Crossbar RRAM

A New Era of Storage Innovation for a Content Rich World

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Santa Clara, CA
August 2016

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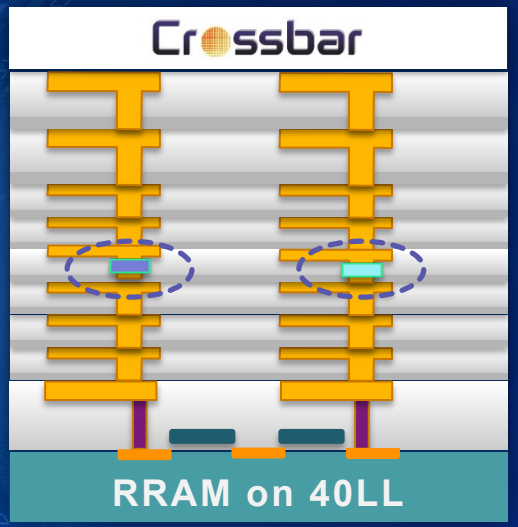
Flash Memory SUMMIT

This is Real!



Excellence in execution

11 months from start to results

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Flash Memory SUMMIT

Crossbar-1 Advantages for IoT Applications

Byte write in **12us**

0 block erase required

Read in **25ns**

Embedded macros and stand-alone chips

Available at 40nm, scalable below 10nm

Cell size not constrained by RRAM, scales with select transistor

Fewer process steps and masks vs eFlash

-40/150C support withstands solder reflow

Operating voltage **below 2V** No high-voltage forming process required

10 year retention 100k cycles

Fast **Scalable** **Reliable**

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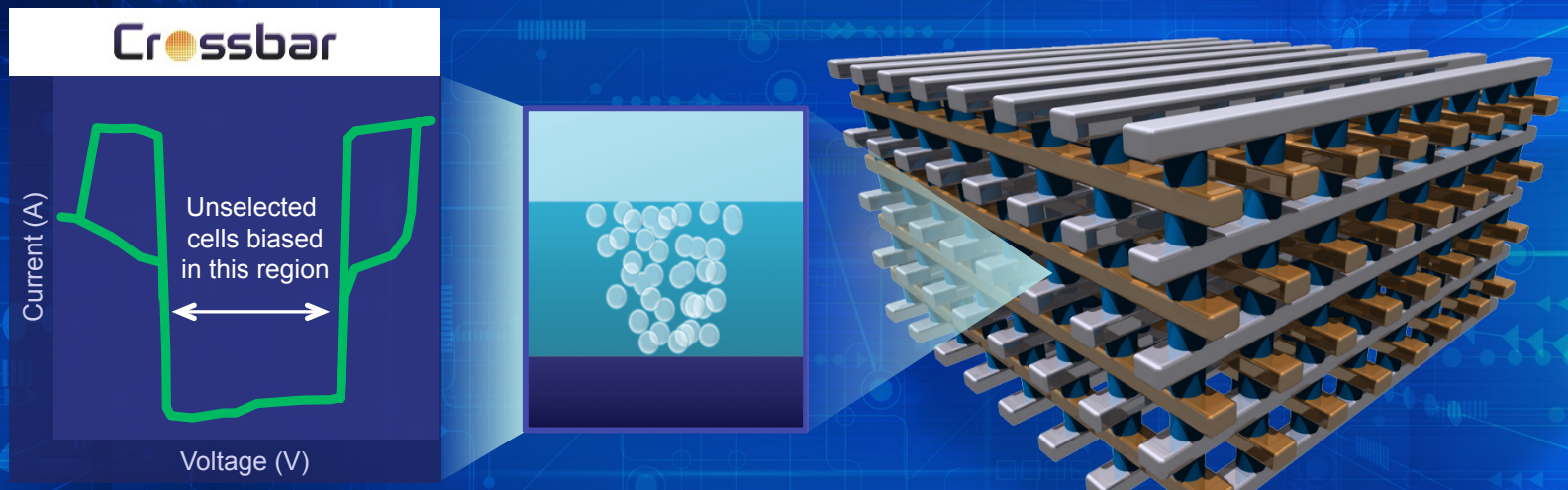
Crossbar-N in progress



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Building a New Class of Low Latency Storage

