

# MICROELECTRONICS TRUST AND ASSURANCE

*Silicon to systems-level analysis for mission-critical platforms*

**BATTELLE**

# Vertically Integrated Microelectronic Security Solutions: From Silicon to Systems

Rising reliance on semiconductors and other hardware components developed and sourced from the commercial sector has introduced new challenges for organizations responsible for national defense and homeland security.

How can you ensure that faulty or malicious microelectronic devices and systems do not find their way into hardware that controls our defense weapon systems, infrastructure and other mission-critical systems?

Systems integrators require state-of-the-art and novel solutions for microelectronics trust and assurance. Battelle offers a systems engineering approach to the problem by creating and delivering practical, scalable solutions that produce accurate and reliable results. We help our clients:

- Conceptualize, develop and mature new verification and assurance instrumentation and characterization techniques for microelectronics and electronic subsystems
- Leverage automation tools to reduce both time and costs associated with verification and assurance
- Apply vertically integrated solutions to ensure the security and reliability of the system, subsystems and individual components

## A Scalable, Science-Based Approach to a Complex Security Challenge

All modern defense and infrastructure systems are reliant on microelectronic devices and embedded systems for their operation and competitive advantage. If these components are faulty or compromised in the supply chain, either intentionally or accidentally, the risk of mission failure is dramatically increased.

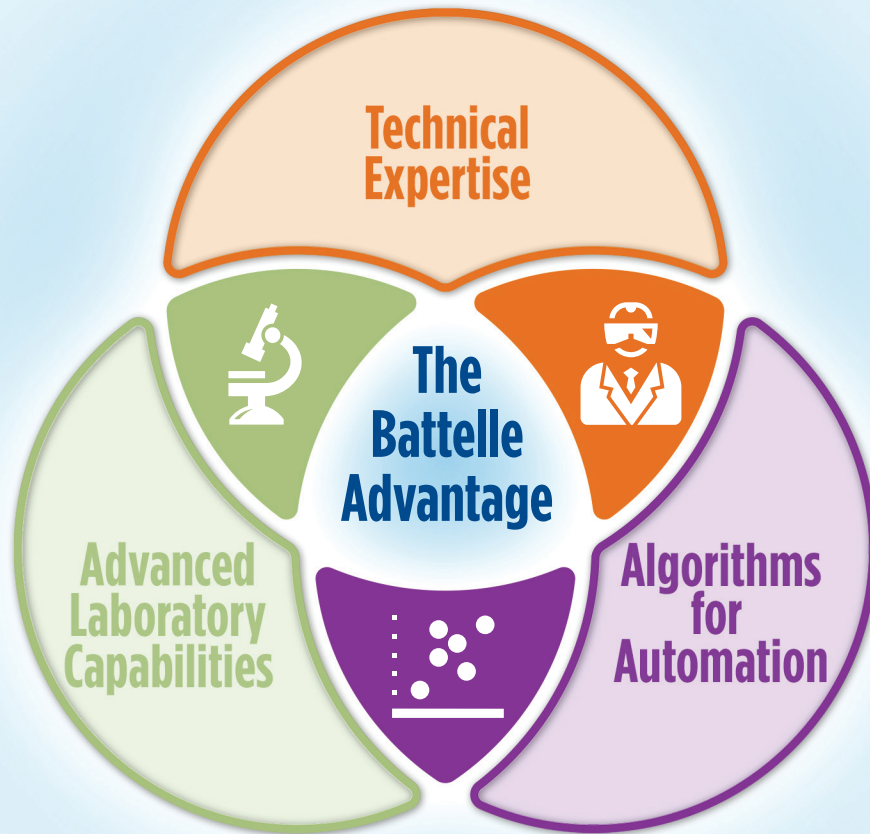
As electronic systems have become more complex and expensive, it is no longer practical to rely only on components manufactured by government accredited facilities. However, introducing commercially sourced chips and embedded systems creates tremendous challenges and risks for systems integrators.

- A complex, multi source supply chain makes it difficult to maintain a trusted chain-of-custody.
- The complexity of modern integrated circuits and electronic systems exceeds the ability of humans to inspect all of their elements and identify flaws or intentional alterations.

Battelle applies vertically integrated, multidisciplinary research methodologies to close the gap between the increasing complexity of electronic components and the ability to verify and assure system functionality. We are creating new methods to bring together advanced instrumentation, novel algorithms and artificial intelligence (AI), informed by decades of experience developing complex embedded systems security solutions for national security customers.

## A Trusted Partner in Microelectronics Assurance and Verification

Battelle has worked closely with the U.S. Department of Defense and other government agencies and organizations to address cyber challenges for more than 20 years. We provide objective, science-based solutions for hardware and microelectronics verification that leverage state-of-the-art instruments, algorithms and methods, along with the deep expertise of our Microelectronics Assurance Team.



### Technical Expertise

Our Microelectronics Assurance Team includes Ph.D.-level mathematicians, systems engineers, cybersecurity experts, materials scientists and computer scientists who bring a unique blend of expertise to the challenges of electronics verification and assurance. This domain expertise spans photonics, electron and ion beam microscopy, firmware and embedded system vulnerability research, reverse engineering, cryptography, semiconductor fabrication processes, failure analysis and computational physics.

### Advanced Laboratory Capabilities

Battelle's microelectronic security laboratory houses specialized tools and equipment for both destructive and nondestructive device and subsystem characterization, including Barricade™ second order effect characterization, scanning optical (SOM) and electron (SEM) microscopy, focused ion beam (FIB) imaging, preparation and circuit editing, probe station with laser circuit edit, wire-bonding and physical and chemical de-packaging equipment. Additionally, we have developed application-tailored large area, multispectral automated optical inspection (AOI) capabilities for circuit card and electronic subsystem characterization and assurance.

### Algorithms for Automation

We are actively developing unique algorithms and AI programs to automate and scale trust and assurance processes with applications to verification and assurance of electronic systems. Our learning and process automation algorithms go beyond human limitations to address the problem of growing complexity in the electronics market.

## Silicon to Systems-Level Physical and Functional Verification

Battelle is researching solutions that address risks at every level in the system including microelectronic chips, printed circuit boards, embedded firmware and the integrated system. This vertically integrated approach enables us to qualify and define risk at each level of the design and quantify risk impact to the overall system based on mission capability requirements. In partnership with our clients, our team has developed a microelectronic assurance program that meets and exceeds mission gaps, needs and requirements for testing of an individual component and/or a systems-level diagnostic of physical and functional verification.

Physical Verification	Functional Verification
<p><i>Is the component or system built correctly for its intended function? Has it been altered or compromised?</i></p> <ul style="list-style-type: none"><li>• Destructive analysis</li><li>• Design verification</li><li>• High-resolution optical and scanning electron microscope (SEM) imaging</li><li>• Advanced semiconductor failure analysis technique development, including applied scanning optical microscopy (SOM)</li></ul>	<p><i>Does the component or system function as intended?</i></p> <ul style="list-style-type: none"><li>• Nondestructive detection of counterfeit microelectronics using device side channels</li><li>• Novel active and passive nondestructive technique development</li><li>• Applied mathematics for complexity tolerance trust and assurance</li></ul>

Every day, the people of Battelle apply science and technology to solving what matters most. At major technology centers and national laboratories around the world, Battelle conducts research and development, designs and manufactures products, and delivers critical services for government and commercial customers. Headquartered in Columbus, Ohio since its founding in 1929, Battelle serves the national security, health and life sciences, and energy and environmental industries. For more information, visit [www.battelle.org](http://www.battelle.org).

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ID 673 03/22

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It can be done