An Atomic-aware Design to Maximize Energy Utilization on NVP-based Self-powered Sensor Systems

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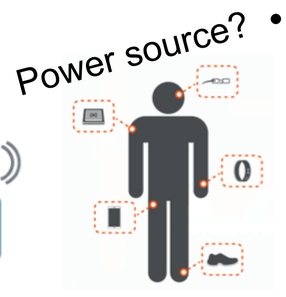
Motivation

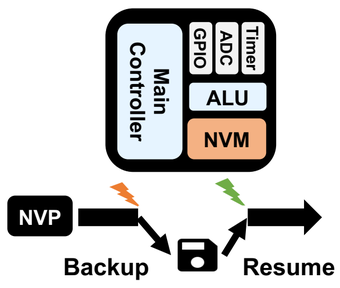
- In our increasingly connected world, there will be more devices than humans.
- Energy harvesting is deemed more sensible than battery charging.

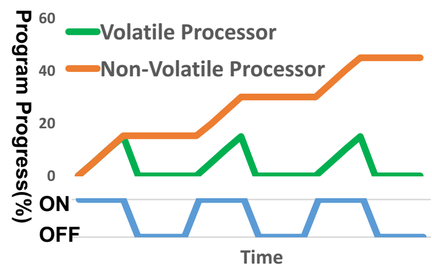


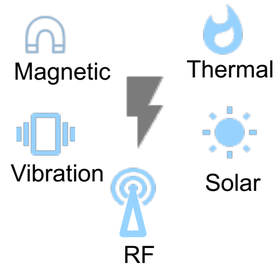
- Battery?
  - Size & Weight
  - Safety & Health concern
  - Recharge inconvenience

Emerging HW Solution

- Diverse energy sources from surroundings like solar, thermal, piezo, RF, etc., but all unstable.
- The first nonvolatile processor enables accumulative execution.



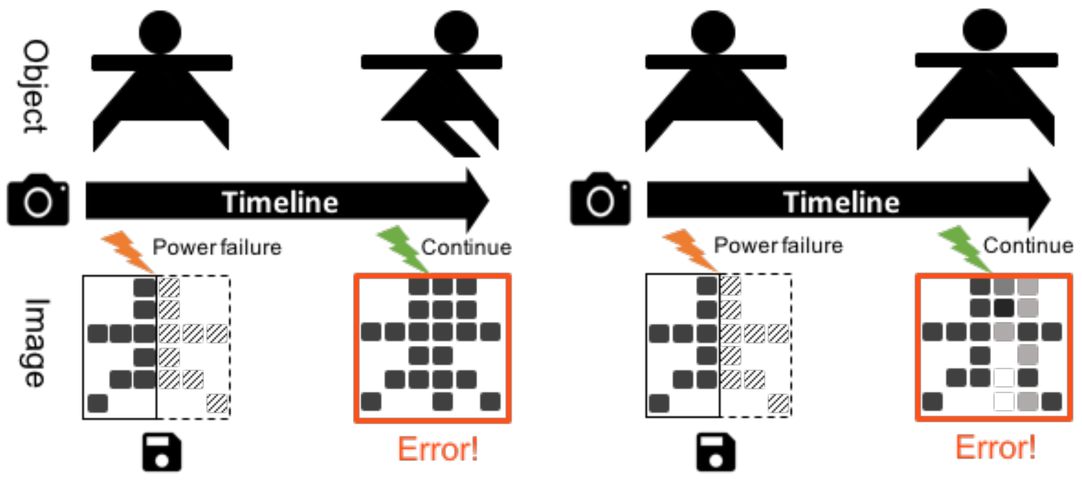




Y. Wang, Y. Liu, S. Li, et al. A 3us wake-up time nonvolatile processor based on ferroelectric flip-flops. In Proc. of ESSCIRC ,149-152 , 2012.

