Advanced Detection of Electronic Counterfeits (ADEC)
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Nokomis Background

• Nokomis is dedicated to the detection, identification, classification and diagnostics of electronics based on electronic emission signatures
  – Nokomis products exploit EM emissions for our customer’s benefit
  – Providing unique detection and diagnostics capabilities since 2002

• Over $15 Million in R&D Resulted in ADEC Core Sensor
  – Sensitive receiver developed over several years
  – Application specific digital signal processing/automated detection techniques leveraged
  – 17 Phase I SBIRs, 7 Phase II SBIRs, 11 Phase III SBIRs

• Experienced staff/specific skill set for application
  – Multiple years experience in sensitive EM/RF effects analysis
  – Significant institutional experience in electronic device detection, analysis and diagnostics methodologies
Company Overview

- Small business - offices in Charleroi, PA; Toledo, OH; Athens, GA

- Unique capability to support ADEC
  - Three anechoic chambers – largest is 50’ x 18’ x 15’
  - 50,000 square foot facility
  - Secure facility for assessment of counterfeit modalities
  - All employees are U.S. citizens

- Substantial Counterfeit Part Repository (18000 parts in inventory)

- Unique signature assessment capabilities
ADEC Part Screening Configurations

- Detects anomalies in electronic parts
- Detects counterfeits and verifies trusted parts
  - Piece part screening
  - Part screening on fully integrated boards

Screening of Boards After Integration

- Assessment of Fully Integrated Boards
  - Original Part
  - Counterfeit Chip
  - Invalid Part
    - Mean score: 82.5

Piece Part Screening
Current Counterfeit Dilemma and Applicability of ADEC
Uncovering Counterfeits

• The counterfeit problem continues to increase in size, scope and sophistication

• Limitations with standard methods of electronic component screening
  – Low chance of counterfeit ID
  – Too costly
  – Overly specific
    • Poorly labeled chips
    • Pin continuity
    • Temperature testing

Large percentage of counterfeit components not identified until problems occur during use!

Counterfeit Problem

- Counterfeit part incident reports from January through the end of August 2012 averaged 107.3 per month, up slightly from 107.1 in 2011
  - 1,336 separate verified counterfeit part incidents
  - Transactions involved more than 834,079 parts
  - Sources include GIDEP and ERAI

- Integrated Circuit (IC) counterfeiting especially critical Field Programmable Gate Array (FPGA), Memory and Microprocessor counterfeiting continue to increase

- Government screening methods still incapable of ensuring integrity of system subcomponents
  - Counterfeits highly likely to be responsible for critical system functions in military systems now!
US Defense Electronic Parts
Supply Chain

Original Component Manufacturers (OCMs)

Part screening points
Counterfeit
Insertion Points

Authorized Distributors

Independent Distributors & Brokers

Circuit Board Assemblers

Defense Prime Contractors & Subcontractors

Parts, Subsystems, & Systems

Department of Defense Depots & Installations


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Industry Standard Testing Methods

- Sophisticated counterfeits can evade detection methods
  - High-quality labeling
  - Functional component
    - Up-marked
    - Recycled

- Limited testing risky
  - Counterfeits easily overlooked
  - Single questionable component
  - Can compromise entire system

- More extensive testing required
  - Expensive
  - Time-intensive

Source: NASA briefing; Workshop and Exhibition on COUNTERFEIT ELECTRONIC PARTS; October 1, 2009
All electronics give off unintentional radiated emissions

- All electronics radiate electromagnetic energy that is characteristic of their function, design, and construction
- Integrated circuits can be characterized by emission signatures, and changes to those signatures indicate counterfeit devices
- Electromagnetically reactive markers whose signatures (fingerprint) change predictably can be leveraged to provide authentication, and provide dynamic levels of security
ADEC Piece Part Screening

- ADEC System repurposes mature device detection technology for counterfeit detection
  - Phenomenology heavily researched
  - Capability proven through extensive testing
    - Government-sponsored
    - Substantial IR&D
  - Leveraged to detect counterfeit electronics
- Counterfeit detection modality is non-contact and non-invasive
  - Radio frequency measurements
    - Multiple channels/high throughput
    - Emissive content analyzed
    - Embedded processing assets
    - Algorithms assess component signature
- Unintended emissions are produced by all electronic components
  - Autonomous analysis and categorization
  - Authentic or suspected counterfeit determined

