

Project Zap



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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

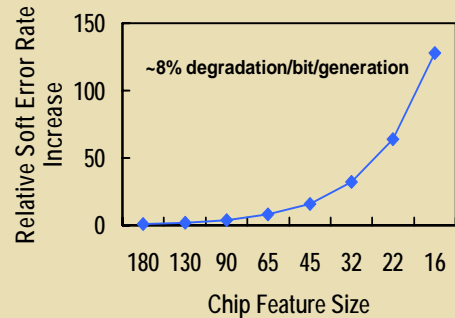
"Solar Particles" Affect Satellites; Cause < 5% of Terrestrial problems

"Galactic Particles" Are high-energy particles that penetrate to Earth's surface, through buildings and walls

Alpha particles from heavy metals

-- 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

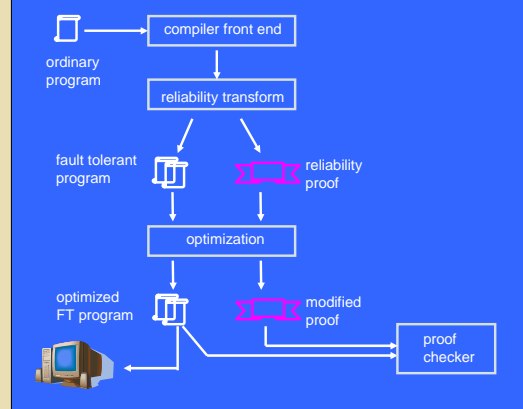
Answer basic scientific questions about software-controlled fault tolerance:

- 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 ==> formal proofs provide perfect fault-coverage relative to a well-specified fault model

Architecture for a Reliability-Preserving Compiler



Impact

L. Mackey, winner CRA outstanding ugrad award.

Students & Collaborators

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