



Phase II SBIR : Contract Number W0113M-08-C-0155
Ballistic Missile Defense Anti-Tamper Volume Protection
SBIR Phase II Enhancement : SENTINEL Transition Task
SBIR Phase III : SENTINEL Testing Enhancement

Introduction To
Sensed ENERGY Transient INTERrogation ELEMENT
(SENTINEL)

for effective volume protection



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SENTINEL Project Executive Summary



“SENTINEL is a hardware anti-tamper technology that determines and reports the trust-worthiness of the operating environment for a protected (powered) electronic volume.”

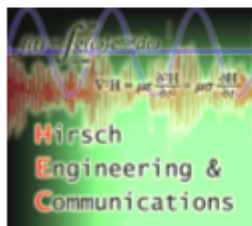
- SBIR-funded testing proved discrimination of true from unintended or hostile environments
- Low cost and simple: Prototype has only 51 components (13 active components), software executes in programmable logic, commercial parts cost (based on prototypes) ~ \$65.00.
- Robust: Very high design stability and operating reliability
- It works! Very low false alarm rate
- Easily integrated into designs, or added to existing circuits or systems to be protected.
- User-transparent - no special operator actions required, once installed.

Today's Agenda



1. Team Introduction
2. SENTINEL Overview
3. Integration Project Approach
4. Opportunities for Safe and Secure Systems
5. Summary/Q&A

SENTINEL Team



SENTINEL Overview



Overall Problem Addressed by SENTINEL

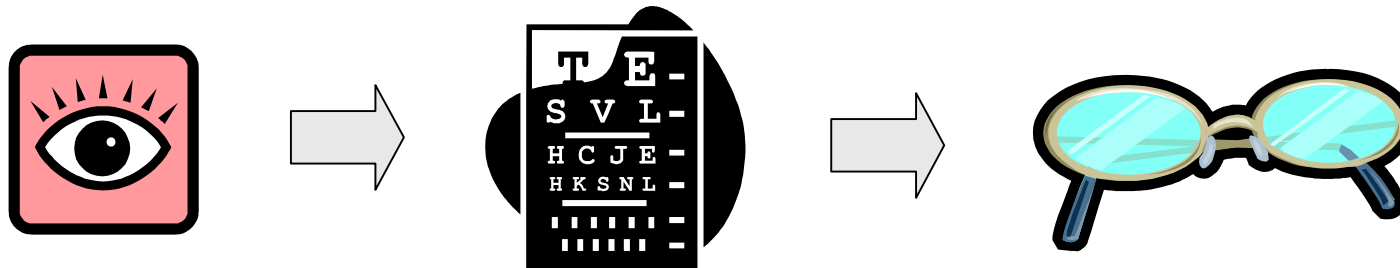
- An electronic "volume":
 - May be a subsystem, module, circuit board, MCM, or any electronic entity
 - Can **fall into an adversary's hands** a variety of ways (loss, abandonment, theft, etc.)
 - **Must be protected** from the adversary operating, analyzing or exploiting the volume's hardware and software (or firmware) functionality
 - **Must be allowed to operate with "normal" variations** such as temperature changes, aging, multiple operational modes
- Significant problem for behavioral or functional data/signal pattern tamper detection techniques, due to:
 - Adaptive processing, functional complexity - **many "normal" patterns** to learn
 - Many modes with data/signal pattern variations - require **constant updating**
 - Pattern monitoring processing - **consumes operating time and bandwidth**
 - *Reverse engineer could intercept signals, analyze them, and break the code.*

For SENTINEL we sought a more simple, effective, inexpensive solution.

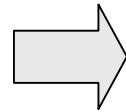
We succeeded, using power-up signature verification.

