DOWNLOAD PDF MAGNETIC STORAGE HANDBOOK

Chapter 1 : Mee C. (Author of Magnetic Storage Handbook)

*Magnetic Storage Handbook [C. Mee, Eric Daniel] on www.nxgvision.com *FREE* shipping on qualifying offers. This is a new edition of the definitive reference - everything you need to keep pace with today's fast-changing field.*

Van Wijngaarden, Kees A. Areas Commun , " New methods are presented to protect maximum runlength-limited sequences against random and burst errors and to avoid error propagation. The methods employ parallel conversion techniques and enumerative coding algorithms that transform binary user information into constrained codewords. The new schemes have a low complexity and are very efficient. The approach can be used for modulation coding in recording systems and for synchronization and line coding in communication systems. The schemes enable the usage of high-rate constrained codes, as error control can be provided with similar capabilities as for unconstrained sequences. Index TermsBurst correction codes, enumerative coding, forward error correction, modulation coding, Reed--Solomon codes, runlength codes, synchronization. Show Context Citation Context In Section V, we propose several combinatorial constructions of specific high-rate constrained codes. The codes arise in the context of coding for channel Gavril , " Until some potentially superior technology such as perpendicular recording becomes practical, several solutions were proposed to extend the longitudinal recording. Among them, the most promising in this stage of evolution of magnetic recording seems to be the magnetic recording media with thermal st Among them, the most promising in this stage of evolution of magnetic recording seems to be the magnetic recording media with thermal stabilization layers and the recording media comprising monodisperse high-anisotropy nanoparticles in a self-organized patterning. Both these types of media have been found to have higher thermal stability delaying the superparamagnetic effect , low noise and higher signal resolution which, in turn, led to higher areal density and a better signal-to-noise ratio. The media with thermal stabilization layers consist of two antiferromagnetically coupled ferro-magnetic layers. On the other hand, the self-organized patterned media permit the better control of the film surface, of the uniformity of the composition, of the geometry of constituent nanoparticles and their magnetic easy axis orientation which led to the improvement of recording properties. Understanding the magnetic properties of these media ensures the control of the reversal and stability of these systems, and is essential in determining their storage potential and in achieving their design. With the rapid growth of the production and storage of large scale data sets it is important to investigate methods to drive the cost of storage systems down. Many energy conservation techniques have been proposed to achieve high energy efficiency in disk systems. Unfortunately, growing evidence sho Unfortunately, growing evidence shows that energy-saving schemes in disk drives usually have negative impacts on storage systems. Existing reliability models are inadequate to estimate reliability of parallel disk systems equipped with energy conservation techniques. To solve this problem, we firstly propose a mathe-matical model- called MINT- to evaluate the reliability of a parallel disk system where energy-saving mechanisms are implemented. The capacity of hard drives has grown exponentially over time. When hard drives became available for personal computers PCs , they only offered five-megabytes capacity. During the mids, the ty

