

# Breakout

Q1	121	Repair	Carter	Adve
Q2	122	Filter	Nassif	Carter
Q3	204	Multilevel	Adve	Quinn
Q4	324	Strategic	Mitra	DeHon
Q5	201	Diffrel	DeHon	Huang
Q6	213	Adapt	Quinn	Savage

# Q5: Differential Reliability

- What would a theory and framework for expressing and reasoning about differential reliability look like?
  - Express allowable noise?
  - Reflecting/exposing noise to application-level?
  - Express or analyze reliability needs of pieces of a computation?

# Discussion

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- Lori Betchtold
- Chris Wilkerson
- Eugene Normand
- Andrew “Bunnie” Huang
- André DeHon

# Outline

- What does it do for you?
- Mechanisms
- Examples
- Where does it arise?
- Characterization and Requirements
- Understand when possible benefit?
- Relate to other questions

# What does it do for you?

- Reduce costs (area, delay, energy) for a given level of reliability
  - Don't have to spend cost for everywhere for weak link
- Increases space for optimization

# Mechanisms increase Reliability

- Physical
  - Larger feature size
  - Larger Energy (e.g. Vdd)
  - Slower Clock
  - Margining
- Logical
  - Replication/Voting
  - ECC

# Examples

- Lightweight Checked Computation
  - For rollback/retry
- Corrected/ECC
- Convergent Numerical computation
  - Correctness depends on exit condition
  - Errors in update impact performance
- Control vs. Data plane in signal processing

# Differential Redundancy

## Problem: Faults Have Wildly Opportunity Different Effects





# Where does it arise?

- Application-level specification on importance?
- Internal resource allocation in an optimization problem
  - CAD Tool
  - Adaptive

# Characterization of Reliability

- How capture/metric/relate components to next layer in hierarchy?
  - To CAD
  - To system designers
- FIT rate?
  - Not capture enough
  - Need richer characterization?
    - Dimensions?

# Capturing Requirements

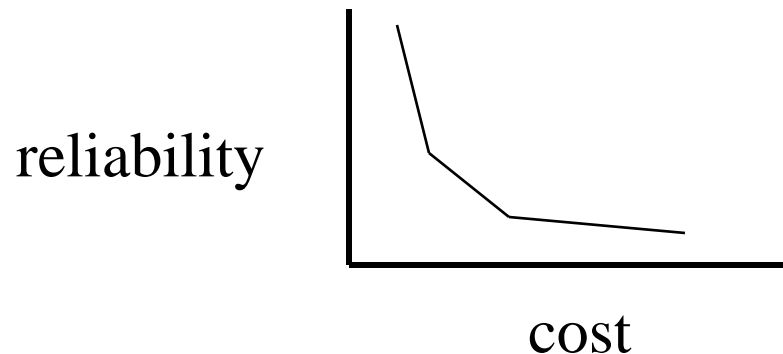
- Reflect in Programming Language
  - Noise-specification for data type
    - Idea: PSNR Ratio...
    - Coarse-grain for typing
    - Control loops -> reliable
    - Data plane -> statistical (noise-level spec)
- High-level reliability specification
  - E.g. Verilog annotation? Option to synthesis?

# Analysis and Optimization

- State-of-the-art today
  - Heuristics and rules of thumb
- Vision/Goal for the future
  - Automate
    - Adequately capturing “reliability” of comp.
      - Across all the relevant axes
    - Tools to evaluate
      - Composite number for design
      - Annotated where that comes from → identify weak points, sensitivity points
    - Opens up: optimization/algorithms explore the space

# Understand Space of What's Possible

- What kind of tradeoff do we need for this to be interesting?
  - Delta cost/delta reliability
  - How much cost savings will be needed to make this worthwhile?
  - Regions of space where viable?



# Relation Other Questions

- Lightweight Checking
  - Reliable check guards noisy computation
- Adaptability
  - Adaptation controller more reliable
  - Adaptation to figure out reliability for each subcomponent