IBM Almaden Research Center

Storage Class Memory based Storage Systems in 2020

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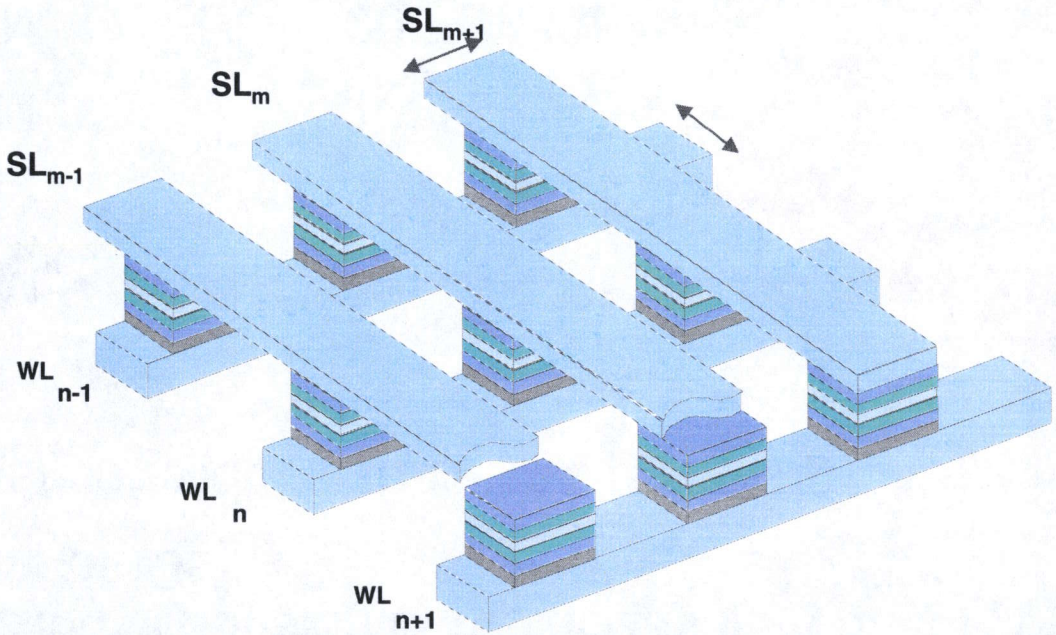
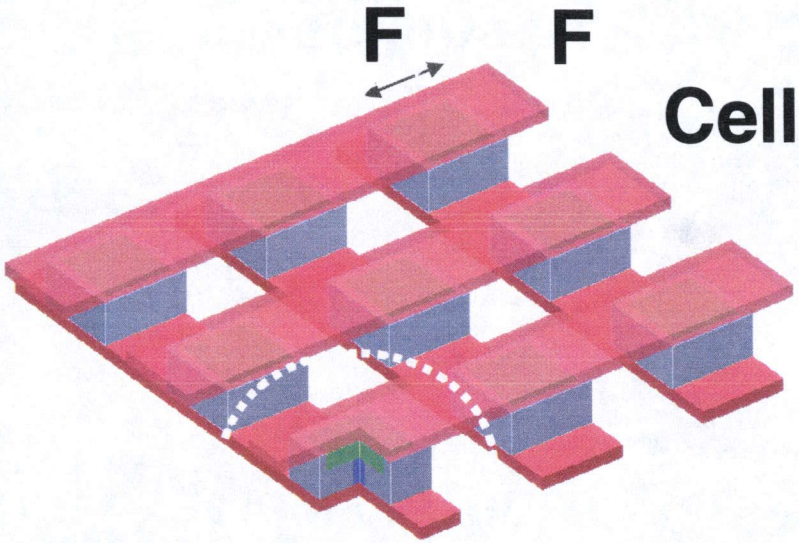
Non-volatile, universal semiconductor memory: Storage Class Memories (SCM)



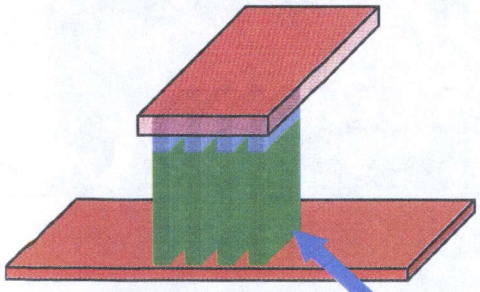
- **It is relatively easy to identify materials that show bistable hysteretic behavior (easily distinguishable, stable on/off states).**
- **Everyone is looking to make a dense crosspoint memory.**
  - Looking for semiconductor performance, reliability, low-power, robustness, etc
- **But it must be cheap**

Crossbar Memory Fundamentals

standard crossbar memory



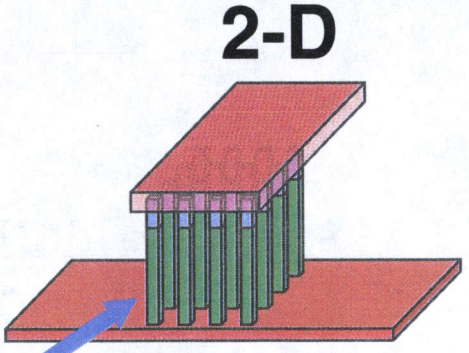
Cell size = $4F^2$



$4F^2/n$

What if we can put more cells at a crossbar?

