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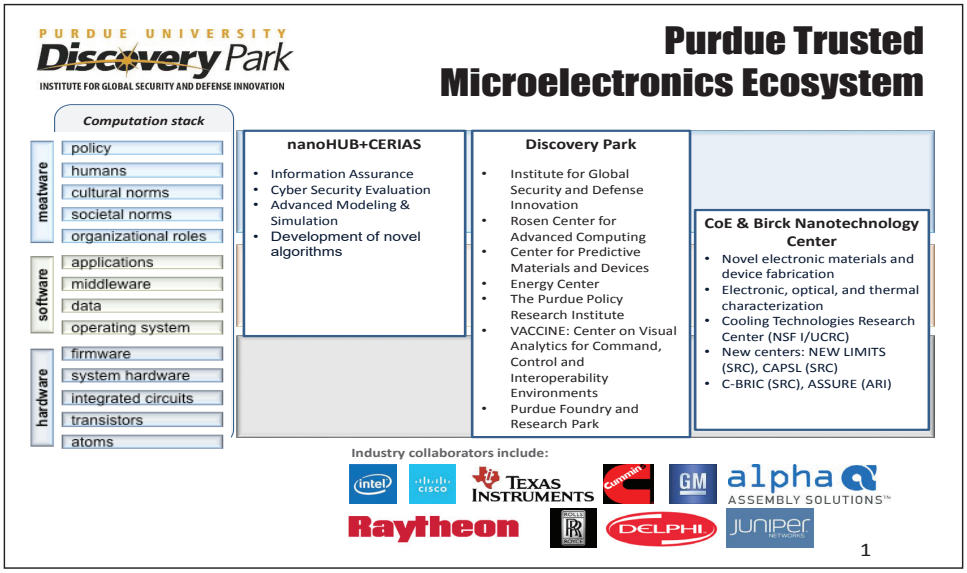
Trusted Microelectronics

A Critical National Need

Growing threats in microelectronics come from multiple directions and multiple sources along the supply chain, and for multiple reasons:

- **Quality escape**–products failing to meet specifications or required performance
- **Reliability failure**–failure during use or from environmental factors
- **Fraudulent products**–counterfeit or other than genuine devices from relabeling, cloning, out-of-spec, etc.
- **Malicious insertion**–by hard or soft coding or defects to enable physical attack or to cause mission failure
- **Anti-tamper**–unauthorized extraction of sensitive intellectual property
- **Emerging threats** combining two or more categories



ASSURE Program

Purdue University's Peter Bermel, associate professor of electrical and computer engineering

(Purdue University photo)

Purdue University, Indiana University, Notre Dame and the Indiana Innovation Institute (IN3) will collaborate on a two-year program to make sure that security and reliability of trusted microelectronics are baked in, and not an afterthought.

To help launch this next-level generation of trusted microelectronics, the Indiana Innovation Institute (IN3) has awarded Purdue a $2.3 million contract to help develop the ASSURE program (Achieving Scientifically Secured User Reassurance in Electronics).

The ASSURE program is being led by Peter Bermel, associate professor of electrical and computer engineering at Purdue.

The ASSURE teams will examine known hardware capability gaps in integrated circuits, memory and interconnects; design; materials, fabrication and indicators of imminent failure.

The specific goals of ASSURE are:

- Address vulnerabilities in military electronics.
- Create a national research center of excellence in trusted and reliable military electronics.
- Establish partnerships that will drive research, workforce training, and economic development in Indiana.

Key Faculty

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Example projects advancing the state of the art:

- **Creating secure circuits to prevent IP piracy using novel materials.** Purdue investigators Joerg Appenzeller, Purdue's Barry M. and Patricia L. Epstein Professor of Electrical and Computer Engineering, scientific director of nanoelectronics, Birck Nanotechnology Center; Zhihong Chen, professor of electrical and computer engineering; University of Notre Dame investigator X. Sharon Hu, professor of computer science and engineering.
- **Quantifiying risk and developing microbump reliability in logic and memory components.** Purdue investigators Carol Handwerker, Purdue's Reinhardt Schuhmann Jr. Professor of Materials Engineering; Ganesh Subbarayan, professor of mechanical engineering; and John Blendell, professor of materials engineering.
- **Using advanced imaging to detect potential failures and counterfeit devices.** Purdue investigators: Bermel; Ali Shakouri, Purdue's Mary Jo and Robert L. Kirk Director of Birck Nanotechnology Center, professor of electrical and computer engineering; and Peide "Peter" Ye, Purdue's Richard J. and Mary Jo Schwartz Professor of Electrical and Computer Engineering.
- **Using models of extreme conditions for devices, and simulations of design improvements.** Purdue investigators Alejandro Strachan, professor of materials engineering; and Gerhard Klimeck, professor of electrical and computer engineering, director of the Network for Computational Nanotechnology, and the Reilly Director of the Center for Predictive Materials and Devices.
- **Developing non-destructive tools to measure aging.** Purdue investigators: Bermel and Ashraful Alam, Purdue's Jai N. Gupta Professor of Electrical and Computer Engineering.
- **Instruct students on how to design "system-on-a-chip" devices.** Purdue investigator: Mark C. Johnson, director of Instructional Laboratories, School of Electrical and Computer Engineering.
- **Predicting and mitigating failures in environments with radiation, such as outer space.**
- **Developing probabilistic computing capabilities to offer many similar capabilities as quantum computing, but using much more conventional, existing hardware.**
- **Using chemical-based sensing to detect unique signatures of particular foundries in fabricating integrated circuits.**
- **Adding software-based detecting of malicious code obfuscation.**
- **Collaboration to add further software-based resilience and secure compilers.**

Key Purdue Research Thrusts:

- **Fraud detection:** characterizing the age of electronics via rapid, self-referenced measurements (Alam, Appenzeller, Bermel)
- **Protection from malicious attack:** TMD FETs for secure circuits through polymorphic logic gates (Appenzeller, Chen, Hu, Niemier)
- **Lifetime prediction:** Multiscale end-to-end reliability modeling of electronic and MEMS devices (Strachan, Klimeck)
- **Reliability failure:** High-resolution thermal characterization for early fault detection in power electronics (Shakouri, Ye, Bermel)
- **Radiation-endurance modeling of floating gate and charge-trapping non-volatile memory** (Alam)
- **Microbump Reliability of 3D Packages:** Accelerated testing and lifetime (Handwerker, Blendell)
- **Techniques for software vulnerability detection** (Delp)

The Indiana Innovation Institute (IN3), formerly the Applied Research Institute, was established in 2015 with the support of a $16.2 million grant from Lilly Endowment Inc.