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Use of negative capacitance to provide voltage amplification for ultra low power nanoscale devices

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It is well known that conventional Field Effect Transistors (FET's) require a change in the channel potential of at least 60 mV at 300K to effect a change in the current by a factor of ten, and this minimum subthreshold slope S puts a *fundamental lower limit* on the operating voltage and hence the power dissipation in standard FET based switches. Here we show that by replacing the standard insulator with a ferroelectric insulator of the right thickness it should be possible to implement a ***step-up voltage transformer*** that will amplify the gate voltage thus leading to values of S lower than 60 mV/decade and enabling low voltage/low power operation. The voltage transformer action can be understood intuitively as the result of an effective negative capacitance provided by the ferroelectric capacitor which arises from an internal positive feedback that in principle could be obtained from other microscopic mechanisms as well. Unlike other proposals to reduce S this involves no change in the basic physics of the FET and thus does not affect its current drive or impose other restrictions.