# MulBERRY: Enabling Bit-Error Robustness for Energy-Efficient Multi-Agent Autonomous Systems

**Zishen Wan**[1], Nandhini Chandramoorthy[2] , Karthik Swaminathan[2], Pin-Yu Chen[2], Kshitij Bhardwaj[3], Vijay Janapa Reddi[4], Arijit Raychowdhury[1]

[1]Georgia Tech, GA [2]IBM Research, NY [3]LLNL, CA [4]Harvard University, MA

Georgia Tech College of Computing
Center for Research into Novel Computing Hierarchies

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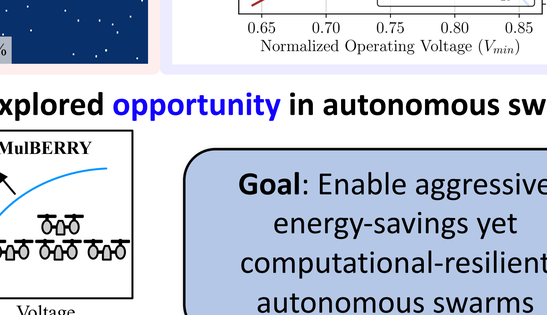
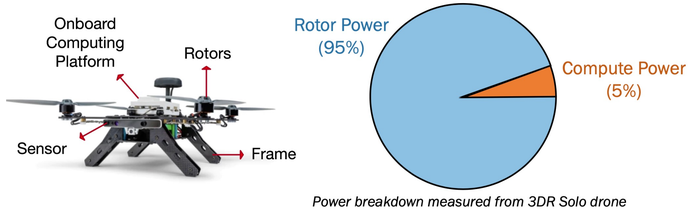
## Background and Motivation

❖ **Efficient and Resilient Autonomous Swarms** is essential for diverse application scenarios

✓ Challenge 1: distributed resource-constrained nodes

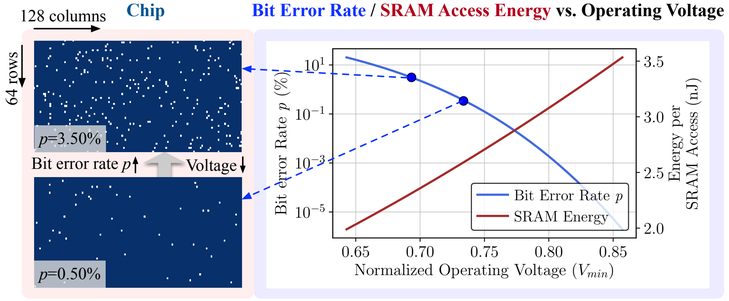



✓ Challenge 2: complex cyber-physical UAV systems

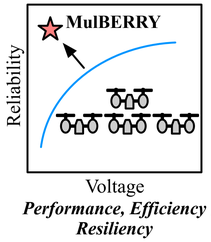



*Power breakdown measured from 3DR Solo drone*

✓ Challenge 3: low-voltage reduce energy quadratically but induce bit errors brining reliability concern