Net effect: Density n^2
Cost n^2



$4F^2/n^2$

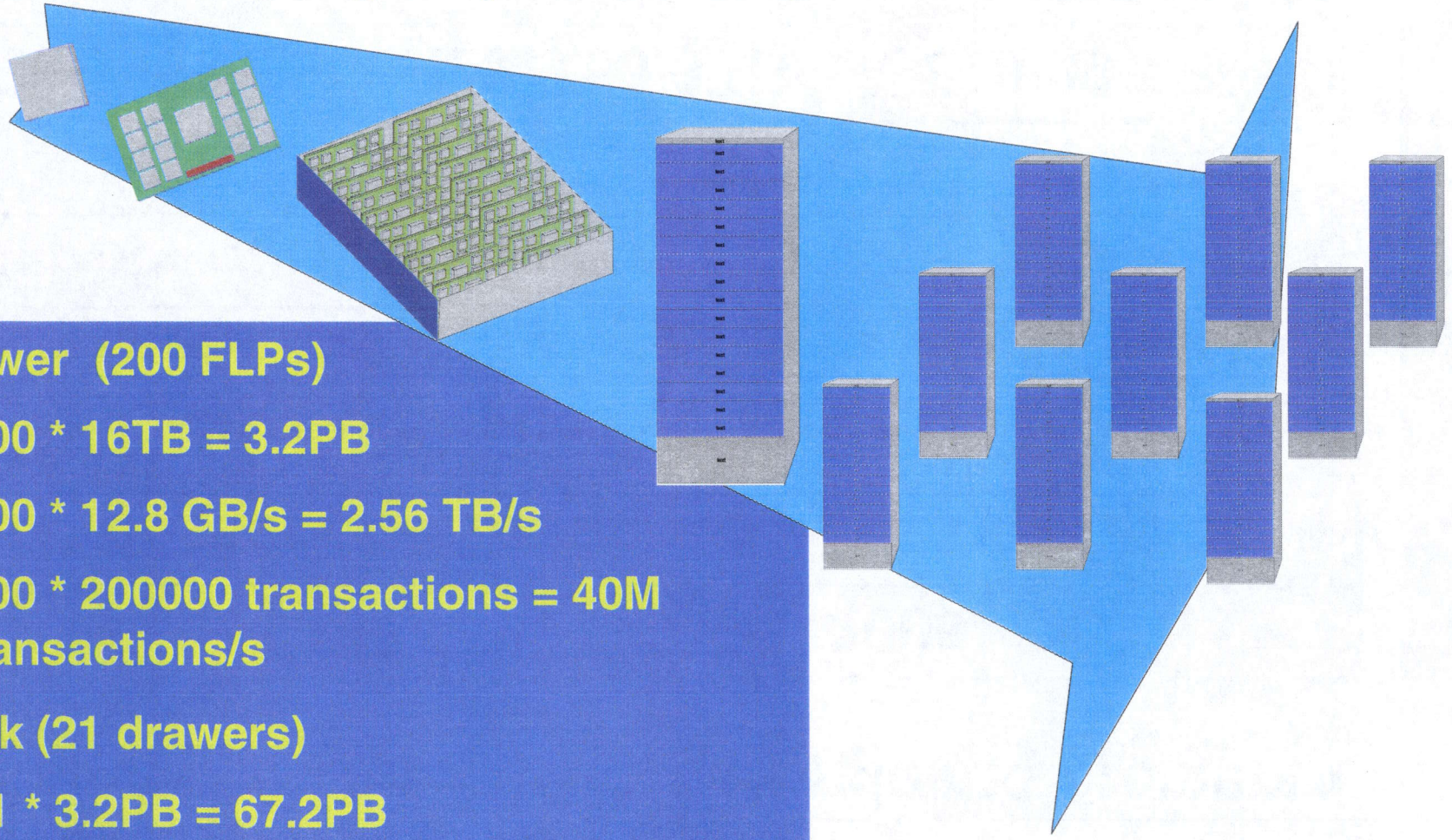
Memory Cells between CMOS lines

Conservative SCM module 'Specs' in 2020

- **SCM modules are block oriented storage devices**

Capacity	**1**	**TB**
Read or Write Access Time	**<1**	**us**
Data Rate	**>1**	**GB/s**
Sustained transaction rate –1us + 4K / 1GB/s = 5us	**200,000**	**SIO/s**
Sustained bandwidth –4KB/5us = >800MB/s	**800**	**MB/s**
Write endurance	**10^{12}**	

2020 SCM Storage System Rack



- **Drawer (200 FLPs)**
  - 200 * 16TB = 3.2PB
  - 200 * 12.8 GB/s = 2.56 TB/s
  - 200 * 200000 transactions = 40M transactions/s
- **Rack (21 drawers)**
  - 21 * 3.2PB = 67.2PB
  - 21 * 25.6 TB/s = 53.3 TB/s
  - 21 * 40M = 840M transactions/s

Transaction Driven 2020 Storage System

- **"Capture" or SigInt Applications: random, small block operations**
- **Assume performance of 10,000 15K RPM disk drives and 70%/yr CAGR in requirements**
  - –6ms access with command queuing → 300SIO/s

	2005	2020	
Transaction Rate	**3**	**467**	**MOP/s**

- **Number of Racks to meet requirements**

	SCM		Disk	
Transaction Rate	**840MOP/s**	**1**	**0.4MOP/s**	**1168**

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Questions