Chapter 2 : Magnetic tape data storage - Wikipedia

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Open reels[edit] Initially, magnetic tape for data storage was wound on Tape cartridges and cassettes were available starting in the mids and were frequently used with small computer systems. With the introduction of the IBM cartridge in , large computer systems started to move away from open reel tapes and towards cartridges. Of the eight tracks, six were data, one was a parity track , and one was a clock, or timing track. Making allowances for the empty space between tape blocks, the actual transfer rate was around 7, characters per second. IBM computers from the s used ferrous-oxide coated tape similar to that used in audio recording. Magnetic tape dimensions were 0. Most tape drives could support a maximum reel size of Between servo control of powerful reel motors, a low-mass capstan drive, and the low-friction and controlled tension of the vacuum columns, fast start and stop of the tape at the tape-to-head interface could be achieved: When active, the two tape reels thus fed tape into or pulled tape out of the vacuum columns, intermittently spinning in rapid, unsynchronized bursts resulting in visually striking action. Stock shots of such vacuum-column tape drives in motion were widely used to represent "the computer" in movies and television. This was known as seven-track tape. Recording density increased over time. Common seven-track densities started at six-bit characters per inch CPI , then , and finally The end of a file was designated by a special recorded pattern called a tape mark , and end of the recorded data on a tape by two successive tape marks. The physical beginning and end of usable tape was indicated by reflective adhesive strips of aluminum foil placed on the back side. They were essentially a personal storage medium. The tape was 0. LINCtapes and DECtapes had similar capacity and data transfer rate to the diskettes that displaced them, but their "seek times" were on the order of thirty seconds to a minute. In the context of magnetic tape, the term cassette usually refers to an enclosure that holds two reels with a single span of magnetic tape. The term cartridge is more generic, but frequently means a single reel of tape in a plastic enclosure. A tape drive that uses a single reel cartridge has a takeup reel in the drive while cassettes have the take up reel in the cassette. This type is similar to a cassette in that there is no take-up reel inside the tape drive. Compact cassettes were logically, as well as physically, sequential; they had to be rewound and read from the start to load data. Early cartridges were available before personal computers had affordable disk drives, and could be used as random access devices, automatically winding and positioning the tape, albeit with access times of many seconds. The term BPI can mean bytes per inch when the tracks of a particular format are byte organized as in 9-track tapes. Half-inch has historically been the most common width of tape for high-capacity data storage. Recording method is also an important way to classify tape technologies, generally falling into two categories: The linear method arranges data in long parallel tracks that span the length of the tape. Multiple tape heads simultaneously write parallel tape tracks on a single medium. This method was used in early tape drives. It is the simplest recording method, but also has the lowest data density. Each head still writes one track at a time. After making a pass over the whole length of the tape, all heads shift slightly and make another pass in the reverse direction, writing another set of tracks. This procedure is repeated until all tracks have been read or written. Compared to simple linear recording, using the same tape length and the same number of heads, data storage capacity is substantially higher. Tape heads are placed on a drum or disk which rapidly rotates while the relatively slowly moving tape passes it. In this method a spinning disk, with the tape heads embedded in the outer edge, is placed perpendicular to the path of the tape. Another early method was arcuate scan. In this method, the heads are on the face of a spinning disk which is laid flat against the tape. The path of the tape heads forms an arc. This method is used by virtually all current videotape systems and several data tape formats. However, since the rate at which data is written or read to the tape drive is not deterministic, a tape drive usually has to cope with a difference between the rate at which data goes on and off the tape and the rate at which data is supplied or demanded by its host. Various methods have been used alone and in combination to cope with this difference. If the host cannot keep up with the tape drive transfer rate, the tape drive can be stopped, backed up, and restarted known as shoe-shining , with the restart optionally occurring at a lower speed. A large memory buffer can be used to queue the data. The Linear Tape-Open article covers this. Modern tape drives offer a speed matching feature, where the drive can dynamically decrease the physical tape speed as needed to avoid shoe-shining. On most modern drives, this is no longer true. Linear Tape-Open type