3D X Point Technology

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***Abstract* – In this era, memory is considered to be an important parameter for storing data, Previous memory like RAM ROM Flash Drive etc. have flaws which can be overcome with 3D X Point Memory Technology.3D X Point technology is a new class of non-volatile memory. This technology sharply increasing because of its high speed/performance. It is up to 1,000 times lower latency & exponentially greater endurance than NAND & 10 time denser than DRAM.. In This paper we have discussed about its unique and transistor less Architecture design. The most immediate application of 3D X point based products will be as a layer of storage between DRAM and SSD.**

***Key word*- NAND Flash Memory, DRAM, 3D X Point Memory**

I. INTRODUCTION

3D X point memory is an entirely new class of nonvolatile memory. This memory is jointly developed by Micron-Technology & Intel Corporation Released in 2015. The 3D cross point innovative and have a transistor less cross point architecture. 3D X POINT based on solid state drive (SSD). The first commercial Solid state drive is yet hit the market. The 3D X point is 1000 Times and more durable than NAND Flash storage that currently used in mobile device and SSD. 3D cross point is build to create high performance, high storage, memory solution & nonvolatile memory that was affordable. Data can be stored closer to the processor and accessed quickly. 3D Xpoint memory is 10 times denser than the DRAM Chip and faster than Flash memory. Initial capacity 16 GB per die across two memory layers, But the future will be able to increase the number of memory layers to improve system capacities.

II. TIMELINE OF MEMORY

As times passed changes are required in main memory also so the brief details of changes occurred in main memory are given below:

RAM:

The RAM memory was invented by William tube in the year 1947. Memory Data is stored on the cathode ray tube as electrically charged spots. First electronically stored memory program was implemented which is developed in University of Manchester in England by the William Tube. This memory read and writes operation is performed by electron beams which are part of cathode rays tubes. Initially capacity of storage of RAM is very low; it can store only few hundred bits near about to thousand bits. But in comparison vacuum tubes the size of RAM is very small and these work very fast than vacuum tubes and more power efficient.
For digital storage, Williams Tube used a series of electronic in CRT. The capacity of RAM is near about 128 Byte.

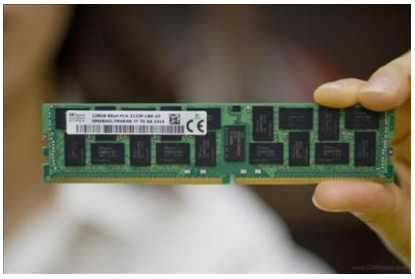

Figure No.1: Random-Access Memory.

PROM:

PROM stands for Programmable Read only memory. This memory was invented by Wen Tsing Chow in 1956 at the request of United State Air Force, productized by American Bosch Arms Corporation in Garden City New York. After a RAM, this memory comes up with a more secure and flexible way to store data on the computer. Is a type of read only memory that can be modified only once by a used with the help of special hardware called PROM programmer. An electronic current is supplied by the machine to a specific cell in the ROM that blows a fuse in them. This process called burning the ROM. Initial capacity of PROM is 128 Bytes. PROM is commonly used in video games consoles, mobile phones, and microcontrollers, Medical devices, HDMI and many other automotive electronic devices.

Figure No.2: Programmable Read Only Memory

SRAM:

It stands for Static Random Access Memory. Static Random Access Memory is a type of Random Access memory which is introduced by Bob Norman in 1961 & productized by Jay Last.in this memory Flip Flops are used to store the Data. It is volatile memory means that data is lost when power is off. Transistor Logic means TTL and ECL are used. Its Initial capacity was 128 Bytes. SRAM is often used in Microprocessor registrar and primary Cache. It is Expensive and not dense enough for high capacity needs.

Figure No.3: Static Random Access Memory.

DRAM:

DRAM is Dynamic Random Access memory. Dynamic Random Access Memory is coined in 1966 at IBM Thoms J.W. Research Center.by Dr. Robert Dennard. This memory stores each bit of data in a separate transistor within an integrated circuit. The capacitor can be either charged or discharged, that is 0 and 1, these two states are taken to represent the two values of a bit DRAM is volatile memory, since it loses its data quickly when power is removed. DRAM is simpler, less expensive and capable much higher densities than SRAM. It is used in smart phones, personal computers, workstations, video games controller, and tablets.

Figure No.4: Dynamic Random Access memory

EPROM: Erasable programmable read-only memory is programmable read-only memory programmable ROM that can be erased and reused. This is a non-volatile form of memory.by shining an intense ultraviolet light through a window it is Erasure. EPROMs are easily recognizable by the transparent fused quartz window in the top of the package, through which the silicon chip is visible, and which permits exposure to ultraviolet light during erasing.

Figure No.5: Erasable Programmable Read-Only Memory.

NOR Flash Memory:

NOR flash memory was invented by Dr. Fujio Masuoka & productized by Intel in 1984. It is a type of non-volatile storage memory that does not require power to retain data. In NOR flash memory one end is connected to the bit line and other is connected to ground directly because of this it acts like NOR gate so its arrangement is called NOR flash. NOR Flash memory is used in embedded applications. Initial capacity was 1MB. This type of memory is used in mobile phones, washing machines, mp3 players, DVD players, digital Camera etc.

