Neuromorphic

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Background

The aim of this workshop is to connect reliability and neuromorphic communities – the latter outlines device parameters/characteristics relevant to NC operations at the device, as well as circuit and system, levels that help reliability experts and scientists to better formulate related measurements.

What is the scope of device reliability in neuromorphic applications?

At this stage of technology development, it is constructive and timely to widen considerations beyond conventional degradation: Reliability study is expected to address any features/variabilities in device characteristics that detrimentally affects NC operations. The reliability question of practical importance is, then, whether devices meet the ultimate circuit/system performance requirements. For instance, synaptic weight update should exhibit linear and symmetric change of the device conductance – thus, identifying a possible range of operation conditions (and related structural features) when these characteristics are suboptimal presents an important reliability assessment task.

Discussion Topics

We will discuss topics related to degradation and variability as part of reliability assessment and their impacts to test/analysis requirements.

Toward the end, the expectation is that we will outline a basic framework for the reliability assessment of neuromorphic devices that will help both the reliability and neuromorphic communities to further refine their approaches and methodologies in NC.

Summary

A workshop “Neuromorphic Device Reliability: beyond conventional degradation” was organized in conjunction with the main program. It was discussing drifting/fluctuating of device parameters that affects changes in device characteristics detrimentally impacting NC operations. Question of practical importance: does device meet circuit/system performance requirements? It requires identifying parameters to monitor and determining test conditions relevant to circuitry operations.

Discussion was initially focused on practical aspects – what/how measurements can be done to catch performance problems. We started with variability related to changes induced by employed operations and then extended it to instability caused by spontaneous fluctuating changes occurring over time, somewhat related to retention generally considered as a continuoes shift of the memory read value. We outlined 3 types of read variability: (a) device-to-device that affects cross-bar network operations; (b) switching variability (for each individual device) when conductance value fluctuates/drifts while it’s expected to return to previously reached value – can be caused by local structural changes; (c) noise-

induced variability – read is affected by the noise magnitudes/frequency that may change with each switching event (due to different distributions of capture/emission defects).

The workshop discussion then shifted to device characteristics affected by their use conditions. It clearly indicated that generic approach to reliability assessment apparently doesn't work well in NC where device performance requirements strongly depend on the employed algorithms and architecture. Each type of NC implementations should be evaluated considering its operation conditions. Such specificity of reliability characteristics to an NC implementation can be the cause of confusion and contradictory claims when materials, structures and operation conditions are not clearly defined.