Shaheen: An Open, Secure, and Scalable RV64 SoC for Autonomous Nano-UAVs

- Versatility & safety: nano drones are small and agile, making them ideal for accessing hard-to-reach areas or tight spaces and performing inspection & maintenance.
- Cost-effectiveness: nano drones are relatively inexpensive to produce and operate.

Shaheen addresses these challenges, ensuring Performance while maintaining Energy Efficiency and providing advanced virtualization support. The design incorporates an energy-efficient Programmable Multi-Core Accelerator (PMCA) for neural network inference and a Host Subsystem based on CVA6, a 64-bit Linux capable CPU, enhanced with Hypervisor support and a lightweight mechanism for timing-channels mitigation to isolate concurrent execution of multiple software stacks (trusted and untrusted), preventing security threats and ensuring multi-domain operations.

**HW-SW stack & Application scenario:**

**Physical implementation details:**

- Memory hierarchy: Nano-UAVs' State-of-the-Art (SoA) SoCs rely on 32-bit processors, small on-chip SMPs and off-chip memories accessible through peripheral interfaces. Instead, Shaheen's memory hierarchy features a 1MB 8P and an ultra-low-power, low-area, low-pin-count, fully-digital HyperRAM memory controller that can drive up to 512MB @1.6Gbps directly on the AXI-4 bus.
- PMCA energy-efficiency: The PMCA is built around 8 RISCy (RV32) cores sharing 16 16KB SRAM banks. The cores feature dedicated RV32 extension, including hardware loops, SRAM banks. The cores feature dedicated RV32 extension, including hardware loops, SRAM banks. Instead, Shaheen's memory hierarchy features a 1MB 8P and an ultra-low-power, low-area, low-pin-count, fully-digital HyperRAM memory controller that can drive up to 512MB @1.6Gbps directly on the AXI-4 bus.
- Memory hierarchy: Shaheen integrates logic locking, which consists in modifying a hardware IP to add a new input, specifically a logic locking key, to be applied to unlock the original IP functionality. Without the proper logic locking key loaded, the chip is non-functional.