

A Journey of Digital Storage from Punch Cards to Cloud

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Abstract: - Various data storage devices have been developed till now to serve the increasing demand of mankind to store data. In today's modern world of technology people have become so familiar to the storage and backup devices such as CDs, DVDs, and USB key etc. The trend of floppy disks, cassette tapes have vanished from the current basket of storage devices. Such obsolete devices as punch cards, magnetic tapes, floppy, etc have been forgotten by the ensuing generations, which provided a broad way for the innovation of current available storage devices that are being used by everyone. Although the existing storage media provide a good storage option but still they do not ensure the data security and the cost of data loss therefore some other mechanism is needed which can deal with data storage, its security and backup facility. Cloud is the most suited and remarkable technology towards these issues. Nowadays cloud storage is gaining popularity amongst all other devices as it is capable of storing BIG DATA (both structured and unstructured) of almost any size over cloud service provider's premises and provides excellent backup quality.

Keywords: - Cloud, Hard Disk, DVD, Compact Flash, Dropbox, Hacking.

I. INTRODUCTION

In the present time when anyone talks about computer storage the first thing that comes into the mind of people is CDs, DVDs, or USB key but the technology has taken much more complex and innovative shape nowadays. The use and even the name of Floppy Disk or Punch Card nearly vanished from the present world. This study provides a keen glimpse of a journey of digital storage from the mechanical storage to magnetic storage to optical and to cloud storage. During the initial years of technology, the storage was just hardware made up of some magnetic material under the absolute control of computers. As the time passed the structure of the storage systems both physically and logically started developing more innovatively with more security mechanisms. The tremendous growth in the size of data has led to the invention of the different storage media from punch cards, magnetic tapes, hard disk, floppy disk, CDs, to DVDs and presently the Cloud Storage. The need of cloud is recognized when the data have extended the capacity of existing storage technologies and taken the form of BIG DATA which is impossible to store on the CD, DVD, or hard disks on a single computer. Cloud provides the mechanism of storing data securely on the cloud provider's storage at geographically dispersed areas via Internet either free of cost or on pay as you go basis.

II. EVOLUTION OF STORAGE DEVICES

1) **Punch Cards:** Punched cards were the oldest form of data storage, used in 1725. Basile Bouchon used penetrated paper roll in order to design different types of patterns on the cloth with the help of a stored program to control an automated machine. Later in 1976 hisco-worker Jean-Baptiste Falcon made an improvement of Basile's design by making use of penetrated paper cards put together, which made it possible to speedily change the program. The loom designed by Bouchon and later improved by Falcon was semi-automatic and required manual feed of the program. That was the world's first manufacturing automation. In 1801, Joseph Jacquard used punched cards as a weaving machine controlling device to make manufacturing more automatic. In the late 19th century, these cards were used as an input technique for the ancient calculating machines. Herman Hollerith the father of modern automatic calculations patented the mechanism of punch cards on June 8, 1887 and used it in 1890 for the storage and processing of census information in a tabular form. He founded a company which is now known as IBM as developed punch cards later called as IBM Cards which was used for almost 100 years. Punch card can be referred to as first backup device which could be used for data restore in case of data loss.

2) **Punched Tape:** Punched tape was a long ribbon of paper with holes on it to store data. Like punch cards the first version of punched tape was used in weaving looms to create different embroidery designs, where cards fed in to machines with individual instructions that were responsible for the machine movement, later

those instructions fed as a connected stream of cards, which led to the mechanism of communicating data as a continuous card or simply tape instead of a stream of individual cards. In 1846 punched tapes were used to send telegrams by Alexander Bain. In computers, punch tape used both as data input and data output where each row on tape consisted of one character.

3) **Phonograph:** Thomas Edison discovered phonograph late in 1877, the primary device both for recording and reproducing the sound unlike other inventions which could only record sounds. Initially he experimented by recording the sounds on a paraffin paper sheet having the capability of both recording and reproducing the sound. Later he replaced the use of a paper sheet with a thin foil of tin called phonograph cylinder made up of metal material commonly known as records those days. There were two diaphragms and a needle unit, one used for recording and another used for playback.

