From Cradle to Cradle

A Journey Towards a Circular Economy for Data Storage

Jonmichael Hands, Chia Network, CDI secretary & treasurer

The Circular Economy for the ICT Industry

- Use (life) extension
- Reuse
- Sharing
- Repair
- Refurbish
- Remanufacture
- Disassembly
- Recycle
- Disposal

The current state of storage security…

“We shred everything”

https://arstechnica.com/information-technology/2022/10/why-big-tech-shreds-millions-of-storage-devices-it-could-reuse/

Who is the Circular Drive Initiative (CDI)?

McDONOUGH INNOVATION

SEAGATE

Micron

Western Digital

chia

Steward Members

What is our *vision*?

Foster a sustainable future by enabling the circular economy in data storage

We strive to ensure that data storage devices can be securely reused.

CDI is a 501(c)(6) non-profit

Partnering with McDonough Innovation

"I love the idea that these storage drives can be repurposed, with new data, wisdom, intelligence, and cleverness to better the human condition. These renewed drives will help us remember the future. Storage reuse effectively demonstrates the Cradle to Cradle Circular Technosphere concept and I believe it can be a leading example in the ICT industry.

William McDonough, Chief Executive

Barriers to a Circular Economy for Storage

Data Security, Policy, and Government Regulations

Zero risk policies due to large impact of data breaches

Government regulation on data privacy and controls

Transparency

Transparency around processes, device health and reliability are critical for trust.