ADEC Detects Counterfeits Prior to Integration into Weapon Systems
ADEC: Sensitivity and Discrimination

- Sensor technology state-of-the art for extracting extremely weak phenomena
- Ultra-sensitive Hiawatha receiver forms core of ADEC system
  - Product of more than $15M in targeted government investment
  - Unique design features
    - Extremely sensitive front-end
    - Multi-channel
    - High throughput
    - Substantial back-end processing
      - Achieves significant processing gain
- Developed specifically for unintended emissions assessment of electronics
Where Does ADEC Fit In?

- ADEC offers improved performance at lower cost compared to existing methods

<table>
<thead>
<tr>
<th>Counterfeit Types</th>
<th>No die</th>
<th>Wrong-die</th>
<th>Board pull</th>
<th>Failed real part</th>
<th>Speed up-marking</th>
<th>Spec up-marking</th>
<th>Temp up-range</th>
<th>Lesser part / knock-off</th>
<th>high-end counterfeit</th>
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<tbody>
<tr>
<td></td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
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<td>Possible</td>
<td>Possible</td>
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<tr>
<td></td>
<td>Yes</td>
<td>Likely</td>
<td>Yes</td>
<td>Likely</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Modified from “Basic Detection Methods for Counterfeit Components,” Integra, March 2010*
Comparative Costs

• **Visual Inspection**
  - Visual and acetone tests: $0.05 / piece
  - X-ray or de-capsulation: $125 / piece

• **Minimal Functionality Tests**
  - Simple devices: $1K – $2K NRE + $1 / piece
  - Complex devices: $3K – $5K NRE + $2 / piece

• **Full Functionality Tests**
  - Simple devices: $2K – $5K NRE + $5 / piece
  - Complex devices: $5K – $20K NRE + $7.5 / piece
    (assumes software exists for component)
  - Burn-in: $2K – $5K NRE + $2/piece

• **ADEC System**: $.5K - $1K NRE + $0.25 / piece

*Cost data of existing methods taken from “Basic Detection Methods for Counterfeit Components,” Integra, March 2010*
ADEC User Interface: Logging In

- Standard user login upon system startup
  - Username
  - Password
- Optional: additional verification from fingerprint reader
  - Strengthens identity proofing
- User classifications
  - Admin: Full access to basic and advances features
  - Operator: Access to all basic features; limited access to advanced features
ADEC User Interface: Basic User Screen

- **Active part to screen**
- **Editable Serial No.**
- **Button to select part to screen**
- **Status bar**
- **Push button to start scan**
- **Primary status display**
- **System connection status**

The ADEC User Interface includes:

- **Active Part**
  - Manufacturer: Altera
  - Part No.: EPM7160ELC84-12
  - Part Type: Programmable Logic
  - Serial No.: 0001
  - Use Serial Number
  - Auto-Increment
- **Scan Results**
- **Detection History**
- **Initiate Scan**
- **System on Standby**
- **Menu**
- **About**

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Supporting Americas Advanced Technology

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The ADEC User Interface: The User’s Experience

- System startup
- Select part
- Initiate scan
- Scan performed
- Result displayed
- Detection history appended
- Load next part
ADEC User Interface: Part Selection

- Select from parts within ADEC signature database
  - Filter by manufacturer
  - Filter by part type
    - Microcontroller
    - Microprocessor
    - Programmable Logic
    - Memory
    - Other
  - Manual search field
- Database easily updated as new parts are identified and characterized
ADEC User Interface: Advanced Features

- Advanced mode for maintenance engineers and R&D (admin level users)
- Spectral display for each channel
- Manual tuning
- Review, append, and export logs
- Record received data for additional analysis
Recent Work Emphasis

• Nokomis maintains continually growing inventory of counterfeit components
  – Emission collection and analysis
  – Part information is recorded and stored
    • Source and date received
    • Reason for being suspect
    • Any source or traceability information available

