**Cross-layer Accelerated Self-Healing (CLASH)**

- Aging Effect in FPGA chips and systems

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**BACKGROUND**

- Circuit reliability
  - Defined in term of mean time between failures (MTBF)
  - Process, voltage, temperature and aging variations (PVTA) have a substantial effect
  - Relatively hard to capture and deal with

- Aging Effect
  - Deterioration of circuit performance over time
  - More significant with extremely scaling technology
  - Including bias temperature instability (BTI), Hot carrier injection (HCI), time-dependent dielectric breakdown (TDDB), Electromigration (EM), etc.

**Purpose**

- Capture aging/wearout effect in FPGA based systems
- Develop accelerated recovery mechanism to rejuvenate electronic system
- Based on test chip

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**PLATFORM**

- Ring Oscillator
  - Each ring oscillator can be enabled separately
  - Clock divider is used to achieve fine granularity
  - I/Os are assigned based on availability

- Aging Sensors

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**MEASUREMENT RESULTS**

- Ring Oscillator Frequency vs. Line Position
- Power, Performance vs. Line number

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**MUTUAL EFFECT MEASUREMENTS**

- Mutual effect will affect the performance of ring oscillator
- Self-heating can also influence performance and power

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**EXPERIMENT SETUP**

- Stress and Recovery System Setup
- Programming FPGA Chip
- Temperature characteristic measurement in Thermal Chamber