Standalone RRAM Potentials and Challenges

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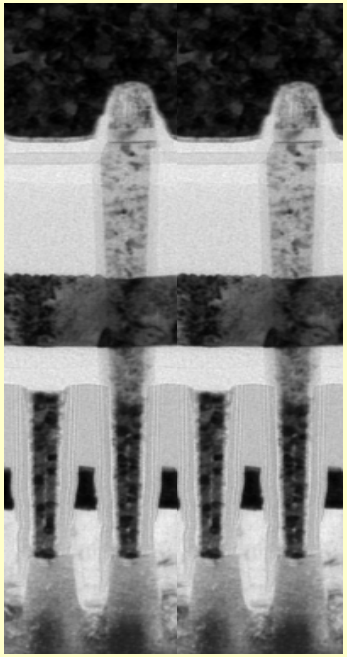
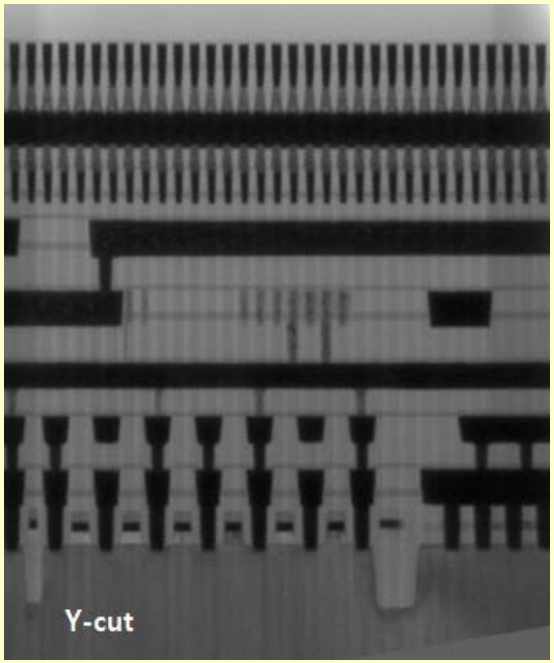
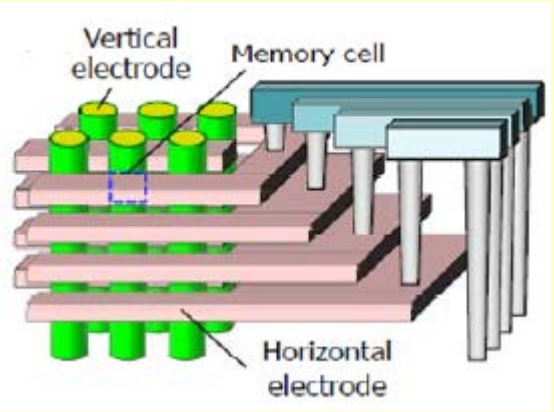
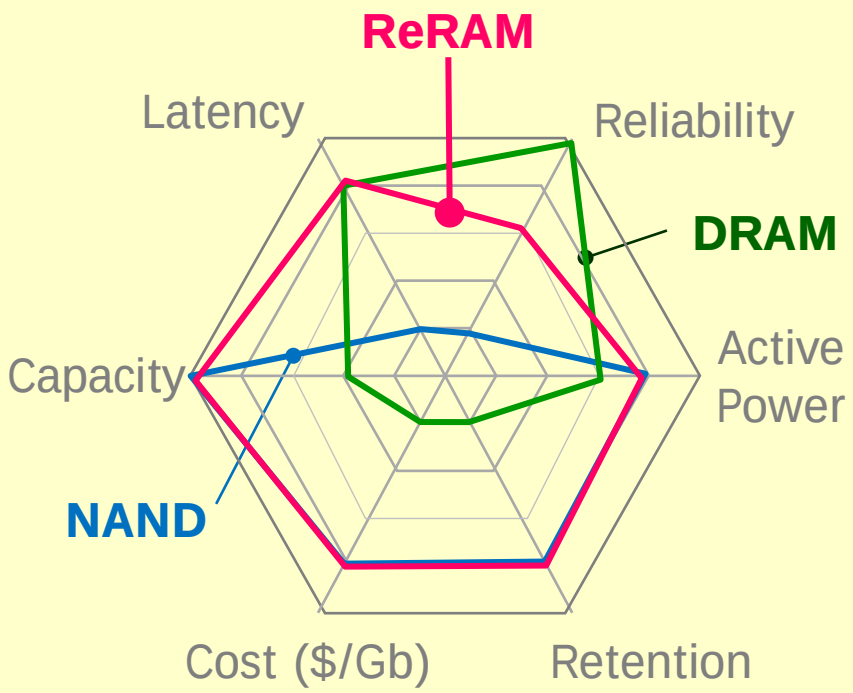
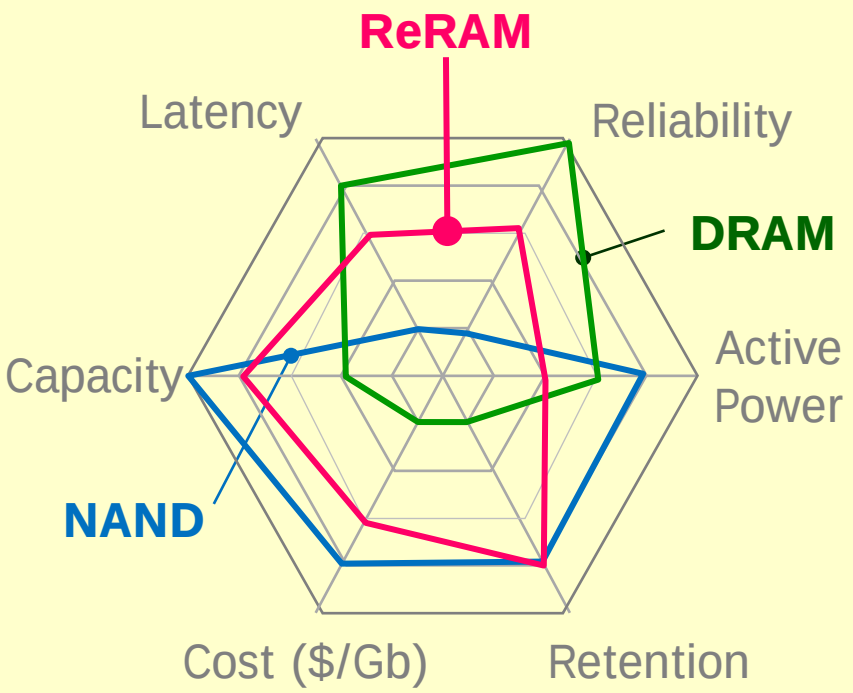
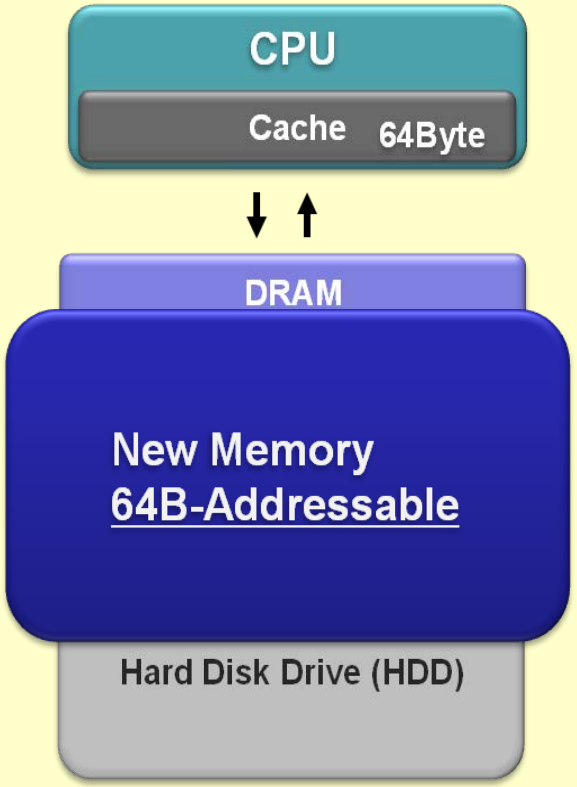
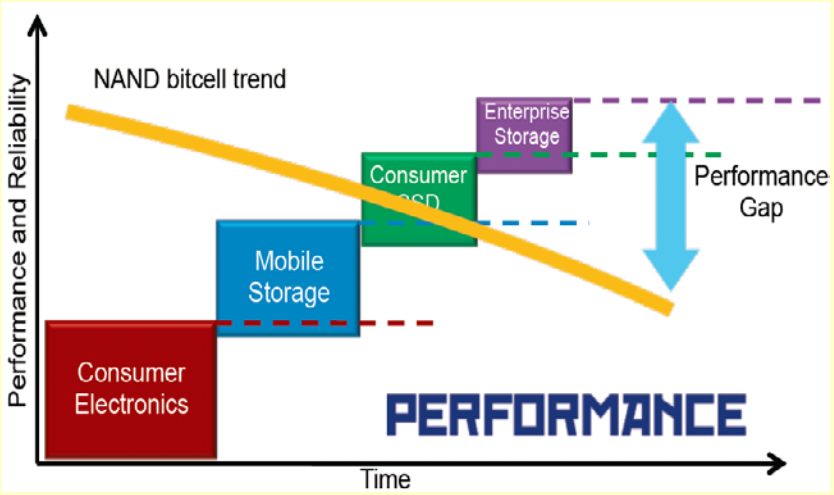
Array candidates for stand-alone

DRAM-like Array (SK hynix, 2011 VLSI)	Multi-plane X-bar array (SK hynix, 2 planes)	Vertical array (Samsung, 2012 IEDM)
		
1T1R unit cell	1R or 1S1R unit cell Buried core circuits	1R or 1S1R unit cell

RRAM features

Initial expectation (unit cell level)	Current status (Array level)
	
Promising storage candidate : Fully cover NAND	Shrunken position : Vertical NAND Low power efficiency : Sneak current Intermediate position : DRAM ~ NAND

Memory technology trend : SCM

SK hynix, 2012 FMS	Rambus, 2012 FMS
	
DRAM-like Byte Accessibility, Fast & Direct transfer between CPU and High Density Storage	NAND performance degradation

RRAM vs NAND : Brand-new

- Totally different one : architecture, operation
  - No block/string operation : Byte accessible
  - Better performance : Latency & Endurance
- Very tricky to reduce cost
  - Multi-planes X-bar array : high process cost
- Vertical RRAM
  - Lateral disturbance issue

High performance & a little expensive (vs NAND)
Need to setup Eco-system (Controller, Protocol)
Check the competitor's status