4) **Telegraphone:** Telegraphone was invented in 1898 by Valdemar Poulsen. It became the first practical magnetic sound recording and reproduction equipment. The various magnetic fields were generated by the sound recorded on a magnetized wire that could be later used for sound play back. It proved successful in receiving attention when it was first put in an exhibition at the Exposition Universelle in Paris.

5) **Magnetic Tape:** German engineer Fritz Pfleumer first patented the magnetic tape in 1928. In 1932, AEG began work on the manufacture of Magnetophon based on the idea of Fritz's magnetic tape. But in 1936, his idea declared as void by German National Court because the idea has been given by him of coating paper tape with iron dust was presented in Poulsen's work. The very first recording with Magnetophon took place in November, 19, 1936 in Ludwigshaven. Magnetic tape was not used for recording data until 1951 on UNIVAC-1. A thin band of nickel coated bronze of 1/2 inch broadly used as a recording medium which could record 128 characters per inch on 8 tracks at a speed of 100 ips, leading to data rate of 12800 characters per second. Later on from 1950 IBM started making use of oxide plated tape, very similar to the one used in audio recording.

6) **Magnetic Drum:** It was found in 1932 by G. Taushek in Austria based on the principle given by Fritz Pfleumer. It consisted of a read/write head for each track and ferromagnetic coating on metal drum. The write head produced electromagnetic pulse when it passed over the ferromagnetic coated metal drum. Polarization of some of the ferromagnetic particle is done to read the recording back. Drum memory was extensively used in the time period of 1950's and 1960's which was an early type of computer memory which worked as main memory for many machine of that time, where data and programs being placed over the drum by using either the paper tape or the punch cards. Core memory later came into existence with no moving parts and faster speed replaced drum memory. Core memory survived until the entry of semiconductor memory.

7) **Williams Tube:** The first random access computer memory was invented at the University of Manchester by Professor Frederick C. Williams and his colleagues. Electrostatic cathode ray tubes were used as digital stores, which were capable of storing 1024 bits of data successfully. Later this capacity was increased to 2048 bits by one of William's colleague named Tom Kilburn. The primary advantage of Williams's tube was that it could address and read any memory location directly.

8) **Selectron Storage Tube:** RCA (Radio Corporation of America) produced random access computer memory like known as Selectron Storage Tube. Its production was initiated in the year of 1946 but due to some reasons it was not by the middle of 1948. Novel Selectron Tube was capable of storing 4096 bits. It was 5/3 inches large vacuum tube with a cathode in the middle. There were two different wires forming a cylindrical grid around cathode, covered with a dielectric material and there was a signal plate in other words a metal conductor on the final layer. Selectron tube was much faster than William's tube but soon they both replaced by even faster core memory.

9) **Delay Line Memory:** Delay line memory works in a similar way of inserting a repeating telephone number from the directory until the number is being dialed by the person. It basically functions by imparting an information pattern into the path of delay. The very basic concept of this memory is to set up a loop which let the recirculation of information pattern that is only possible if the trail part of the delay path connected back to the starting point through amplifying and timing circuits. A column of mercury with Piezo transducers was used to make it which consisted of a combination of speaker and microphone at either end of the tube which worked by sending data to Piezo from computer which in turn generate a wave in mercury which travel through the tube from where the another Piezo read this wave and sent it back to the computer.

10) **Magnetic Core:** In 1949, American physicist, An Wang started working on an earliest form of computer memory named magnetic core also known as ferrite core and became able to patent the system on his own. He worked on by storing information using magnetic ceramic rings from polarity that contain magnetic field by manually assembling core arrays.