Figure No.6: NOR flash memory

NAND Flash Memory:

NAND flash memory is invented by Dr.Fujio Masuoka & productized by Toshiba in 1989. NAND flash memory stores data in an array of memory cells. this memory cell made from floating-gate transistors. Insulated by an oxide layer are two gates, the Control gate, and the floating gate. NAND flash memory commonly used for high speed, high capacity storages in personal computers, Tablets, smart phones, digital Cameras etc. its initial capacity was 16MB.

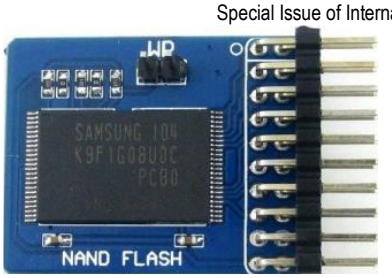

Figure No.7: NAND Flash Memory.

III. 3D X POINT

3D Xpoint technology, a simple stackable & transistor less design where the memory cells sit at the intersection of word lines and bit lines, allowing the cells to be addressed individually. Because of this, data can be written and read in small sizes that create the fast, inexpensive and nonvolatile memory with low latency. 3D cross Point is a resistance based technology that works by a bulk property change to alter the resistance level of a cell and thus differentiate between a 0 and 1 It is high endurance with same storage density and faster than NAND technology. This technology has the possibility of replacing the need of NAND based slow solid state drive. Intel and Micron wouldn't disclose any internal read/write voltages, but they were told that the voltages are considerably lower than in NAND.As this memory is 1000X faster than NAND and compact (denser) than DRAM. It can replace both memories.

- Once the most significant hurdles in modern computing in the time, it takes the processor to reach data on long term storage.
- As the digital world balloons exponentially from 4.4 Zettabyte of data created in 2013 to an expected 44 zettabyte yg8iby 2020.
- 3D X Point technology can turn this immense amount of data into valuable information in nanoseconds.
- The performance benefit of 3D x-point technology could enhance the PC experience. Allowing customer to enjoy faster interactive social media and collaboration as well as the more immersive gaming experience.

IV. ARCHITECTURE

3DX POINT is constructed by packing lots of capacity into a tiny footprint. They started by slicing sub-microscopic layers of materials into columns each containing a memory cell and a selector.

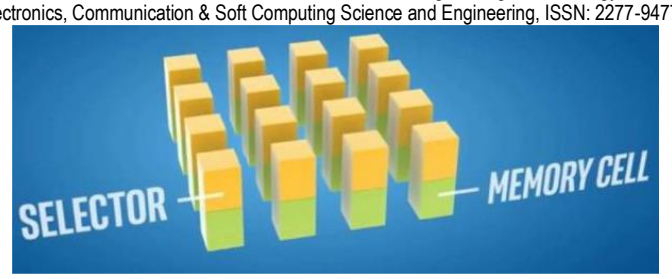

Figure No.8: Selectors and memory cell of 3D X Point

Then they connected those columns using an innovative cross point structure consisting of perpendicular wires that enable memory cells to be individually addressed by selecting one wire on top and another at the bottom.

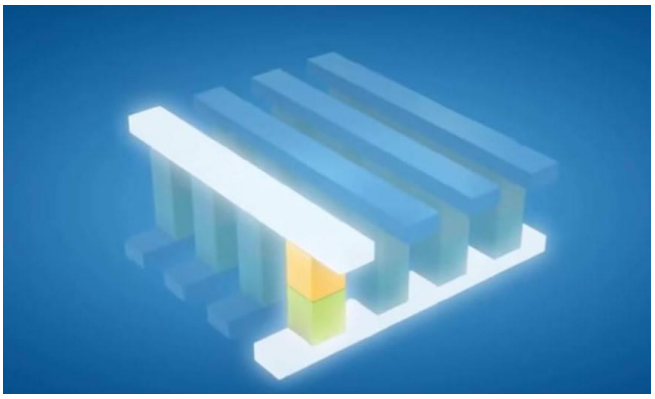

Figure No.9: Perpendicular Wires used in 3D Xpoint

They can stack these memory bridges three-dimensionally to maximize & density and whereas DRAM requires a transistor at each memory cell to access or modify the cell making DRAM big and expensive. Each 3D XPOINT memory cell can be written to or read by simply varying the voltage sent to its selector completely eliminating the need for transistors.

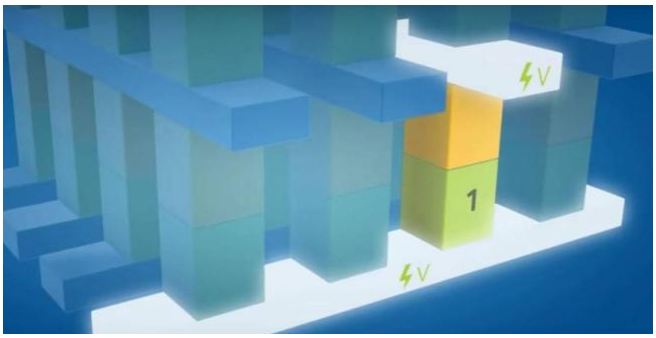

Figure No.10: Voltage transition in 3D X Point

3D X Point is innovative, transistor-less cross point architecture creates a three-dimensional checkerboard are shown in the diagrams, allowing the cells to be addressed individually. As a result, data can be written and read in small sizes, leading to fast and efficient read/write processes.

