CSULB — College of Engineering

Computer Engineering

Ethics Report

CECS 490A

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Table of Contents

Summary

As Moore's Law comes to a halt in the realm of processing power and CPUs, the secondary storage sector faces a similar problem of increasing data density: how can hard drive manufacturers increase the amount of data that will fit on the same amount of physical space on a hard drive? Or equivalently, how can they decrease the amount of physical disk space that a given amount of data will take up? One solution to this problem is shingled magnetic recording (SMR) technology, as opposed to conventional magnetic recording (CMR) technology (also known as perpendicular magnetic recording (PMR) technology). According to Le et al., CMR works by having the data "tracks" be separate from each other, so that each track can be written to and read from individually; however, SMR works by overlapping different data tracks so that instead of there being a "buffer" between adjacent tracks, one track is written on top of the other (856). The tracks are "shingled" or overlapped with one another just like shingles on a roof. This creates tracks that are much smaller, allowing for more data to be written onto the disk. The disk can read from these smaller tracks with no problem; the problem lies in updating or rewriting data. Since each track is written over another track, if the user wants to update data on his or her HDD, the physical location in question on the disk must be overwritten, which means that the data on the next track over will be destroyed. In order to restore it, the disk must save it and rewrite the same data, which will then cause the *next* track to be destroyed; this process will continue until the end of the disk is reached, meaning that if the user wants to rewrite some data on a fully-shingled disk, and that data happens to be located at the very beginning of the disk, the whole disk must be rewritten (Le et al. 857). Note that this problem does not exist for appending

data to the disk, since there is no data to destroy by overwriting the next track over (since it does not exist yet), so SMR drives are by design optimized for long-term storage where data is rarely overwritten. Also, SMR drives usually employ “bands” of data tracks so that this “domino effect” does not spiral out of control (Le et al. 857). Another fact about SMR drives is the fact that in order to avoid replacing data and rewriting the entire disk, the updated data is simply written to a new location (the end of the track) and the old location is freed by a garbage collector (Niu et al. 86). This creates yet another weakness in terms of speed when compared to CMR drives.

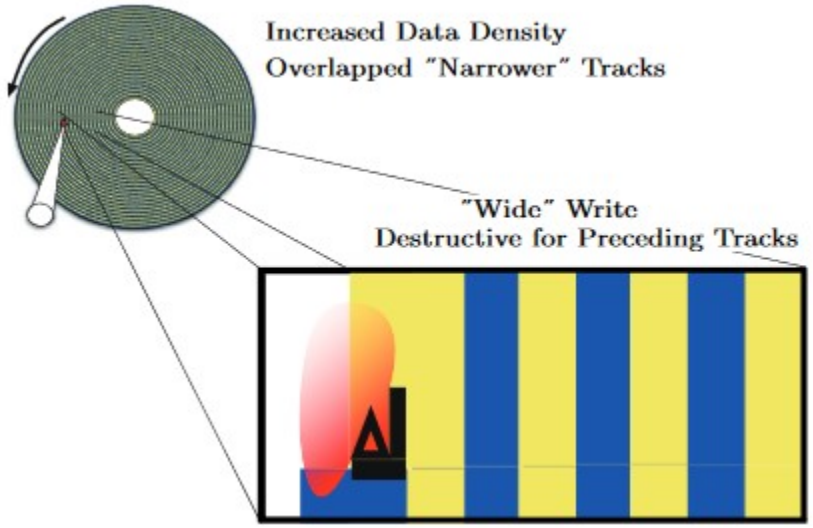

Figure 1: A representation of SMR technology. Notice the blue track being written over the yellow track to the right. Image taken from Le et al. p. 857.

Due to the fact that SMR drives are better suited to append-only applications such as long-term data storage, there is nothing inherently wrong with SMR technology for certain workflows and use cases. However, the ethical dilemma rises when several hard drive manufacturing companies such as Seagate, Toshiba, and Western Digital (WD) decided to adopt

