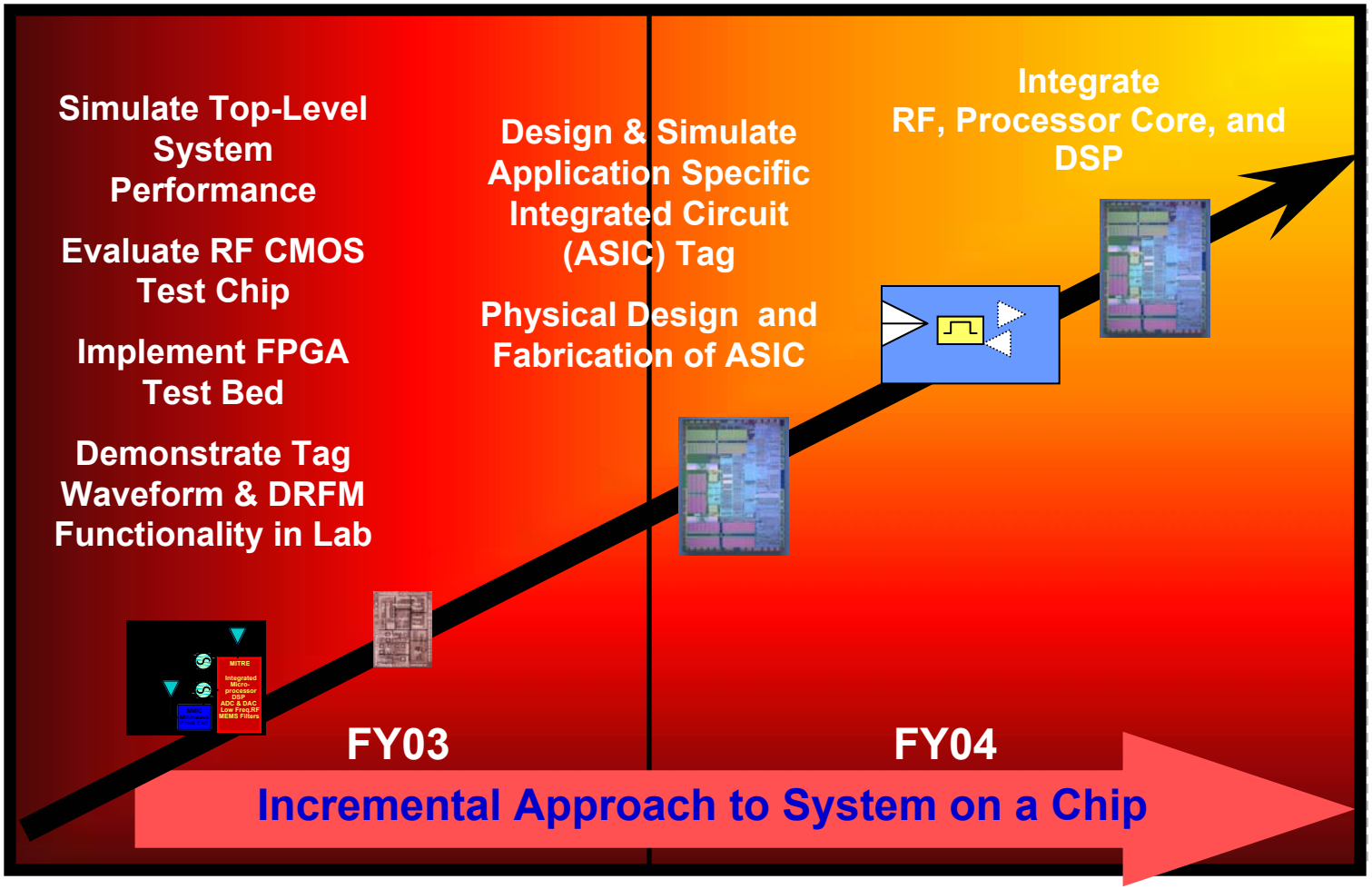
Future Plans



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