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Will a New Milli-Volt Switch Replace the Transistor for Digital Applications?

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In contemplating the headlong rush toward miniaturization represented by Moores Law, it is tempting to think only of the progression toward molecular sized components. There is a second aspect of Moores Law, that is sometimes overlooked. Because of miniaturization, the energy efficiency of information processing steadily improves. We anticipate that the energy required to process a single bit of information will eventually become as tiny as 1 electron Volt per function, truly indeed a molecular sized energy. Inevitably most logic functions including storage, readout, and other logical manipulations will eventually be that efficient. However there is one information-processing-function that bucks this trend. That is communication, especially over short distances. Our best projections of improvements in the short distance communication function show that it will still require hundreds of thousand of electron Volts, just to move one bit of information the tiny distance of only 10 micro meters. Why this energy per bit discrepancy for communications? It is caused by the difference in voltage scale between the wires and the transistor switches. Transistors are thermally activated, leading to a characteristic voltage ¿¿kT/q. Wires are long and they have a low impedance, allowing them to operate efficiently even at 1milli-Volt. The challenge then is to replace transistors with a new low-voltage switch , that is better matched to the wires. I will present some of the technical options for such a new switch.