# Fixating on Fixity — Is Your Choice of Checksum in Conflict with Your Climate Goals?

Preliminary findings of research by:
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#### **Premis**

- Users need to *trust* archives
- Ttrust means objects are *authentic*
- When preservation of the essence of the object is complete and declared authentic, it stops changing and becomes fixed
- To confirm a digital object has not changed, we use fixity
- Crytographic hashes, in the form of checksums, are the mechanism for confirming digital objects are not changed
- Unchanged digital objects are truthworthy



#### How hard can it be?

- Select a range of checksum types to compare
  - MD5, SHA256, SHA1, Okum, CRC32
- Set up some computers to compare
  - New, old, Mac, PC, Linux, cloud
- Try different storage
  - External spinning drive, SSD, NAS, SAN, cloud
- Gather sample files (does file size have an impact?)
  - Lots of small files, some medium-sized files, big files
- Write some scripts
- Find a partner to run the tests in a different environment
  - WGBH/AAPB is our partner
- Report results



## Early challenges

- How to measure the power consumption?
  - We purchased inexpensive plug-in meters
  - Do we include the external drive?
  - If so, how do we allocate power consumption from remote storage (NAS)
- Low repeatability of tests
  - Wildly varying results when test were run several times
- Quickly discover how many tests are needed



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5 (checksum types)

x5 (computer types)

x5 (external storage)

x3 (file sizes)

x3 (multiple passes)

x2 (two partners)

= 2,250 test runs!

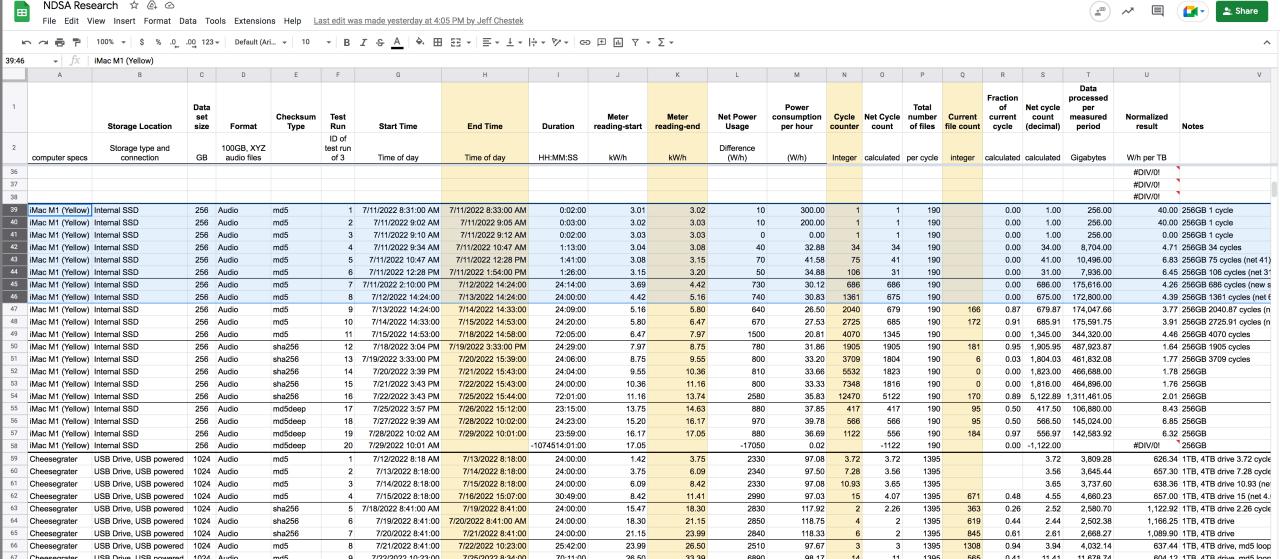


## Simplification

- Limit tests to MD5s and SHA256
- Use new, out of the box, iMac M1
  - Disconnected from network, nothing else installed
- Measure power consumption of computer only
- Expand the data size from 100GB to looping for 24 hours
  - Averages many test passes
  - Generates power consumption values big enough to compare



## A peak at the data set



## Simplification — early results

- Repeatable test results!
- Confirmation of scripts and process
- Clarification of questions and next steps

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Tests have expanded to

- External HDD vs SSD
- New computer vs old computer (aka "free hardware")
- Using different CLI apps and scripts to test speed of code



## Preliminary findings

- Do not use an old computer
  - Carbon footprint is 100—200x greater than current power efficient CPUs
- SSDs leave spinning discs in the dust
  - May be 25x less carbon intensive
- File size does not meaningfully impact results
  - 1 video file of 100GB has the same results as thousands of smaller files of 100GB
- Surprise: SHA256 may have lower carbon footprint than MD5
  - The opposite of a starting assumption
  - Building tests to control for possible variables to confirm finding



#### Planning testing and goals - 1

- #1 Quantify and provide data to support recommendations for best strategy in different use cases
  - Small archive with one computer and external drives
  - Small institutions or depart with large, local RAID (Drobo, Synology, etc)
  - Large institutional repository
  - Cloud
- Expand tests to other OS platforms
- Package process to share
  - First to WGBH for peer review
  - For anyone to use



#### Planning testing and goals - 2

- Run tests on AVPreserve's Fixity Tool
  - Engage AVPreserve in discussion to test our methods and know their tool
- Quiescent tests
  - How much of the power is from a computer just being one vs. verifying checksums?
- Is it time and carbon efficient to download files from remote storage to a local SSD to verify the checksum?
- Publish results and share raw data
- Full presentation will be at the CLIR/NDSA/DLF in October



#### Additional information:

- george.blood@georgeblood.com
- On Facebook: George Blood LP
- On Instagram: @georgebloodlp
- Reports and PPTs at www.georgeblood.com
- CLIR/NDSA/DLF
  - Presentation in person at the 2022 Digital Preservation Conference in Baltimore, Maryland. The conference will be held October 12-13

