Sustainable Nanoelectronics for Cloud–Edge Intelligence

Abstract

This talk presents two complementary hardware approaches for advancing sustainable, scalable computing: (1) silicon-on-insulator (SOI) electron qubits with multi-gate control for quantum cloud acceleration, and (2) ferroelectric synapses and neurons for energy-efficient neuromorphic inference at the edge. First, we describe how multi-gate SOI architectures enable precise electrostatic confinement, tunable coupling, and error-mitigating control in CMOS-compatible quantum dots, supporting manufacturable quantum processors deployable in cloud environments. Second, we introduce CMOS-compatible ferroelectric (e.g., HfO_2-based) devices as non-volatile, analog-programmable synapses and spiking neurons that enable low-energy updates and inference, supporting always-on, privacy-preserving edge intelligence. We discuss a cloud–edge co-design in which quantum resources perform centralized training, optimization, or secure computation, while ferroelectric neuromorphics execute real-time inference locally, thereby reducing data transfer and improving overall energy efficiency. These two platforms are presented as illustrative examples of potential pathways toward a more sustainable cloud–edge computing ecosystem.

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