Aggressive CMOS technology scaling trends exacerbate the aging-related degradation of propagation delay and energy efficiency in nanoscale designs. Recently, power-gating has been utilized as an effective low-power design technique which has also been shown to alleviate some aging impacts. However, the use of MOSFETs to realize power-gated designs will also encounter aging-induced degradations in the sleep transistors themselves which necessitates the exploration of design strategies to utilize power-gating effectively to mitigate aging. In particular, Bias Temperature Instability (BTI) which occurs during activation of power-gated voltage islands is investigated with respect to the placement of the sleep transistor in the header or footer as well as the impact of ungated input transitions on interfacial trapping. Results indicate the effectiveness of power-gating on NBTI/PBTI phenomena and propose a preferred sleep transistor configuration for maximizing higher recovery.

Furthermore, the aging effect can manifest itself as timing error on critical speed-paths of the circuit, if a large design guardband is not reserved. To mitigate circuit from BTI-induced aging, the Reactive Rejuvenation (RR) architectural approach is proposed which entails detection and recovery phases. The BTI impact on the critical and near critical paths performance is continuously examined through a lightweight logic circuit which asserts an error signal in the case of any timing violation in those paths. By observing the timing violation occurrence in the system, the timing-sensitive portion of the circuit is recovered from BTI through switching computations to redundant aging-critical voltage domain. The proposed technique achieves aging mitigation and reduced energy consumption as compared to a baseline circuit. Thus, significant voltage guardbands to meet the desired timing specification are avoided resulting in energy savings during circuit operation.

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The public is welcome to attend.