11) **Hard Disk:** Rotating platters with a spindle to rotate on are used in hard disk with a magnetic surface which reads and writes the digital data. An electromagnetic fluctuation is transferred through a write head to write data on to the disk closed to a magnetic material which changes the polarization. The same procedure is reversed to read the data back. The computer developed by IBM named IBM 350 disk file in 1956 was the first system with a disk drive with fifty 24 inches platters and total capacity of 5 million characters.

- 12) **Music Tape:** Compact music audio tape was introduced by Philips in 1963 [2]. Initially he used the music tape for dictation machines and it became very popular by 1979 for the purpose of distributing the prerecorded music. The use of music tape in Sony's Walkman became a trend in 1979. Later in the era of 1980's cassettes were being used in so many computers such as TRS-80, Commodore 64, BBC Micro, Amstrad CPC, and ZX Spectrum as an alternate of floppy disk to store programs and data.
- 13) **DRAM:** Dynamic Random Access Memory accumulates information bits in an electric circuit as an electrical charge in a separate capacitor was introduced by Robert H. Dennard in 1966.
- 14) **Twistor Memory:** Twistor memory was strengthened by forming magnetic tape around a wire that produces electric current, at Bell Labs. It was used at Bell Labs between 1968 and 1970 and later it was totally replaced by RAM chips.
- 15) **Bubble Memory:** Bubble Memory was discovered in 1970 by Andrew Bobeck [6] which accumulates a single of information in bubble like diminutive magnetized area inside emaciated magnetic recording film. The disadvantage of bubble memory was its slow access.
- 16) **8" Floppy:** In order to load microcode into System/370 mainframes IBM initiated creating a simple and reasonably priced system which should be quicker than tape drives named as 8 inch Floppy Disk which can be read and written to a floppy drive in 1967. It makes up of a supple, circular and simple magnetic storage medium encompassed in a plastic wallet and capable of storing 80 kilobytes of data.
- 17) **5.25" Floppy:** 5.25" Floppy was introduced by Alan Shugart in 1976 [3]. It was very compact in size as compared to 8 inches floppy which was very big for computers. Also this disk was much cheaper than 8 inches floppy. Up till this time, only one side of the floppy could be used but later in 1978 two sided for the purpose of reading 5.25 inch floppy was developed. Also the capacity of floppy increased to 360 kilobytes.
- 18) **Compact Disk:** During 1960 James T. Russell [3] came up with an idea of recording and replying music by using light. In order to give a structure to his idea he invented optical digital television recording and playback machine in 1970, but his work did not recognise much. In 1975 Philips representatives came to James's lab, they paid James millions of dollars and asked him to develop CD based on his original idea. In 1980, after completion of CD development they presented it to Sony. Then the very first CD player was developed called CD-101 by Sony.
- 19) **3.5" Floppy Disk:** A 3.5 inch floppy disk unlike its predecessors had a metal cover which provided protection against external damages to the magnetic film inside. It could store 360 KB information single- sided initially and later its capacity increased to 720 KB double- sided format. Later HD format developed which was capable of storing 1440 KB data and used by IBM on their PS/2 in 1987.
- 20) **CD-ROM:** The physical format used to store digital data in Compact Disk Read Only Memory was similar to an audio compact disk. It can encompass 650- 700 MB data by encoding the small bits of data into the lower surface of plastic disk. Sony and Philips first established a standard for CD- ROM named yellow-book.
- 21) **Digital Audio Tape:** A signal recording and playback machine was developed by Sony in 1987 named Digital Audio Tape (DAT). DAT resembles to audio cassette with 4mm magnetic tape placed in a protective shell to store digital data.
- 22) **Digital Data Storage:** Sony and Hewlett Packard introduced a format called Digital Data Storage based on DAT for data storage and backup solutions utilizing magnetic tape in 1989.
- 23) **Magneto Optical Disk:** MOD emerged in the year of 1990. Two technologies optical and magnetic are used in this optical disk format. Special optical drive is required to read such disk. It comes in two sizes 3.5" and 5.25" with a capacity one of 128MB/230MB/540 MB/640MB/1.3GB/2.6GB.
- 24) **Mini Disc:** This storage device is capable of storing any type of digital information especially audio. This storage device was introduced by Sony in 1992. It was a replacement for audio cassette tapes. In 1993 Sony introduced MD for storing computer data, but it proved not that much successful to gain the interest of people so nowadays this storage device is only used for audio data.
- 25) **Digital Linear Tape:** Digital Equipment Corporation was the initiator of DLT and later Quantum Corporation purchased DLT in 1994. DLT invented as an alternative to magnetic tape storage for computer data storage.
- 26) **Compact Flash:** It is also referenced as flash drives that made use of flash memory to store digital data in an embedded disk. It is more robust, non- volatile and solid as compared to other disk drives, utilize power around 5%, and function at 3.3 or 5 volts. CF devices are used in digital cameras, laptops, desktop computers.
- 27) **Zip:** A removable disk storage system known as Zip was invented by Lomega in 1994. Zip is used to store digital files with much faster speed than floppy drives but little slower than hard disk drives. Seek time of the original Zip drive is about 28 milliseconds with 1MB/sec data transfer rate which is much higher than floppy drive with 500KB/sec transfer rate and several hundred milliseconds average seek time, also in Zip system the concept of write protection and media access protection was introduced via passwords for the first time.
- 28) **DVD:** DVD became successful to get the position of the next generation of digital disk storage. It is much faster, bigger in capacity, better option for storing multimedia data including audio, video, still pictures,

