Transient Faults

*Transient faults* are temporary hardware anomalies that alter values and corrupt computations. Major hardware vendors have admitted transient faults have caused costly failures in high performance systems at America Online, EBay, Los Alamos Labs and elsewhere in recent years.

How Transient Faults Happen

- High-energy particles pass through devices and collide with silicon atoms
- Collisions generate electric charges that can cause transient faults

### Transient Fault Rate Trends

Fault rates increase when feature size decreases, voltages decrease, feature density increases and clock rate increases.

**Trustworthy Software**

Mechanisms to detect and recover from transient faults may be implemented in both hardware and software. *Software solutions* have little to no additional hardware costs, may be customized for particular applications or environments, and may be deployed immediately when problems arise in the field. Many software solutions have been proposed, but do they actually work?

**Agenda**

**Answer basic scientific questions** about software-controlled fault tolerance:

- Do software FT techniques actually work?
- For what fault models? How do we specify them?
- How can we prove it?

**Build compilers** that produce trustworthy software for execution on faulty hardware

- Perform reliability transformations & optimizations
- Generate machine-checked proofs that compiled code is really fault tolerant
- No need for fault-injection testing ==&gt; formal proofs provide perfect fault-coverage relative to a well-specified fault model

**Impact**

L. Mackey, winner CRA outstanding ugrad award.

**Students & Collaborators**

J. Ligatti, L. Mackey, F. Perry, G. Reis

---

Project Zap
David Walker (PI), A. Appel, D. August, D. Clark, M. Martonosi (Co-PIs)

NSF Cyber Trust PI Meeting
January 28-30, 2007
Atlanta, Georgia

Princeton University