• Parts database contains substantial counterfeits
  – Over 90 different part types with 18,000+ total counterfeit parts and counting
  – Parts received from 6 distributors

• Emphasis on programmable logic, microcontrollers, microprocessors, and memory
### Parts Database/Inventory

#### Programmable Logic
- **Manufacturer:** Xilinx, Altera, Lattice Semiconductor, Actel, OKI, National Semiconductor, Sharp, SGS-Thompson, 4 Star, Inland Empire, PCX, IDT, Maxim, Xilinx, Sensible Micro, and others.
- **Part Types:** CPLD, PLD, CMOS, CMOS Logic, DSP Logic, EPROM, Flash Memory, EPROM, and others.
- **Part Numbers:** Various part numbers are listed for each manufacturer.

#### Microcontrollers
- **Manufacturer:** Philips, National Semiconductor, Motorola, TI, Texas Instruments, SGS-Thompson, PCX, Maxim, Xilinx, Sensible Micro, and others.
- **Part Types:** Microcontroller, Microprocessor, and others.
- **Part Numbers:** Various part numbers are listed for each manufacturer.

#### Memories
- **Manufacturer:** Texas Instruments, Micron, AMD, Atmel, INTEL, Nuvoton, Hynix, and others.
- **Part Types:** SRAM, DRAM, CMOS, SRAM, and others.
- **Part Numbers:** Various part numbers are listed for each manufacturer.

#### Others
- **Manufacturer:** Others - OF INTEREST
- **Part Types:** Various part types are listed as Others - OF INTEREST.
- **Part Numbers:** Various part numbers are listed as Others - OF INTEREST.

**Note:** The table includes information on parts, manufacturers, part numbers, part types, quantities, and notes related to the parts. The table is comprehensive and covers a wide range of electronic components.
Recent Pilot Testing

• 7 parts provided by a Fortune 500 company
  – Contained sprinkled sampling of both counterfeits and authentic parts for an aviation specific program

• Nokomis procured 40 certified authentic parts from the OCM separately to provide baseline

• 2 Groups conducted separate testing on the parts
  – Group 1: Determine if exploitable content present
  – Group 2: Characterize performance of automated system

• Groups prevented from sharing data until conclusion of tests
Recent Pilot Results

- All blind studies accurately identified the same 2 parts as authentic and the same 5 parts as counterfeit
  - Each part scanned for 3 seconds
  - 100% true positive rate
  - 0% false alarm rate
  - 100% specificity

<table>
<thead>
<tr>
<th>Part</th>
<th>Individual Algorithm Scores</th>
<th>Combined Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>10  13.33  22.84</td>
<td>15.32</td>
</tr>
<tr>
<td>K</td>
<td>85  93.33  100</td>
<td>93.64</td>
</tr>
<tr>
<td>L</td>
<td>10  20   15.76</td>
<td>16.65</td>
</tr>
<tr>
<td>M</td>
<td>10  0    0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>N</td>
<td>10  26.67  19.52</td>
<td>17.72</td>
</tr>
<tr>
<td>O</td>
<td>95  86.67  100</td>
<td>92.17</td>
</tr>
<tr>
<td>P</td>
<td>10  13.33  18.38</td>
<td>14.04</td>
</tr>
</tbody>
</table>
Next Steps

- The ADEC system will be available for purchase at the end of August 2013
  - Contact Nokomis if you have counterfeit detection needs

- Nokomis intends to perform multiple additional pilot tests to continue to validate system performance and reliability
  - Industry and government partners are necessary for this testing
  - Contact Nokomis if your entity is interested in partnering on a pilot test
Summary

• ADEC technology effectiveness verified
  – Demonstrated against multiple counterfeits
  – Cost-effective technology for identifying high-quality IC counterfeits
• Highly autonomous system
  – Simple user interface
  – All functionality autonomous after user selections made
• Multiple algorithm combination greatly improves component screening results
  – High confidence fingerprinting of components/low false positives
• Statistical results favorable and improvements continuously being implemented
• Undertaking additional Pilot activities across several programs to further improve results and develop a wider statistical range of parts and applications