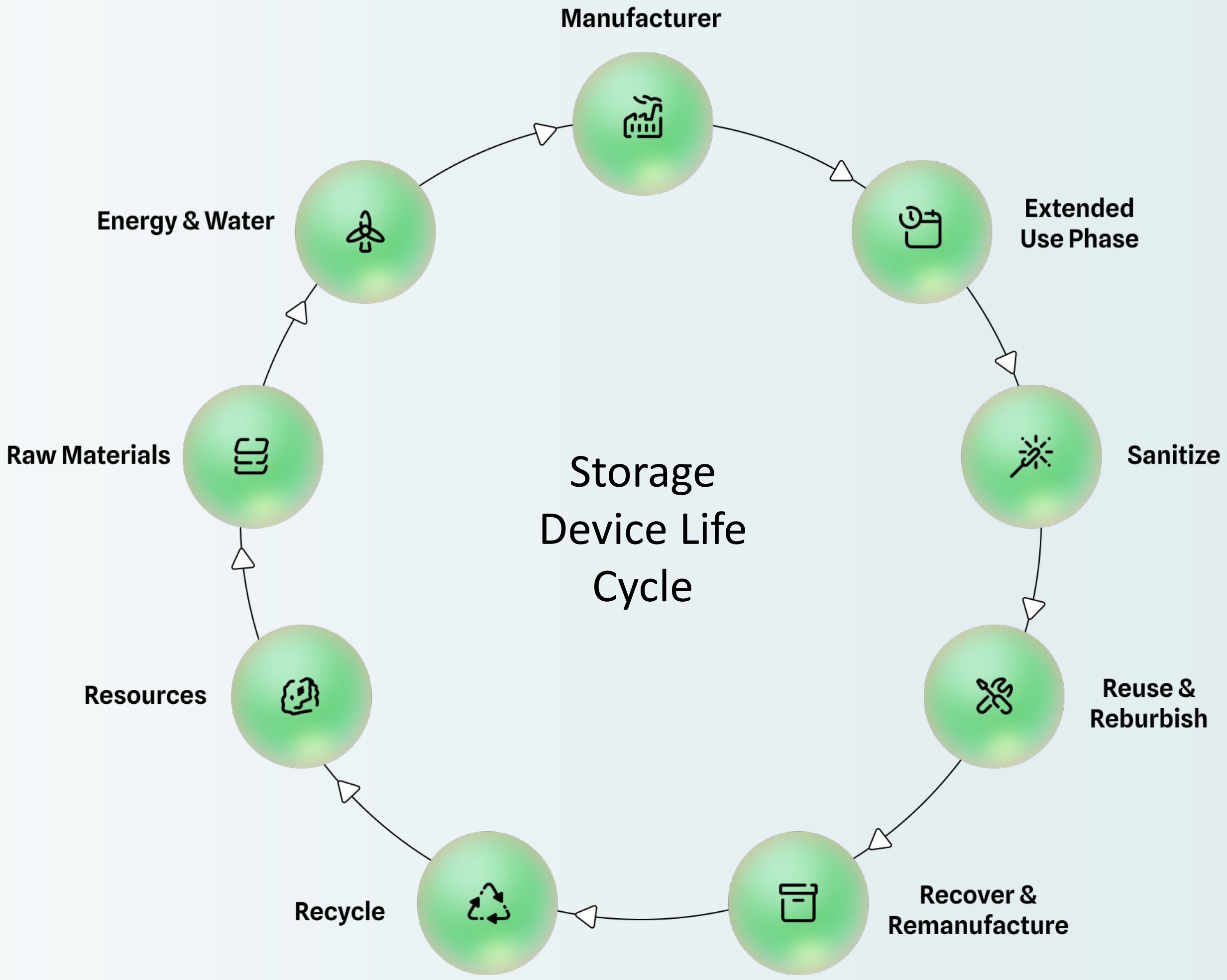
Vibrant Secondary Markets

Are required to economically reclaim and repurpose used storage devices.

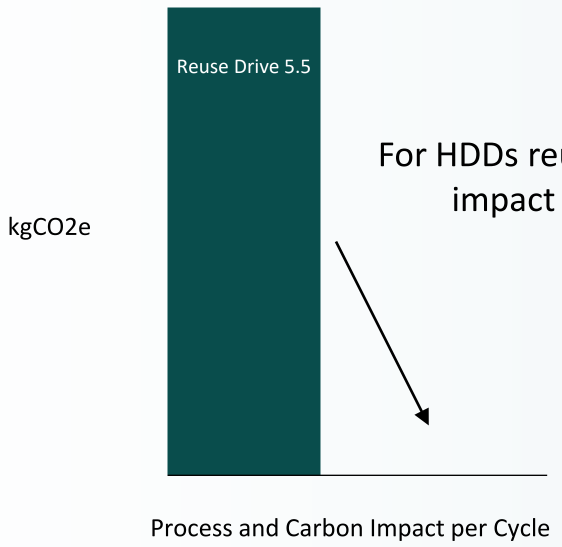
Metrics

There is a lack of transparency and data availability around product information, environmental impact, carbon accounting for circular business models

A Practical Circular Economy for Storage



Reuse is the Largest Impact for Circularity



For HDDs reuse was 275x more impact than recycling

Jin, H., Frost, K., Sousa, I., Ghaderi, H., Bevan, A., Zakotnik, M. and Handwerker, C., 2020. [Life cycle assessment of emerging technologies on value recovery from hard disk drives](). *Resources, Conservation and Recycling*, 157, p.104781.

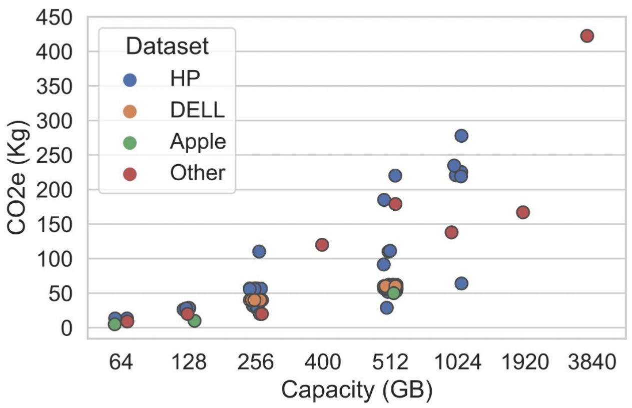


Figure 4: Carbon emissions for manufacturing 94 Solid State Drives, data based on Life Cycle Analysis (LCA) reports published by eight vendors.

https://arxiv.org/pdf/2207.10793.pdf

SSDs have a large amount of embedded carbon from manufacturing

What is CDI Doing?

Develop Sustainable Standards

Make the storage market more sustainable by developing and promoting standards, reporting, and best practices around **circular** business models

Transparency and Reporting

Adopt carbon accounting models that show the real impact of circularity

Rethink the Ecosystem

Enable the broad ecosystem of drive reuse through CDI partners: Decommissioning, media sanitization, verification, and sales channels.