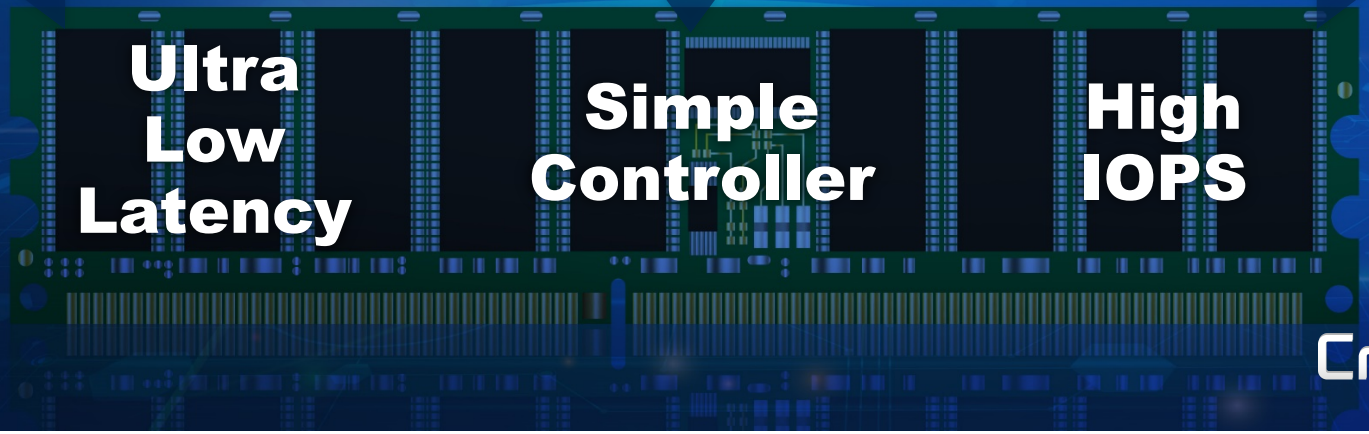
100X | **1us** random read *vs* 100us for 3D TLC NAND

1000X | **2us** writes vs ms, small *vs* large pages

0 | NO **erase operation** required

Simpler HW/SW memory management

24 MIOPS (512B)
on a 4TB NV-DIMM
(no DRAM, no super caps)



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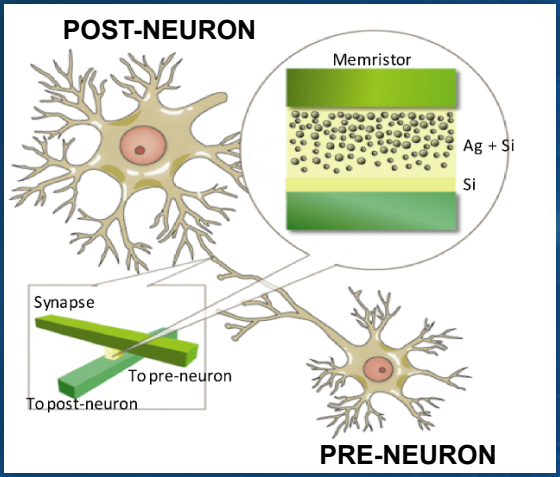
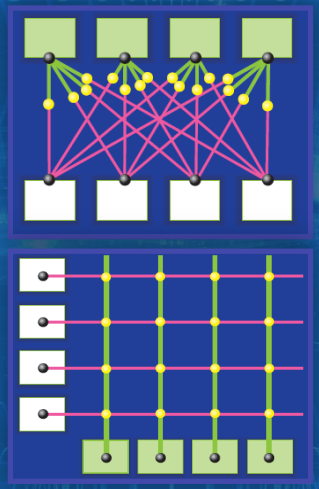
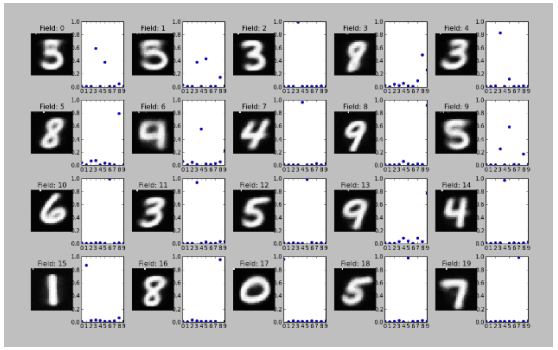
Building RRAM Based Neural Networks



S. H. Jo, T. Chang, I. Ebong, B. Bhavitavya, P. Mazumder, W. Lu, Nano Lett. 10, 1297-1301 (2010).



UNSUPERVISED LEARNING WITH TASK-DRIVEN DICTIONARY



Receptive Fields (28x28)
Random sample of 20 from 50 output neurons

Crossbar Embedded RRAM enabling post Von Neumann architecture processing machines

Crossbar Corporate Facts

At A Glance

- Founded in 2010. Based in Santa Clara, CA
- Leader in Resistive RAM technology
- Path to commercialization:
  - **Crossbar-1 Embedded Memory**
    - IP Licensing in SoC and MCUs
  - **Crossbar-N Storage Solutions**
    - IP Licensing, IC and systems

Patented Technology

- New class of Non-Volatile Memory:
  - **Fast**, Low Latency
  - **Scalable**, 3D, MLC
  - **Dense**
  - **Embedded**, CMOS compatible
- **210 filed**
- **108 issued** by Crossbar + exclusive license to University of Michigan's RRAM inventions

Thank You

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