and computer data. It became profitable to replace audio CD, CD-ROM laser disk, video tape and video game cartridges. After 6 years of introduction of DVD in the year of 2003, there were about 250 million DVD playback devices such as DVD players, DVD PCs, and DVD game consoles.

29) Smart Media: Toshiba introduced Smart Media a flash memory card standard initially named as Solid State Floppy Disk Card, in 1995 which became competition for intel's MiniCard and SanDisk's Compact Flash memory [2]. A single NAND flash with EEPROM chip built-in a thin plastic card is used in the configuration of Smart Media. The primary benefit of it is its lower cost because of the lack of built-in controller. Usually it is used for portable devices such as digital camera can make use of it for storing images and user can take store the images from camera to computer with Smart Media Reader.

30) Phase writer Dual: Phasewriter Dual was introduced by Panasonic in 1995, the first device that used phase change technology to store digital data but CD-Rom and later DVD replaced this device.

31) Advanced Intelligent Tape: Sony invented AIT a magnetic tape format for computer storage used as a backup system only by using the Digital Audio Tape format. The storage capacity of AIT is 4th times larger than DAT.

32) CD-RW: Extended version of CD-ROM is CD-RW (Compact Disk Rewritable) which allows rewriting data over the previously stored data. Approximately 700MB of digital data around 700 times can be written on CD-RW with CD-RW drive.

33) Multimedia Card: Siemens and SanDisk introduced Multimedia Card in 1997 to store digital data based on the concept of Toshiba's Smart Card NAND flash memory [2]. It is 24mm*32mm*1.5mm in size which is much smaller than Compact Flash. It can be used in any of the devices such as cell phones, mp3 players, digital cameras, and PDAs which support SD cards especially in portable devices.

34) Microdrive: The earliest generation Microdrive was introduced by IBM, a mini hard disk with Compact Flash Card format with a capacity of 340 MB at initial time, later with a capacity of 512 MB and 1GB. NASA used the first version of Microdrive.

35) USB Key: USB key is a small, lightweight, removable NAND based, easy to carry flash data storage device. It is also known as a pen drive, key drive, USB stick, jump drive, thumb drive, flash drive, vault drive, USB key. It gets activated only when it is connected to a USB computer and no other external power is required for it.

36) SD Card: Flash memory based digital storage SD Card incorporates DRAM encryption aspect for faster file transfer along with Toshiba's Multimedia Card format. Size of standard SD Card is 32mm*24mm*2.1mm. SD cards are typically used in digital cameras for storing images.