drives use a fixed size block for tape, independent of the host block size, and the inter-block gap is variable to assist with speed matching during writes. On drives with compression, the compressibility of the data will affect the capacity. Sequential access to data[edit] Tape is characterized by sequential access to data. While tape can provide fast sequential data transfers, it takes tens of seconds to load a cassette and position the tape head to an arbitrary place. By contrast, hard disk technology can perform the equivalent action in tens of milliseconds 3 orders of magnitude faster and can be thought of as offering random access to data. Logical filesystems require data and metadata to be stored on the data storage medium. Storing metadata in one place and data in another requires lots of slow repositioning activity on most tape systems. As a result, most tape systems use a trivial filesystem in which files are addressed by number not by filename. Metadata such as file name or modification time is typically not stored at all. Tape labels store such metadata, and they are used for interchanging data between systems. Serpentine tape drives e. This makes it possible to copy and paste files or directories to a tape as if it were just like another disk, but does not change the fundamental sequential access nature of tape. Access time[edit] Tape has quite a long latency for random accesses since the deck must wind an average of one-third the tape length to move from one arbitrary data block to another. Most tape systems attempt to alleviate the intrinsic long latency, either using indexing, where a separate lookup table tape directory is maintained which gives the physical tape location for a given data block number a must for serpentine drives , or by marking blocks with a tape mark that can be detected while winding the tape at high speed. There are several algorithms which provide similar results: Embedded in tape drive hardware, these compress a relatively small buffer of data at a time, so cannot achieve extremely high compression even of highly redundant data. A ratio of 2: The ratio actually obtained with real data is often less than the stated figure; the compression ratio cannot be relied upon when specifying the capacity of equipment, e. Data that is already stored efficiently may not allow any significant compression; a sparse database may offer much larger factors. The compression algorithms used in low-end products are not the most effective known today, and better results can usually be obtained by turning off hardware compression AND using software compression and encryption if desired instead. Encryption[edit] Standards exist to encrypt tapes. Key management is crucial to maintain security. Encryption is more efficient if done after compression, as encrypted data cannot be compressed effectively. Some enterprise tape drives can quickly encrypt data. Symmetric streaming encryption algorithms can also provide high performance. Cartridge memory and self-identification[edit] Some tape cartridges, notably LTO cartridges , have small associated data storage chips built into the cartridges to record metadata about the tape, such as the type of encoding, the size of the storage, dates and other information. It is also common for tape cartridges to have bar codes on their labels in order to assist an automated tape library. Viability[edit] As of , Medium and large-sized data centers deployed both tape and disk formats. Until about the end of the twentieth century, prices and capacities allowed backing up a desktop hard drive to tape more cheaply and more compactly than backing up to an additional external or removable drive. Drive prices offer capacities of hundreds to thousands of megabytes on relatively inexpensive machines. Backing up to an external USB drive became cheaper, and the drive more compact, than tape for a non-networked machine used by a business or serious user. At any single moment in time each TC tape drive can read or write or both read and write [citation needed] to one tape cartridge which can contain up to 5TB of uncompressed data. However, the key difference is that tape drives can exchange their magnetic media the cartridges frequently, while the magnetic media installed inside each hard disk is fixed and cannot be swapped. The drives themselves could be moved if installed in swappable caddies at extra cost, with extra cost hot-swappable infrastructure. Mainframe-class tape drives are almost always installed in robotic tape libraries which are often quite large and can hold thousands of cartridges. The StorageTek SL library is one representative example. The smallest SL library holds up to 1, tape cartridges, for 1. The tape library would likely deliver a higher sustained sequential write speed, the media would be more rugged for off-site storage , the media would meet or exceed long-term archival storage requirements for reliable retrieval decades into the future , and the data center power and cooling requirements would be considerably lower. What has tended to happen in recent years is that the amount of data has grown exponentially[citation needed], with both disk especially and tape participating in the growth. Chronological list of tape formats[edit].