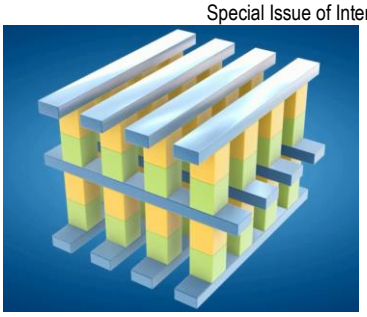

Figure No.11: 3D X Point Structure

The 3D cross point is work on the changing of Voltage of metal line. The 3D cross Point structure consists of a selector and memory cell, which is embedded between two electrodes. to maximize the intensity we design the whole grid into the 3D structure. each cell stores a single bit of data. A cell is made to represent either '1' or '0' through a bulk property change in the material of the cell, which changes the resistance level of the cell .the cell can occupy either high or low resistance level of the cell will change whether the cell is read as 1 or 0.

V. FEATURES TECHNOLOGY 3D X-POINT

- Perpendicular wires combined 128 billion memory cells. Each memory cell stores one bit of data. This allows for high speed and high density.
- In addition to the location in the cross-shaped structure, memory cells arranged in several layers. The original technology allows you to store 128 GB on a single die for the two layers of memory. Future generations of technology will increase the number of layers to scale capacity.
- Access and read or write in the memory cells are made by changing the voltage directed to each selector. This eliminates the need for the transistors, which increases capacity and reduces the cost.
- Due to the small size of the cells, high-speed selectors, low latency, and fast recording cell can switch state faster than any non-volatile memory technology. Trial delivery of products based on the technology 3D XPoint for individual customers will begin later this year. In addition, Intel and Micron developing its own products based on this technology.
- Non-volatile: The data isn't lost when the power is turned off making it a great choice for storage.
- High endurance: It is not significantly impacted by a number of write cycles it can endure, making it more durable.
- Stackable: These thin layers of memory can be stacked to further boost density.
- Low latency: The latency time is significantly reduced due to its structure.

VI. APPLICATIONS

The most immediate application of 3D x point based products will be as a layer of storage between DRAM and SSD. Over the history of computing the number of layers between storage and processors has continued to build – multiple layers of on-die caches, off-die caches, caching SSD's, etc – and 3D X Point memory would further fit into that hierarchy as a storage medium that bridges the gap between DRAM and the current fastest non-volatile storage. By treating 3D X Point memory as another layer of cache, 3D X Point can be used to further speed up applications that are currently bound by either memory capacity or storage latency.
The use cases for 3D X point are potentially significant in number and Intel/Micron believe that it will open the doors for all sorts of new applications. Overall the computing industry has had access to high-speed nonvolatile memory technologies before – magnetic core memory is the traditional poster child here – so there is some precedence here and some fundamental research into the field from the early days of computing.

- NV Write-Cache For RAID
- Meta Data Storage
- Whole System Persistence/Backup
- Storage Tie ring /Server Cache
- Application Data Logging
- Data De-Duplications
- In Memory Database

VII. CONCLUSIONS

In the technical and research area, the demand for 3D X-Point technology sharply increasing because of its high speed/performance, its nonvolatile property, less expensive and one of the most things that it meets the user requirement. The technology uses a new class of non-volatile memory which significantly reduces delays, enabling to store a larger amount of data close to the processor.

VIII. ACKNOWLEDGMENT

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REFERENCES

[1]. Narinder Kumar, Amit Kumar Jain, Journey with Main Memory from Ram (1947) To 3d XPoint (2015): An Overview, International Journal of Advanced Research in Computer Science and Software Engineering Volume 5, Issue 9, September 2015 ISSN: 2277 128Xhttps://www.ijarcsse.com/docs/papers/Volume_5/9_September2015/V5I9-0172.pdf

[2]. Aayush Sinha, Utkarsh Sharma, 3D XPoint and GP-GPUs: Solution to Problem of Big Data, International Journal of Advanced Research in Computer Science and Software Engineering Volume6, Issue9, September2016ISSN:2277128X https://www.ijarcsse.com/docs/papers/Volume_6/9_September2016/V6I9-0178.pdF

[3]. Intel and Micron jointly unveil disruptive, game changing 3D X Point Memory- Jason-Evangelho-http://hothardware.com/news/intel-and-micron-jointly-drop-disruptive-game-changing-3d-XPoint-cross-point-memory-1000x-faster-than-nand

[4]. https://en.wikipedia.org/wiki/3D_XPoint

[5]. 3D X Point™ Technology Revolutionizes StorageMemory-YouTubehttps://www.youtube.com/watch?v=OaAjLyPtoyE