37) Blu-ray Disk: Blu-ray Disk was introduced to store high definition video and high density data which became the next generation of digital data storage. A considerable amount of data can be stored in blue-ray as compared to DVD because of its shorter wavelength blue laser.

38) XD-Picture Card: Olympus and Fujifilm unveiled xD-Picture Card in 2002 based on flash memory format. It is utterly used in Fujifilm and Olumpus digital cameras. Cameras use it to store images and with the help of a card reader the images from the camera can be transferred to the computer. Now a day's computer and laptops come with xD slots. Its size is much smaller as compared to the SD card with 20mm* 25mm* 1.78mm and weight about 2.8g. The primary disadvantage of the xD card is its limited support and availability, greater cost as compared to SD cards.

39) HD-DVD: Toshiba, NEC, and Sanyo supported HD-DVD (High Definition Digital Versatile Disk) which is very much similar to Blu-ray Disk with almost same size and 405nm wavelength blue lasers. It is used to store digital data with high quality.

40) Holographic Memory: Digital information with high density can be stored into crystals or photopolymers by using Holographic technology, the next generation of storage media. Rather than using only surface of the disc to store data, it uses a volume of recording media to store digital data with 3D feature which is the primary advantage of it. Holographic memory is divided into two categories one is write once and another is rewritable media.

41) Cloud Storage (The Online Backup Solution): Cloud storage is a promising technology that provides storage, computing power, network and software as an abstraction and as a service over the Internet. This technology enables its clients to access these services remotely from anywhere, anytime. The primary benefit of cloud computing is that the clients do not need to disburse for the infrastructure, its deployment, the expertise to handle and maintain such infrastructure. Cloud Storage provides a great level of online backup facility to the users who don't want to store their backup files on their own premises because of the danger of disaster or other sites related problems.

III. THE CLOUD ERA

The concept of cloud [9] started establishing its roots back in 1950s with the introduction of large mainframes. The mainframe's gigantic hardware infrastructure was deployed in a server room which was

capable of holding only a single mainframe and multiple users access the mainframe by means of “static terminals”- whose solitary purpose was to aid access to the mainframes.

Later in 1970s, an operating system called VM was released by IBM that enabled the administrators to install multiple virtual machines on their mainframe system (System/370). Introduction of the VM operating system took the concept of shared mainframe access to one step ahead by permitting the installation of several different compute environments on the same physical environment.

After that in 1990s, the telecommunications companies that had begun providing virtualized private network connections with the same service quality as their dedicated point-to-point services at a reduced cost. Telecommunication companies became able to provide shared access to the same physical infrastructure to their users instead of deploying the separate physical infrastructure for the different users.

Later when the demand of users increased to get online, server virtualization in shared environment was the viable way to serve that demand.

Because all of these new inventions the basic indulgent of “cloud computing” initiated online. With the installation and configuration of hypervisor, system became capable of providing all the resources secreted across the entire system environment as the resources were in a single physical node.

IV. CLOUD STORAGE PROVIDERS

There are a number of vendors who offer cloud storage nowadays with varying capacity. However, the best cloud storage providers provide more than just storage which includes availability, security, integrity, multi-platform support, app integration and much more. Following are the various cloud storage providers in the market:

- 1) **Dropbox:** Dropbox provides cloud storage, file synchronization, and client software. Dropbox provides a basic plan of 2GB space free of cost, but you can get more plans by paying or by other ways.
- 2) **Google Drive:** Google unveiled Google Drive in 2012, which provides online storage and file synchronization facilities, also users can share their documents, presentations, spreadsheets, images, videos etc publicly on Google Drive. It provides 15 GB space free of cost, this space can be extended to 100 GB, 16 TB on monthly paid bases.
- 3) **SkyDrive:** SkyDrive is the Microsoft’s Cloud storage service. It provides 7 GB free space and within a year 3 GB more space is provided free of cost to the students. Also the different storage plans available on SkyDrive.
- 4) **SugarSync:** SugarSync provides 5GB free space and many attractive paid plans. It offers file synchronization, sharing, and file backup.
- 5) **Bitcasa Infinite Drive:** An American cloud storage company unveiled Bitcasa in 2011 which provides up to 10 GB free storage and offers more space on paid bases.
- 6) **Nitro Cloud:** Nitro Cloud is another name in the field of online cloud storage which also provides backup facility and offers security to your stuff by implementing encryption.
- 7) **Gmail, Hotmail, and Yahoo:** Gmail, Hotmail and Yahoo e-mail providers stores the e-mail messages on their own servers and users can access their e-mail from their computers or any device connected to Internet.
- 8) **Flicker and Picasa:** Flicker and Picasa provide the facility of making online photo albums by uploading the images on to their servers.
- 9) **YouTube:** Millions and trillions of people can upload their videos on to YouTube servers.

V. SECURITY AND PRIVACY ISSUES IN CLOUD STORAGE

Although cloud computing provides so many benefits to the real world but still it’s not free from issues. The various security challenges posed by cloud storage are as follows:

- 1) **Hacking:** Consumers store their valuable data outside their security boundaries without knowing the actual storage location of data; therefore the security risks get increased than normal. Hacking and many such attacks can affect the clients’ data stored on the cloud infrastructure
- 2) **Data Integrity:** Cloud infrastructure does not impose such security mechanisms to cope with the issue of data integrity. If the cloud is not secure, anyone can access data from anywhere and can make changes in it and restores on the cloud.
- 3) **Data Theft:** It can be a situation where the cloud vendor has to hire more servers on lease from some other cloud vendor in order to serve more users demands. However, the consumer is not aware about this situation so there is great risk of data theft by some intruder from the external servers hired.
- 4) **Data Attacks during Transmission:** As users store and access their data on cloud storage via internet remotely, therefore the risk of various attacks such as denial of service, DNS spoofing, eavesdropping threaten the security of confidential data during transmission.

- 5) **Privacy Issues:** The cloud provider must ensure the security and confidentiality of the client's private data. Since the client's data can be stored on leased servers so the provider must incorporate the mechanisms to restrict the access of user's data to authenticated persons.
- 6) **Infected Applications:** If the cloud is not secure as essential then there can be a case where some malicious user can access the consumer's data and restores it on the cloud by adding its own malicious files.
- 7) **Data Loss:** Data can be lost during its transmission over the Internet and also while it is resting on the cloud storage.
- 8) **Security on Provider Side:** Vendor must provide some effective security techniques to ensure the integrity, privacy, security, and confidentiality [11] of the client's data both from external attackers as well as from internal attackers.
- 9) **Security on Users Side:** instead of taking the advantage of security schemes provided by cloud provider, the clients must also ensure the security of data on their own level.
- 10) **Interoperability and Portability:** Consumers must be permitted to migrate from one cloud to other. In other words there must be no restrictions on consumers to switch from one cloud provider to other securely whenever they want.
- 11) **Reliability and Availability:** There is still a need of providing 'round-the-clock' service at the cloud provider's side; in the absence of which it become near to difficult to provide the agreed availability and reliability of offered services. A major risk in the cloud environment is loss of internet connectivity (that could occur in a range of circumstances such as natural disasters) as businesses are dependent on the internet access to their corporate information [12].

In order to mitigate all these issues cloud provider try to make their cloud highly secure by deploying the various strategies such as Authorization, Authentication, User Roles, Database Roles, Encryption, Hashing and many more.

VI. CONCLUSION

As the time passes the demand for the larger data stores increases. In the modern era of technology, the data have taken the form of BIG DATA which describes the exponential growth of both structured and unstructured data. Now the data have reached the size of zeta bytes and yotta bytes which is not possible to store on the classical devices such as hard disks, CDs, DVDs. Cloud Storage is the solution for encompassing such BIG DATA in a distributed manner on geographically dispersed servers.

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