Chapter 3 : Magnetic Storage - How Removable Storage Works | HowStuffWorks

Magnetic Storage Handbook Ieee 2 E Magnet wikipedia, a magnet is a material or object that produces a magnetic fieldthis magnetic field is invisible but is responsible for the most notable property of.

History[edit] Magnetic storage in the form of wire recording â€”audio recording on a wireâ€”was publicized by Oberlin Smith in the Sept 8, issue of Electrical World. The first publicly demonstrated Paris Exposition of magnetic recorder was invented by Valdemar Poulsen in In , Fritz Pfleumer developed the first magnetic tape recorder. Early magnetic storage devices were designed to record analog audio signals. Computers and now most audio and video magnetic storage devices record digital data. Design[edit] Hard drives use magnetic memory to store giga- and terabytes of data in computers. Information is written to and read from the storage medium as it moves past devices called read-and-write heads that operate very close often tens of nanometers over the magnetic surface. The read-and-write head is used to detect and modify the magnetisation of the material immediately under it. There are two magnetic polarities, each of which is used to represent either 0 or 1. The magnetic surface is conceptually divided into many small sub- micrometer -sized magnetic regions, referred to as magnetic domains, although these are not magnetic domains in a rigorous physical sense , each of which has a mostly uniform magnetisation. Due to the polycrystalline nature of the magnetic material each of these magnetic regions is composed of a few hundred magnetic grains. Each magnetic region in total forms a magnetic dipole which generates a magnetic field. In older hard disk drive HDD designs the regions were oriented horizontally and parallel to the disk surface, but beginning about , the orientation was changed to perpendicular to allow for closer magnetic domain spacing[citation needed]. Older hard disk drives used iron III oxide Fe2O3 as the magnetic material, but current disks use a cobalt -based alloy. Magnetic domains written too close together in a weakly magnetisable material will degrade over time due to rotation of the magnetic moment of one or more domains to cancel out these forces. The domains rotate sideways to a halfway position that weakens the readability of the domain and relieves the magnetic stresses. A write head magnetises a region by generating a strong local magnetic field, and a read head detects the magnetisation of the regions. Early HDDs used an electromagnet both to magnetise the region and to then read its magnetic field by using electromagnetic induction. As data density increased, read heads using magnetoresistance MR came into use; the electrical resistance of the head changed according to the strength of the magnetism from the platter. Later development made use of spintronics ; in read heads, the magnetoresistive effect was much greater than in earlier types, and was dubbed "giant" magnetoresistance GMR. The read element is typically magneto-resistive while the write element is typically thin-film inductive. The record and playback head are mounted on a block called a slider, and the surface next to the platter is shaped to keep it just barely out of contact. This forms a type of air bearing. Magnetic recording classes[edit] Main article: Magnetic tape sound recording Analog recording is based on the fact that remnant magnetisation of a given material depends on the magnitude of the applied field. The magnetic material is normally in the form of tape, with the tape in its blank form being initially demagnetised. When recording, the tape runs at a constant speed. The writing head magnetises the tape with current proportional to the signal. A magnetisation distribution is achieved along the magnetic tape. Finally, the distribution of the magnetisation can be read out, reproducing the original signal. The magnetic tape is typically made by embedding magnetic particles approximately 0. The most commonly-used of these was ferric oxide, though chromium dioxide, cobalt, and later pure metal particles were also used. Analog recording was the most popular method of audio and video recording. Since the late s, however, tape recording has declined in popularity due to digital recording [5]. Examples of digital recording are floppy disks and hard disk drives HDDs. Digital recording has also been carried out on tapes. When writing, the magnetic medium is heated locally by a laser , which induces a rapid decrease of coercive field. Then, a small magnetic field can be used to switch the magnetisation. The reading process is based on magneto-optical Kerr effect. The magnetic medium are typically amorphous R-FeCo thin film R being a rare earth element. Magneto-optical recording is not very popular. One famous example is Minidisc developed by Sony. Domain propagation memory[edit] Domain propagation memory is also called bubble memory. The basic idea is to control domain wall motion in a magnetic medium that is free of microstructure. Bubble refers to a stable cylindrical domain. Domain propagation memory has high insensitivity to shock and vibration, so its application is usually in space and aeronautics. Access method[edit] Magnetic storage media can be classified as either sequential access memory or random access memory , although in some cases the distinction is not perfectly clear. The access time can be defined as the average time needed to gain access to stored records. Accessing different parts of the wire involves winding the wire forward or backward until the point of interest is found. The time to access this point depends on how far away it is from the starting point. The case of ferrite-core memory is the opposite. Every core location is immediately accessible at any given time. Hard disks and modern linear serpentine tape drives do not precisely fit into either category. Different spots on the storage media take different amounts of time to access. For a hard disk this time is typically less than 10 ms, but tapes might take as much as s. Current usage[edit] As of [update] , common uses of magnetic storage media are for computer data mass storage on hard disks and the recording of analog audio and video works on analog tape. Since much of audio and video production is moving to digital systems, the usage of hard disks is expected to increase at the expense of analog tape. Digital tape and tape libraries are popular for the high capacity data storage of archives and backups. Floppy disks see some marginal usage, particularly in dealing with older computer systems and software. Future[edit] A new type of magnetic storage, called magnetoresistive random-access memory or MRAM, is being produced that stores data in magnetic bits based on the tunnel magnetoresistance TMR effect. Its advantage is non-volatility, low power usage, and good shock robustness. The 1st generation that was developed was produced by Everspin Technologies , and utilized field induced writing.