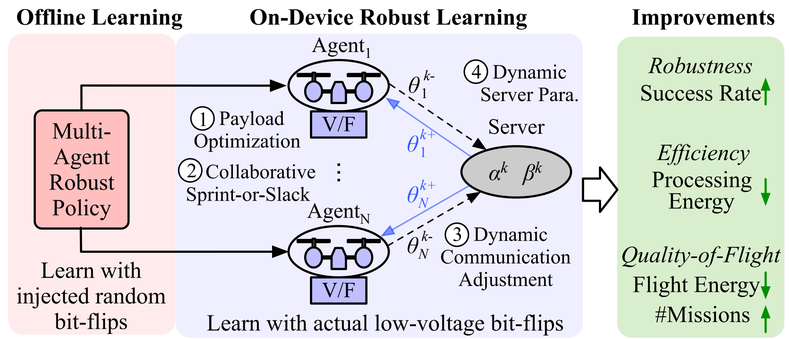

❖ **Unexplored opportunity in autonomous swarms?**




**Goal**: Enable aggressive energy-savings yet computational-resilient autonomous swarms

## Proposed MulBERRY Framework

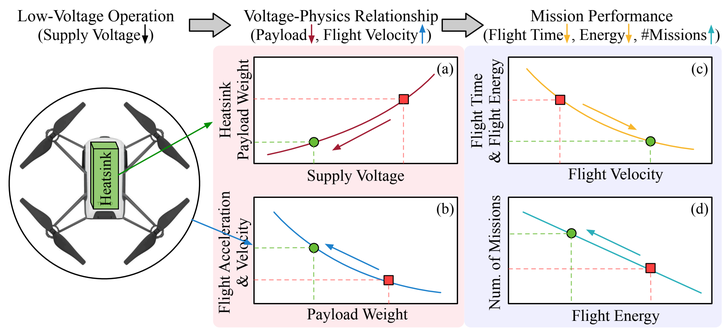
❖ **MulBERRY**: robust learning framework to achieve aggressive energy-savings yet compute-resilient autonomous swarms



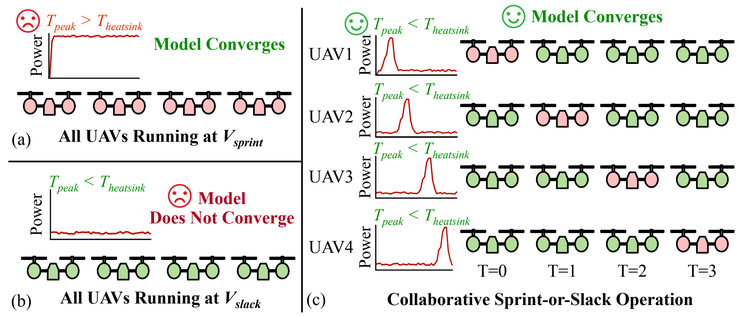

❖ **Key Features**:

✓ Two-stage offline and on-device robust swarm learning

✓ Low-voltage UAV payload optimization




✓ Collaborative sprint-or-slack operation

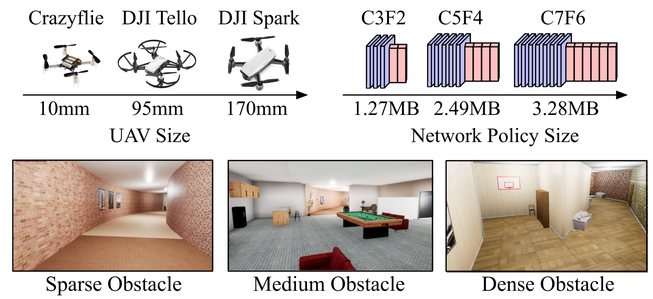



✓ Dynamic agent-server communication and knowledge-sharing parameter adjustment

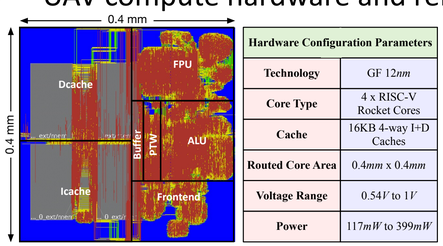
## Evaluation Results

❖ **Evaluation Setups**

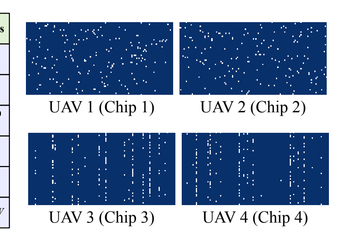
✓ Closed-loop eval.; Diverse environments, UAVs, models




✓ UAV compute hardware and reliability characteristics




| Hardware Configuration Parameters | |
|---|---|
| Technology | GF 12*nm* |
| Core Type | 4 x RISC-V Rocket Cores |
| Cache | 16KB 4-way I+D Caches |
| Routed Core Area | 0.4*mm* x 0.4*mm* |
| Voltage Range | 0.54*V* to 1*V* |
| Power | 117*mW* to 399*mW* |




❖ **Resilience-Efficiency Improvement**

✓ Improve resilience, processing efficiency, and mission efficiency under robust low-voltage operation

✓ Generalize across chips, environments, UAVs, models