CDI Project: A Comprehensive Grading System for Used Storage Devices

- Transparency required to build trust in secondhand market
- CDI workgroup deep understanding of SSD and HDD quality and reliability
- Grading system designed to accurately assess the health and remaining use left
- Includes endurance, power on hours, errors, device self-test, signed vendor firmware
- Definitions for recertification vs. remanufacturing

Summary

- Circularity is common sense. "Efficiency" for the product lifecycle
- Embodied carbon of devices and scope 3 are becoming extremely important to hyperscalers with net-zero commitments - circularity can help!
- CDI is tackling the industry's biggest challenges and barriers to circularity in storage
- Easy to join CDI if you are storage vendor, end customer, ITAD, or anything in between @ circulardrives.org

Media Sanitization

Jonmichael Hands, Chia Network,
CDI secretary & treasurer

IEEE 2883-2022 Standard for Sanitizing Storage

- Align industry on terminology and modern methods and techniques for media sanitization.
- What is sanitization - A process or method to render access to target data on storage media infeasible for a given level of effort.
- Defines Sanitization Methods and Techniques for specific media type (HDD, SSD, optical, removable, etc.)
- Specifies interface specific techniques (SATA, SAS, NVMe), highly focused on using the sanitize command
- Target all logical and physical locations for data – including user data, old data, metadata, overprovisioning. Defines host methods for verification of sanitization.

Media Sanitization Methods

Clear

Logical techniques are applied to all addressable storage locations, protecting against simple, non-invasive data recovery techniques

Destruct

Makes data recovery nearly impossible but results in the storage media becoming unusable

Purge

Logical or physical techniques rendering data recovery infeasible even with state-of-the-art laboratory techniques.

The goal of purge is to maintain the storage media and device in **reusable** state.

Purge Media Sanitization Techniques

Overwrite

Using interface specific sanitize command, overwrite all LBAs with a fixed pattern, minimum of one pass. Multiple pass optional, but is not required anymore.

Block Erase

Use NAND erase blocks, can sanitize a modern SSD in a few seconds to a few minutes.

Doesn’t waste NAND endurance, but verification requires no-deallocate.

Crypto Erase

Requires that the devices supports encryption. Sanitize by deleting the media encryption key (MEK), leaving all the data scrambled.

Very fast, completes in seconds.

Trust in Media Sanitization

Use IEEE 2883 approved purge technique

Check Sanitize Log

Perform verification on host interface

Generate certificate of sanitization

Vendor validation of sanitize

Certifications, TCG OPAL, FIPS 140-3

3rd party audit

Firmware attestation / measurement, hardware roots of trust

Shredding vs. Sanitize Crypto Erase

Which is more secure?

vs.

CDI Made Hacker News!

Y Millions of usable hard drives are

news.ycombinator.co...

NotYourLawyer 55 days ago | prev | next [–]

> The irony is that shredding devices is relatively risky today. The latest drives have 500,000 tracks of data per square inch. A sophisticated data recovery person could take a piece as small as 3mm and read the data off it, Mr Hands says.

I call bullshit on this, unless you can show me a single example of this ever happening anywhere.