SENTINEL Overview

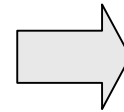
The Technology In Its Simplest Form



**Trigger:
Power-up**



**Monitor:
Signature**

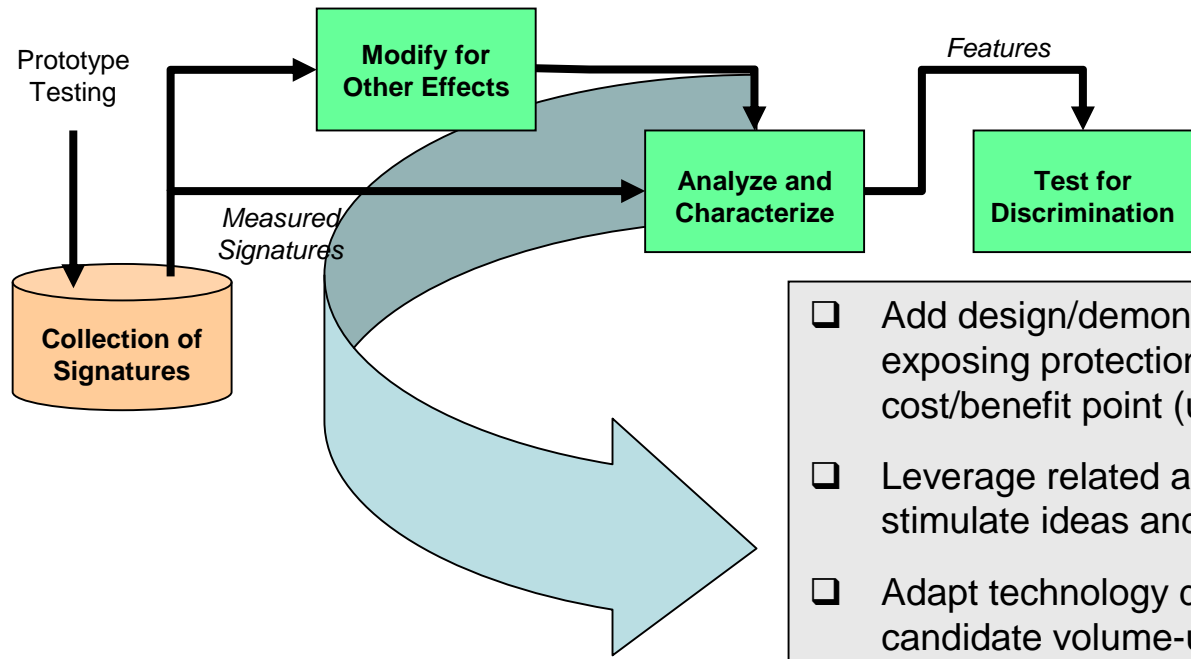


**Response:
Trust "bit"**

SENTINEL As-Is and Ready for Transition

- Must be able to connect to a watch-able point
- Must have a signal-based goodness reference
- Does not pre-define response

SENTINEL Overview



- ✓ **Accelerating Technology Maturity**
- ✓ **Reducing Technology Insertion Risk**
- ✓ **Educating Stake-holders/First Adopters**
- ✓ **Creating Integration/Production Pathways**

- Add design/demonstrate spiral specific to exposing protection value at a definable cost and cost/benefit point (use-case driven)
- Leverage related activities and demonstrations to stimulate ideas and opportunities
- Adapt technology demonstrations specific to candidate volume-under-protection and operating conditions
- Spin-off intermediate product proto-type for development testing and manufacturing plans
- Establish and leverage organizational partnerships for financing, manufacturing, delivery, and on-going support.

Integration Project Approach

Identify and Characterize End-Configuration

Form Factor (see notes)	Stand-alone PCB	Integrated at PCB	Integrated at Chip	Organic
In-Line Integration				
In-Circuit Integration				
External Device				

Where do you fit?

