Weekly Report

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Last week I focused on two Journal submission on the leakage reduction with data retention and TPWL.

1 Voltage Setup Problem

For voltage setup problem, we summarize the problem as: for a given workload, given a probability density function of incoming task rate and QoS requirement, decide (1) the number of Vdd M; and (2) $V_{dd}^1 < V_{dd}^i < V_{dd}^M$, such that the total energy is minimized statistically.

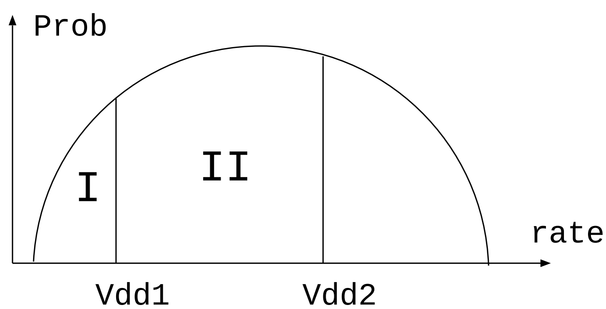

Figure 1: Pdf and Vdd.

As shown in Figure 1, for each incoming task rate, there is a corresponding probability and one V_{dd} to satisfy the performance for such task rate. We select M Vdd as V_{dd}^1, ..., V_{dd}^M. For task rate with corresponding V_{dd} between (V_{dd}^i, V_{dd}^{i+1}], we apply V_{dd}^{i+1} in our dynamic scheduling. For example, in Region I in Figure 1, we apply V_{dd}^1, but in Region II, we apply V_{dd}^2, and etc.

The basic approach to solve this problem is described as follows:

1. For any M, it is easy to see V_{dd}^M (the largest V_{dd}) should be chosen according to QoS requirement. Suppose this voltage is V_{max}.
2. Let M=1, the result is obvious.
3. For $M \geq 2$, solve the voltage setup problem for M V_{dd}. The details will be discuss later.
4. If $Energy_{M+1} - Energy_M < energyoverheadofoneextraV_{dd}$, then exit with result of M V_{dd}.
5. Otherwise, let $M = M + 1$ and go back to step 3.

For any given M, we choose the following approach. First of all, there exist theoretical upper and lower bounds of total energy in our voltage setup problem. The lower bound of total energy is when M become infinite, and the upper bound of total energy is when all $V_{dd}^{i} = V_{max}$. For a solution with M V_{dd}, we can construct a vector $V = (V_{dd}^{1}, ..., V_{dd}^{M})^{T}$. Such vector represents a point in an M-dimensional space. It is very likely that the relationship between the total energy and each point of this M-dimensional space is convex, which we need to prove. Suppose this is true, we can first get an energy consumption E by randomly picking V_{dd}^{1}, ..., V_{dd}^{M}, and then adjust one of them slightly such that the new energy consumption $E^{'}$ is less than E. As long as we always reduce the resulting energy consumption after adjustment, we essentially walk along the convex curve toward the bottom. Finally we can stop at the point with for example, 5% energy consumption overhead compared to the theoretical lower bound. During each adjustment (move), each V_{dd} will have only two choices for adjustment: either becomes smaller or becomes larger. So the algorithm should not be time-consuming.

So, clearly we have two imminent challenges: one is to prove the convexity; the other is to develop the adjust methodology.

2 DVS

After we solve the voltage setup problem, we will implement the dynamic voltage scheduling with the V_{dd} level we design and considering feedback control.

So far only one core is considered. Multi-core configuration should be taken into account later.