Why millions of usable hard drives are being destroyed

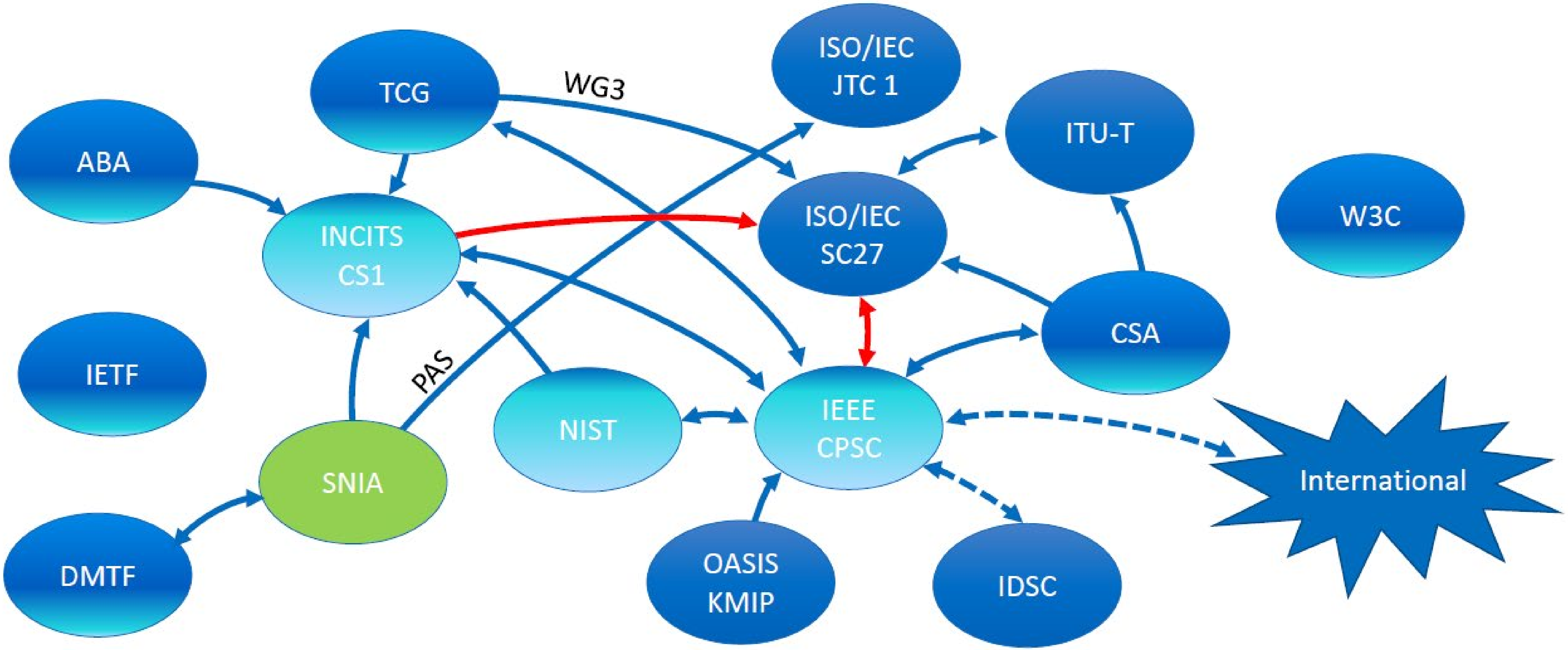
IEEE 2883-2022 Section 6.4

"Although pulverize and shred were once adequate forms of destruct, improvements in reconstruction technology and increases in the density of information on the storage media have rendered these techniques ineffective for storage media other than for low-density storage media (e.g., hardcopy and floppy disks)."

NSA/CSS POLICY MANUAL 9-12 STORAGE DEVICE SANITIZATION AND DESTRUCTION MANUAL

Disintegration—disintegrate into particles that are nominally 2 millimeters in size on edge. It is highly recommended to disintegrate hybrid IS storage devices in bulk lots with other storage devices.

Key Storage Security Players



Standards

- CDI will be supporting IEEE 2883 family of specifications for media sanitization
- Developing our own standard for circular drives

Wiping Standards

Wiping Standards	Wiping Passes
NIST 800-88r1 Clear	1-Pass
U.S. Air Force System Security Instruction 5020	3-Pass
Gutmann AII	35-Pass
Russian GOST-R 50739-95	2-Pass
Pfitzner Algorithm	33-Pass
AR 380-19	3-Pass
Gutmann MFM	18-Pass
British HMG Infosec Standard 5, Enhanced Standar	3-Pass
Canada RCMP TSSIT OPS-II	7-Pass
U.S. Department of Defense 5220.22-M	3-Pass
Gutmann RLL 1,7	26-Pass
U.S. Navy Staff Office Publication NAVSO P-5239-26	3-Pass
Schneier's Algorithm	7-Pass
U.S. Department of Defense 5220.28-STD	7-Pass
Gutmann RLL 2,7	23-Pass
Pfitzner Algorithm	7-Pass
Germany VSITR	7-Pass

Why???

Example with NVMe SSD

1. Find a NVMe SSD’s sanitize capabilities through Identify Controller command
2. Send Sanitize command with action -2, block erase
3. Loop: Monitor Sanitize Status with Sanitize Log
4. Sanitize completes

```
nvme id-ctrl /dev/nvme0 -H | grep sanicap -A 5
sanicap   : 0x2
  [31:30] : 0   Additional media modification after sanitize operation
completes successfully is not defined
  [29:29] : 0   No-Deallocate After Sanitize bit in Sanitize command
Supported
    [2:2] : 0   Overwrite Sanitize Operation Not Supported
    [1:1] : 0x1 Block Erase Sanitize Operation Supported
    [0:0] : 0   Crypto Erase Sanitize Operation Not Supported
```

