TWC: Medium: Language-Hardware Co-Design for Practical and Verifiable Information Flow Control

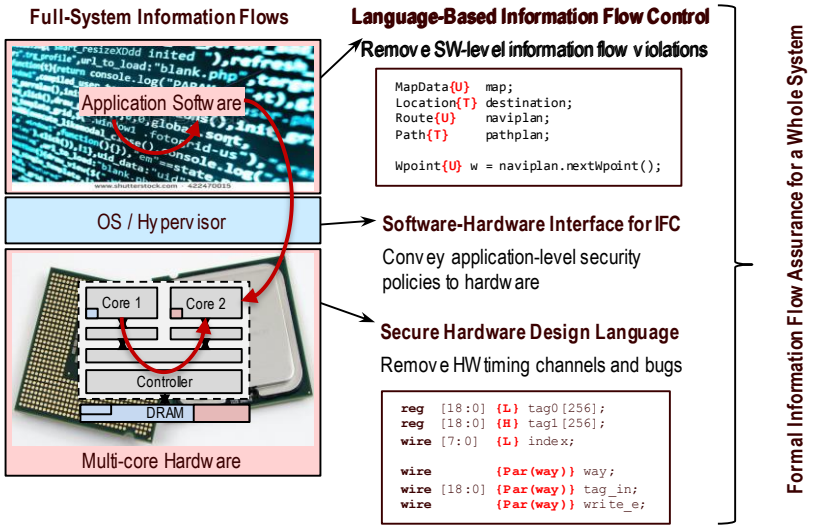
Principal Investigators: **G. Edward Suh and Andrew C. Myers**, Cornell University

Challenge

- **Problem**: Emerging applications and platforms require strong security assurance that is not possible today
  - No information leak among VMs in cloud computing
  - Integrity guarantee for safety-critical autonomous systems
- **Objective:** Co-design software and hardware with strong, comprehensive, verifiable information flow assurance
  - All software-visible information flows in a HW+SW system

Solution and Technical Highlights

- Integrated approach to offer **whole-system security** where all software-visible information flows are **verified statically**.
- Control information flow 1) within software and 2) hardware, and 3) between software and hardware
  - **Software**: Use language-level information flow control (IFC) to verify explicit and implicit flows, mitigate software timing channels, and identify needs for hardware-level control.
  - **Hardware**: Design a multi-core processor with strong information flow assurance, including timing channels
  - **Interface**: Develop a SW-HW interface with label virtualization to convey rich software-level security policies to hardware
- **Formal security assurance** with static information flow analysis
- Major technical developments in HW design and verification
  - **Efficient HW timing channel protection**: uni-directional protection for caches (DAC'16) and memory (HPCA'16), quantifiable information flow control for memory (HPCA'17)
  - **Security verification** of a simple ARM TrustZone prototype using static information flow analysis (ASPLOS'17)



Scientific Impact

- Create a **new capability** to design computing systems with end-to-end security assurance across a whole system, including the software–hardware boundary.
- **New directions** in interdisciplinary research to co-design software, hardware, and formal verification methods for holistic system security

Broader Impact

- **Impact on society:** Significantly improve security and assurance of critical computing platforms
- **Education and outreach:** new course modules for programming languages and architecture, student training, high-school and K-12 outreach, and industry collaboration.