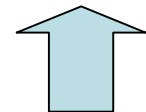
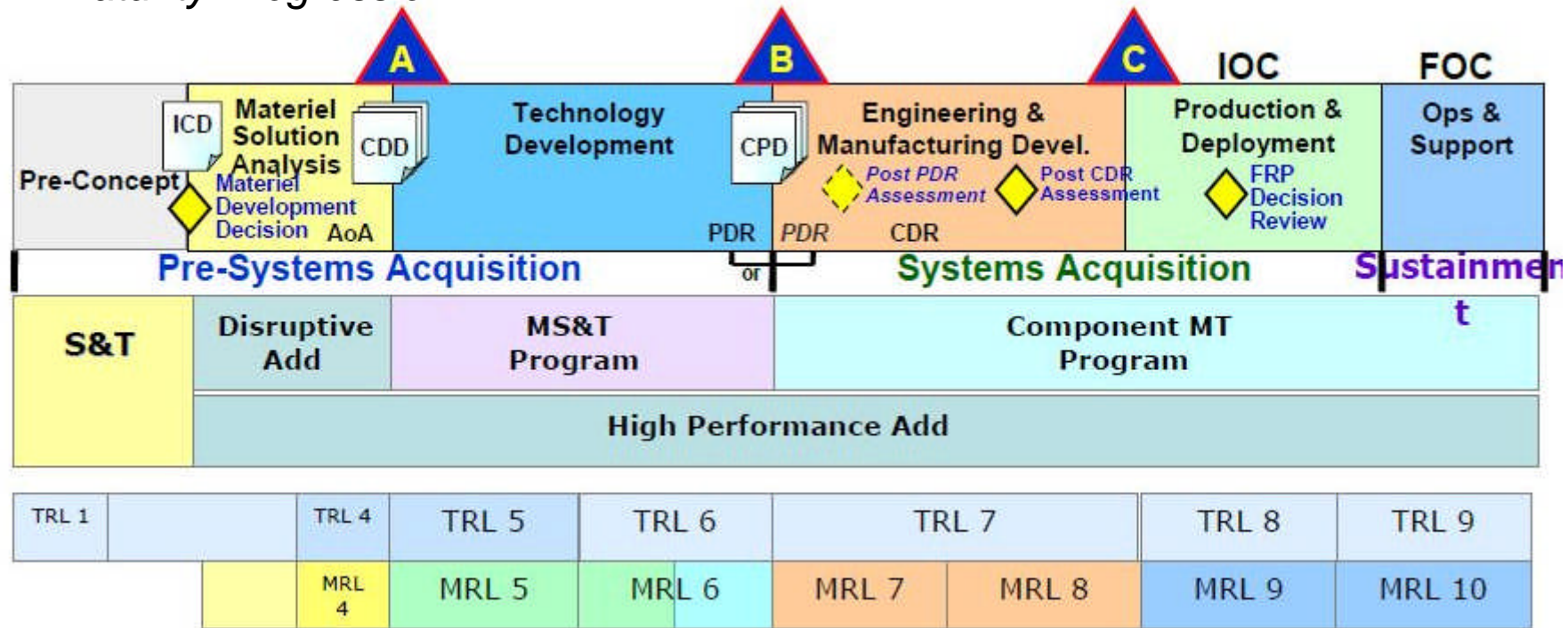
In-Line Integration means SENTINEL is operating within the volume-under-protection but as a discernable device/element.

In-Circuit Integration means SENTINEL is operating within the volume-under-protection but with no discernable separation.

External Device is means SENTINEL is operating as a plug-in outside the volume-under-protection.

Integration Project Approach

Maturity Progression



- Expect to achieve TRL7 by completion of current tasks (Phase 2e and 3)
- Expect to achieve MRL6 to MRL8 by completion of current tasks

Once achieved, meets System Prime requirements for system insertion investigations



Integration Project Approach

Modeling funded SBIR Phase III Testing/Transition Tasks

Task Title	Responsible	Summary
1 – Use Case Definition <i>(New Market Objective 1)</i>	HEC/ Collaborator	Define the operating and signal environment that specifies the need that a SENTINEL-derived product would serve, in the context of the New Market.
2 – Design Experiments <i>(Technology Objective 1)</i>	HEC	Plan experiments to elicit and demonstrate SENTINEL's ability to function in the New Market setting.
3 – Run/Assess Tests <i>(Technology Objective 2)</i>	HEC	Run and assess the experiments. Recommend updates to hardware, software, firmware for CT-Phase II.
4 – Transition Roadmap <i>(New Market Objective 2)</i>	HEC/ Collaborator	New Market scope and assessment, competitive baseline, pathways; market-driven product form factor alternatives; capital alternatives; Ohio Technology Investment Tax Credit Program recommendation
5 – Results Assessment <i>(Technology Objective 2)</i>	HEC	Update self-assessed TRL, MRL; Baseline Market Entry Readiness metrics
6 – Reporting <i>(Support Objectives 1-3)</i>	HEC	Final Report (built incrementally throughout project)

(example from recent successful proposal; typical of future projects)



What We Believe...

- **Tamper resistance is an important core technology and concept in Safe and Secure Systems**
- **Even more important for keeping certified**
- **SENTINEL can help**

What We Are Wondering...

- **Is there really a fit?**
- **As-is or with modification or both (e.g., continuous trigger/monitor, salting)**
- **To what extent are we affected by Air Worthiness Certification?**
- **To what extent can we help Air Worthiness Certification?**
- **What else don't we know?**