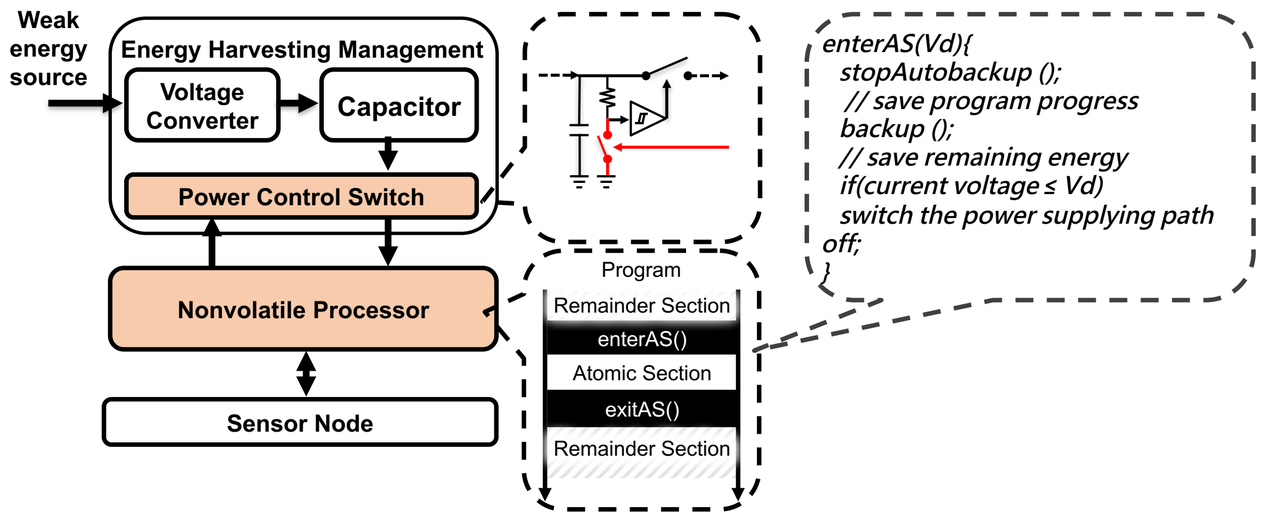
Why Atomic Aware?

- Nonvolatile processors enable accumulative execution but not data integrity.



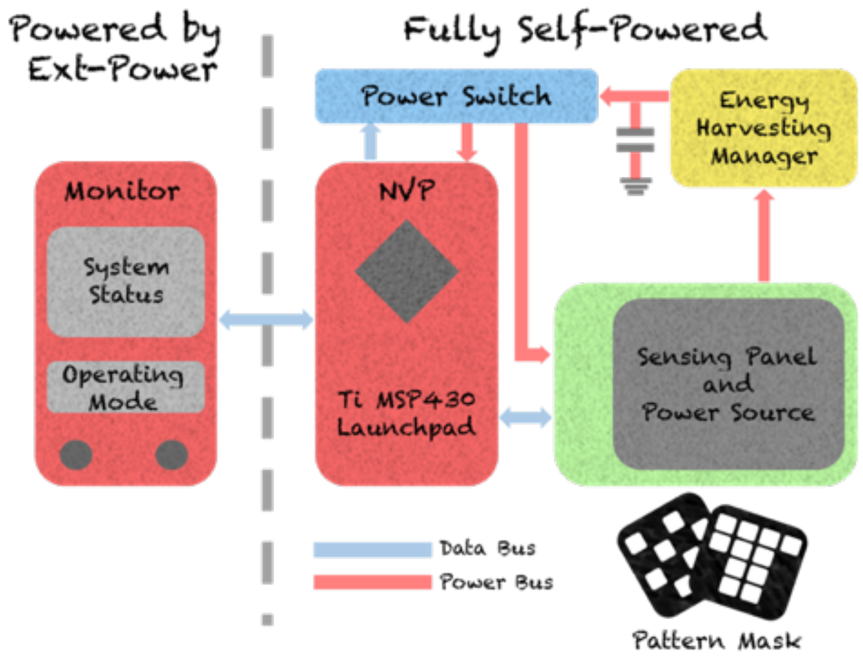
Atomic-Aware Design

- HW/SW co-design to maximize energy utilization.
  - HW ensures that the power pulse is sufficient for an atomic task.
  - SW eases programmers to protect atomic sections.



Exemplary Application

- Self-powered pattern locking



Performance Evaluation

SPSS : Our atomic-aware design.
NOAT : Original NVP-based system.

Program completeness per minute

System	Capacitance		
	450u	*300u*	*150u*
SPSS	29	28	23
NOAT	27	25	20

Ratio of data integrity

System	Capacitance		
	450u	*300u*	*150u*
SPSS	100%	100%	100%
NOAT	58%	33%	15%