RRAM Opportunity for High density memory application

6. Aug. 2014

SuOck Chung

SK hynix R&D Div.

ICT tech trends

Emerging devices

. Wearable
. Automotive
. Mobile health-care
. IoT

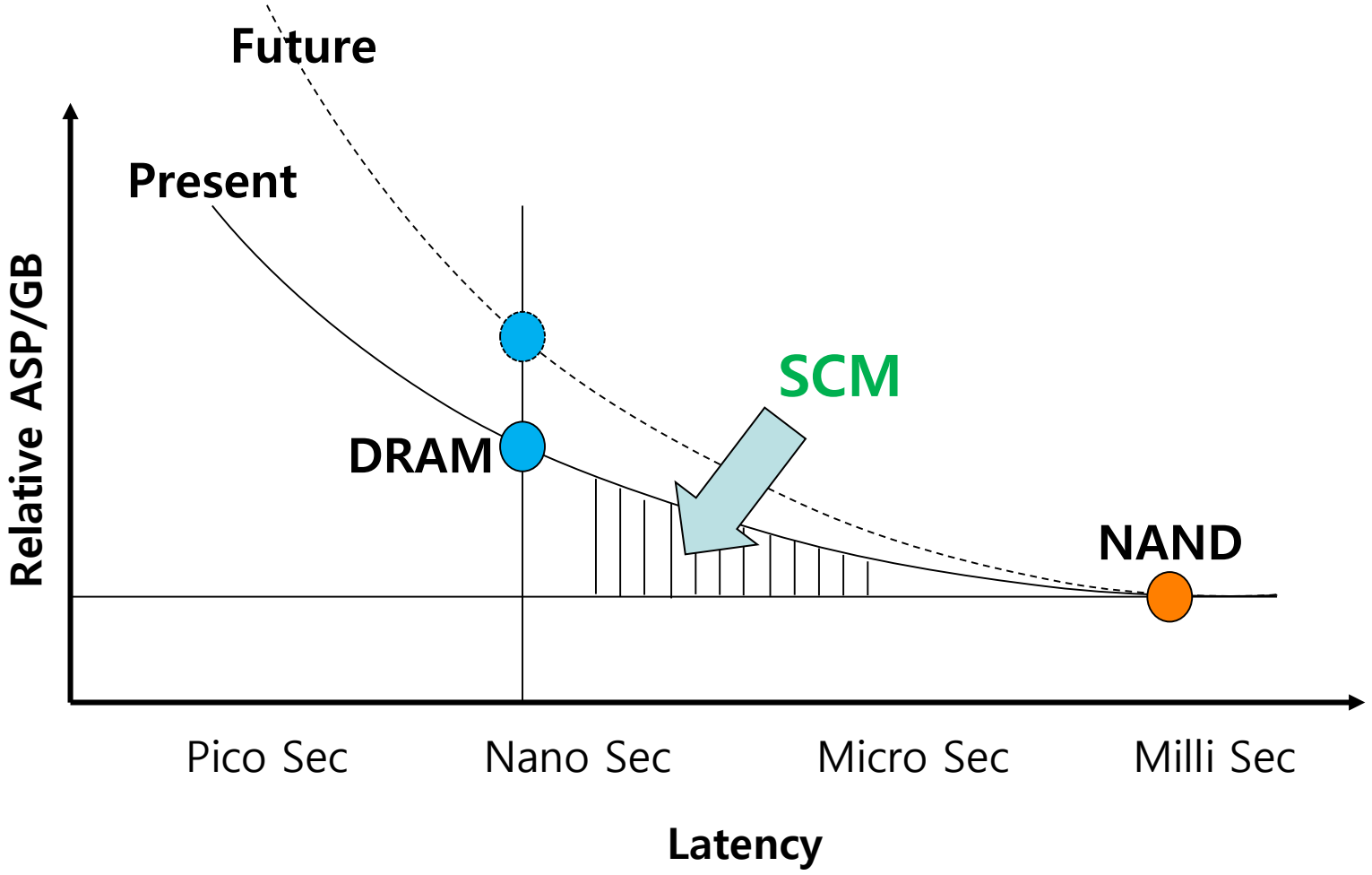
Cloud
Big data
Virtualize
Network

New computing system

. Exascale
. Multi-cores
. New memory technology
  - Byte accessibility
  - Capacity ?
  - Latency ?
  - Bandwidth / power ?
  - Endurance ?