Chapter 4 : Magnetic storage - Wikipedia

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Many storage technologies have been considered in the context of utility-scale energy storage systems. For example, pumped hydro is best suited for large-scale bulk electrical energy storage if suitable geographic topology, geology and environmental conditions exist. Pumped hydro generating stations have been built capable of supplying MW of electricity for four to six hours. This technology is based on three concepts that do not apply to other energy storage technologies EPRI, First, some materials carry current with no resistive losses. Second, electric currents produce magnetic fields. Third, magnetic fields are a form of pure energy which can be stored. SMES combines these three fundamental principles to efficiently store energy in a superconducting coil. SMES was originally proposed for large-scale, load levelling, but, because of its rapid discharge capabilities, it has been implemented on electric power systems for pulsed-power and systemstability applications EPRI, Figure 1 is an illustration of a commercially produced SMES product. Illustration of an application of SMES. As can be seen, the SMES unit supports the site to which it is connected in order to maintain system stability. The combination of the three fundamental principles current with no restrictive losses; magnetic fields; and energy storage in a magnetic field provides the potential for the highly efficient storage of electrical energy in a superconducting coil. Operationally, SMES is different from other storage technologies in that a continuously circulating current within the superconducting coil produces the stored energy. As a result, there are none of the inherent thermodynamic losses associated with conversion of one type of energy to another EPRI, The original development of SMES systems was for load levelling as an alternative to pumped hydroelectric storage. Thus, large energy storage systems were considered initially. Research and then significant development were carried out over a quarter century, beginning in the early s. Internationally, Japan had a significant program for about 20 years, and several European countries participated at a modest level. At several points during the SMES development process, researchers recognized that the rapid discharge potential of SMES, together with the relatively high energy related coil costs for bulk storage, made smaller systems more attractive and that significantly reducing the storage time would increase the economic viability of the technology. Thus, there has also been considerable development on SMES for pulsed power systems. Duue to its rapid discharge capabilities the technology has been implemented on electric power systems for pulsed power and system stability applications. The discharge capabilities of SMES compared to several other energy storage technologies is illustrated in Figure 2. Illustration of the system power rating and the discharge time of several energy storage technologies. As can be seen, SMES has a relatively low power system rating, but has a high discharge rate. While SMES currently is only applied in small scale system stability applications, there are several design and development programs for large-scale SMES plants. This description also briefly covers these design and development programs, even though they mostly stem from the s and early s. Feasibility of technology and operational necessities top: Independent of capacity and size a SMES system always includes a superconducting coil, a refrigerator, a power conversion system PCS , and a control system as shown in Figure 3. Each of these components is discussed in this section. This section also covers the technical attributes of SMES. The maximum stored energy is determined by two factors: The larger the coil, the greater the stored energy; and b the characteristics of the conductor, which determines the maximum current. Superconductors carry substantial currents in high magnetic fields EPRI, All practical SMES systems installed to date use a superconducting alloy of niobium and titanium Nb-Ti , which requires operation at temperatures near the boiling point of liquid helium, about 4. However, the state of development of these materials today is such that they are not cost effective for SMES. Since only a few SMES coils have been constructed and installed, there is little experience with ageneric design. This is true even for the small or micro-SMES units for power-quality applications, where several different coil designs have been used. A primary consideration in the design of a SMES coil is the maximum allowable current in the conductor. The magnetic forces can be significant in large coils and must be reacted by a structural material. The mechanical strength of the containmentstructure within or around the coil must withstand these forces. Cryogenic Refrigerator The superconducting SMES coil must be maintained at a temperature sufficiently low to maintain a superconducting state in the wires. As mentioned, for commercial SMES today this temperature isabout 4. Reaching and maintaining this temperature is accomplished by a special cryogenic refrigerator that uses helium as the coolant. Helium must be used as the so called"working fluid" in such a refrigerator because it is the only material that is not a solid at these temperatures. Just as a conventional refrigerator requires power to operate, electricity isused to power the cryogenic refrigerator EPRI, As a result, there is a tremendous effort in the design of SMES and other cryogenic systems to lower losses within the superconducting coils and to minimize heat flow into the cold environment from all sources. The coil carries a current at any state of charge. Since the current always flows in one direction, the power conversion system PCS must produce a positive voltage across the coil when energy is to be stored, which causes the current to increase. Similarly, for discharge, the electronics in the PCS are adjusted to make it appear as a load across the coil. This produces a negative voltage causing the coil to discharge. The product of this applied voltage and the instantaneous current determine the power. SMES manufacturers design their systems so that both the coil current and the allowable voltage include safety and performance margins. The PCS provides an interface between the stored energy related to the direct current in the coil and the AC in the power grid. Control System The control system establishes a link between power demands from the grid and power flow to and from the SMES coil. It receives dispatch signals from the power grid and status information from the SMES coil. The integration of the dispatch request and charge level determines the response of the SMES unit. The control system also measures the condition of the SMES coil, the refrigerator, and other equipment. It maintains system safety and sends system status information to the operator. Figure 3 illustrates how these components are connected in a SMES system. Schematic of the components of the SMES system. Information derived from the EPRI study. In general, the maximum power capacity is the smaller of two quantities: It is the product of the power capacity and the length of time the installation is to deliver this power. Each of these depends on a variety of factors. The coil mounted in a cryostat is often one of the smaller elements. For small power quality systems, on the other hand, the overall system efficiency is less. Fortunately, in these applications, efficiency is usually not asignificant economic driver. The SMES coil stores energy with absolutely no loss while the current is constant. There are, however, some losses associated with changing current during charging and discharging, and the resulting change in magnetic field. In general, these losses, which are referred to as eddy current and hysteresis losses, are also small. Unfortunately, other parts of the SMES system may not be as efficient as the coil itself. In particular, there are two potentially significant, continuous energy losses, which are application specific: The current in the coil must flow continuously, and it circulates through the PCS. Both the interconnecting conductors and the silicon-based components of the PCS are resistive. Thus, there are continuous resistive losses in the PCS. This is different from batteries, for example, where there is current in the PCS only during charge and discharge. The overall efficiency of a SMES plant depends on many factors. Power quality and system stability applications do not require high efficiency because the cost of maintenance power is much less than the potential losses to the user due to a power outage. Developers rarely quote efficiencies for such systems, although refrigeration requirements are usually specified. Status of the technology and its future market potential top: In Table 1 an illustration of the development status of several key energy storage technologies is given. As can be seen, SMES is a technology that is still largely in the developmental stage. Especially for grid applications, SMES technology is a long-term technology. Development status of several key energy storage technologies.

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Understanding the magnetic properties of these media ensures the control of the reversal and stability of these systems, and is essential in determining their storage potential and in achieving their design.

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