SMR drives for their general-purpose and NAS (network-attached storage) consumer hard drives. Due to the unique advantages of SMR and the shingled construction of the data tracks, SMR used to be used only in drives specifically built for long-term data storage, such as WD Ultrastar 14 TB and 18 TB drives. Additionally, these drives were clearly labeled as SMR to consumers (Salter). However, in 2020, consumers found out that Western Digital had started selling their WD Red lineup of hard drives using SMR technology instead of CMR without changing any datasheets or otherwise alerting consumers in any way (Salter). WD Red drives are marketed as special-purpose drives for NAS or RAID setups. Generally, NAS drives are held up to a more strict standard of quality due to the fact that they are always running, and consumers expect fast and reliable access to their data. However, RAID is not meant for long-term storage, meaning that there are many cases where the user may want to overwrite and update data instead of simply appending it to the end of the track, meaning that write speeds are much slower than the expected speed. In addition, the garbage collection necessary for SMR drives to work takes up valuable time, causing speeds to drop and sometimes disks to time out (Salter). This ended up causing WD Red owners to file a class-action lawsuit against WD; the lawsuit was settled for 2 700 000 USD and "Western Digital denie[d] SMR is inferior technology and denie[d] all accusations of wrongdoing[…]" ("Western Digital").

Personal Reflection

I encountered this issue personally when shopping for a hard drive this year. I have never bought a Western Digital hard drive, but now I have three Seagate Barracuda drives, which I didn't know used SMR technology until now (two in my desktop computer, and one for my

game console). My research on this topic has mainly brought up the warnings of using SMR drives in RAID arrays (which may cause data loss, early failure rates, etc.) but not much on desktop usage.

I believe that any instance of companies not being transparent to consumers about their products is lying by omission and therefore unethical. There are many instances of hard drives being used for important, time-critical systems; if a user's NAS setup is stuck performing garbage collection on an SMR drive, it cannot serve the user the data he or she needs. Perhaps that user is a medical clinic or an emergency room that needs to pull up a patient's data as soon as possible. With SMR drives, either the read speed will be much lower due to SMR's problems or the hard drive might suffer an unexpected early failure due to having to spin 24 hours a day 7 days a week.

WD still is not clear about which drives are CMR and which are SMR; currently, you have to find that information on scattered news websites and articles. Seagate, on the other hand, has a very clear list on their website detailing which of their drives use CMR and which use SMR: https://www.seagate.com/internal-hard-drives/cmr-smr-list/. I believe that this is amazing for consumer transparency and would resolve all the ethical issues that WD is having; making a list would have saved WD 2 700 000 USD from the settlement. In fact, according to the article "Western Digital," WD still has to label all SMR products clearly as SMR for at least four years after the settlement is payed (starting at 22 Dec. 2021) ("Western Digital"). If WD wouldn't have lied (by omission) to their customers and announced their switch to SMR, the company would have saved money and consumers would have been able to make wise purchases; it would be a win-win for both parties involved.

Engineering Ethics

To me, Engineering Ethics simply means doing the right thing while working on engineering projects. “The right thing” is very vague, and is certainly up to interpretation, but I believe that “the right thing” is usually the action that results in the greater good of all people involved. For example, if I were a high-level executive or decisionmaker at WD, I would definitely decide to be transparent in my company’s products. When your customers are trusting you to sell the same product as you’ve always been selling, it’s important not to lose their trust and let them down. As was seen in the whole SMR fiasco, lying to your customers can cost a lot more than the company would have lost on the lower sales if it would have made the SMR information public.

Senior Project Ethical Concerns

The biggest ethical concern that the rest of my group agrees on is the fact that we may accidentally record random passersby without permission, but I think this is a non-issue. The reason for that is there are already many security cameras in public. There are cameras on traffic lights, cameras on private buildings and businesses, and even cameras on cars (dashcams). Our camera will not do any harm. The biggest ethical concern I have with our project is that we may let our customers down, similar to how WD let their customers down. Our project works by automatically recording the crime scene whenever it detects some kind of suspicious activity, and simultaneously sounding the alarm if it is serious. What if a customer’s tires get stolen, or his or her car gets slashed/keyed and the alarm system doesn’t sound and the camera doesn’t turn on? If we somehow fail in creating a good, reliable algorithm for determining when something of

interest to the user is happening to his or her car, our product will be useless and we will have failed at being engineers. That may sound overdramatic, but I believe it's true; if we promise to do something, I believe it is unethical to not follow through on the promise, especially when a customer paid for our product.

Another ethical concern our team has is with digital security; each user will have an account where all his or her footage is saved, so that he or she can watch it later at his or her leisure. However, if someone hacks into his or her account, he or she might be able to see the footage. If the hacker happens to be the perpetrator of the crime, he or she might be able to delete all evidence of it happening. It is our duty to create a secure and safe website for the user to store the camera's footage on, and if we fail on this, our business is unethical and we are basically lying to our customers.

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