➔ SCM

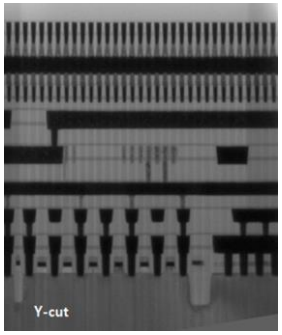
Gap b/w DRAM ~ NAND



RRAM Potentials

←Low Risk high→	DRAM	NAND	PRAM (SLC)	STTRAM	RRAM (TMO)	RRAM (CBRAM)
Byte-Accessible	🟢	🔴	🟢	🟢	🟢	🟢
Write Latency	🟢	🔴	🟢	🟢	🟢	🟢
Write Bandwidth	🟢	🟡	🟢	🟢	🟢	🟢
Endurance	🟢	🔴	🟢	🟢	🟢	🟢
Data Retention	🔴	🟢	🟢	🟢	🟢	🟢
Power / Bandwidth	🟢	🟢	🟡	🟢	🟢	🟢
3D Solution	🔴	🟢	🟢	🔴	🟢	🟢
Bit Density (Cost)	🟡	🟢	🟡	🔴	🟢	🟢
Manufacturability	🟢	🟢	🟡	🔴	🟢	🟡

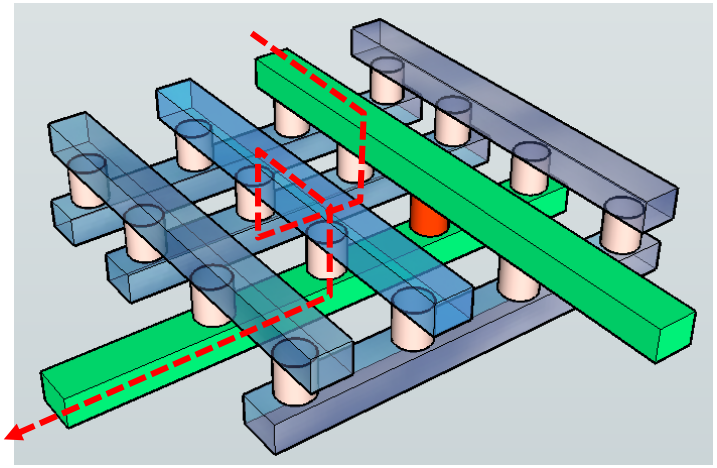
- **Requirements for SCM**
  - Non-volatile, byte accessible
  - High capacity + Short latency + Wide B/W @ moderate power
- **ReRAM is a good candidate**
  - Smaller power consumption than PRAM (I_reset < 1/3)
  - Cross Point Array (XPA) + Multi-Level Stacking (MLS)



2013 FMS, RRAM session

Major challenges

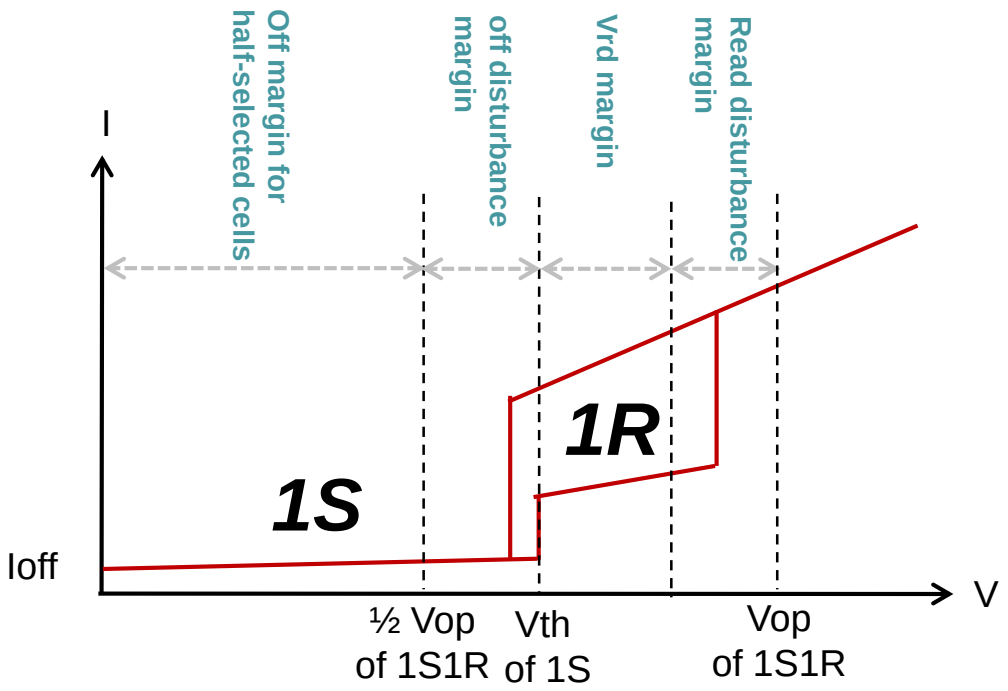
Sneak current effect



Selected cell → Sneak path

- Originated from imperfect off
- Large operation power,
  Sensing noise issue
- Non-linear 1R → 1S1R
  Lower the Ioff of 1S

2 Terminal Operation (1S+1R)



- Simple process merit
- Narrow data window
  → Good match of 1R+1S I-V
  → Higher Vop ?

Summary

- Recent ICT tech trend requires SCM type memory (high capacity + shorter latency + smaller power). RRAM is an attractive candidate for SCM.
- SK hynix has explored and developed core technologies (especially, cell and array architecture) for RRAM production.
- Stackable selector's I_off and cell data window are key success factors for high density RRAM product.