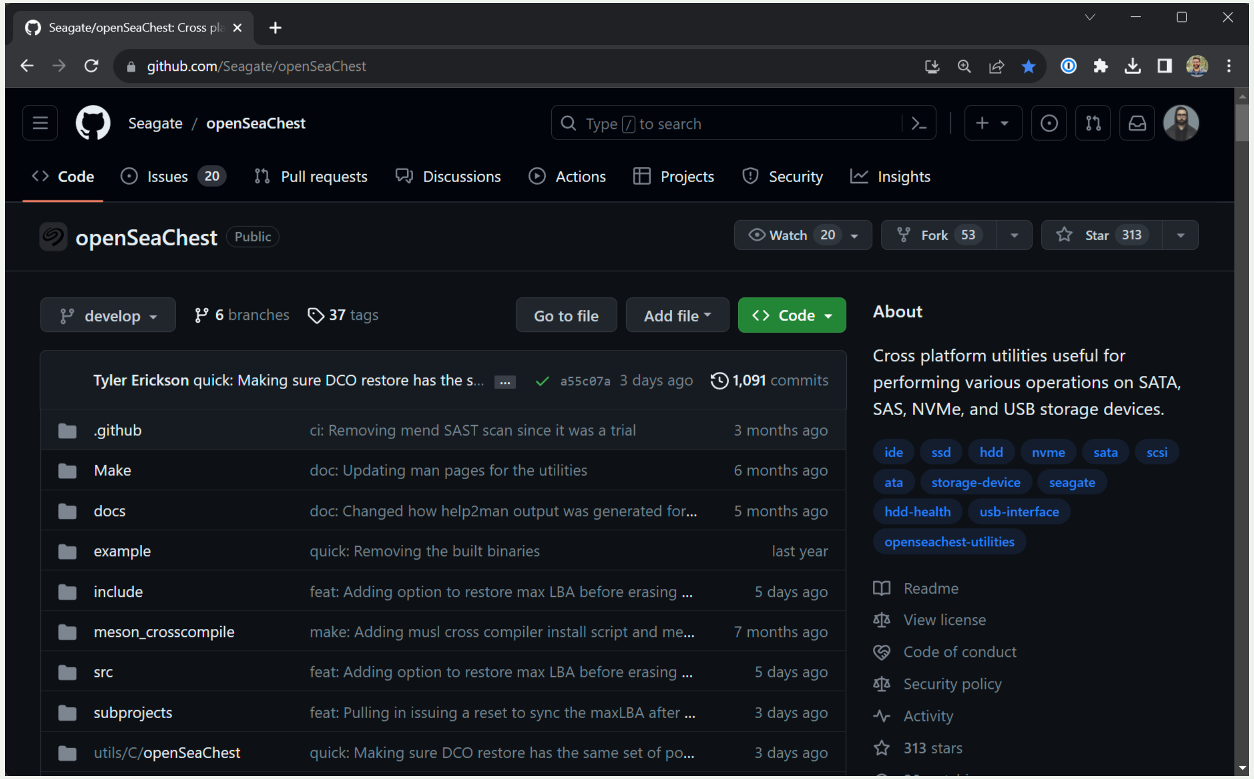
```
nvme sanitize -a 2 /dev/nvme0n1
```

```
nvme sanitize-log -H /dev/nvme0n1
Sanitize Progress                      (SPROG) :  40164 (61.285400%)
Sanitize Status                        (SSTAT) :  0x2
        [2:0]   Sanitize in Progress.
```

```
nvme sanitize-log -H /dev/nvme0n1
Sanitize Progress                      (SPROG) :  65535
Sanitize Status                        (SSTAT) :  0x101
        [2:0]   Most Recent Sanitize Command Completed Successfully.
```

CDI Media Sanitization Project

- Open-source media sanitization tool leveraging Seagate OpenSeaChest
- Supports SATA, SAS, NVMe, HDD and SSD
- Updating to be compliant to IEEE 2883 Purge and verification, getting 3rd party audit
- CDI will be developing user friendly software



Summary

- Purge media sanitization is the key to unlocking the circular economy for storage
- IEEE 2883-2022 is the most modern media sanitization specification and Security in Storage Working Group is very active
- End Users – qualify IEEE 2883 purge media sanitization with your vendors
- Storage vendors – Publish validation of sanitization, use proper marketing for drives that support IEEE 2883 compliant purge, engage in 3rd party audits
- Software developers – help make these tools easy to use and open-source