Data Storage

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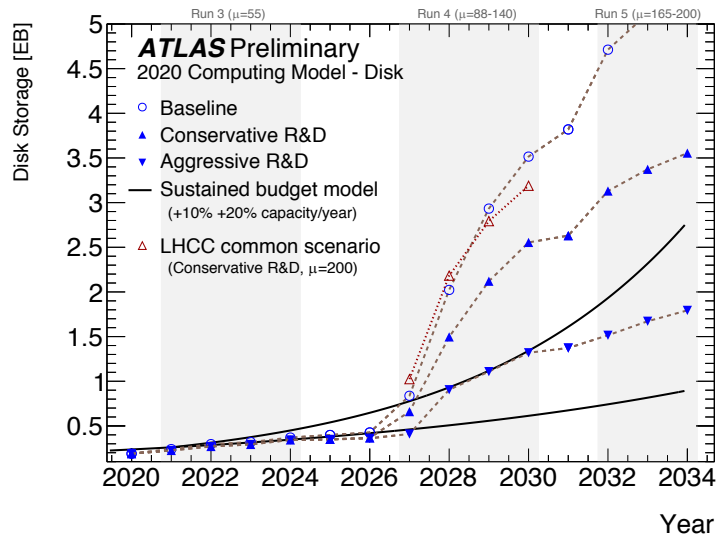
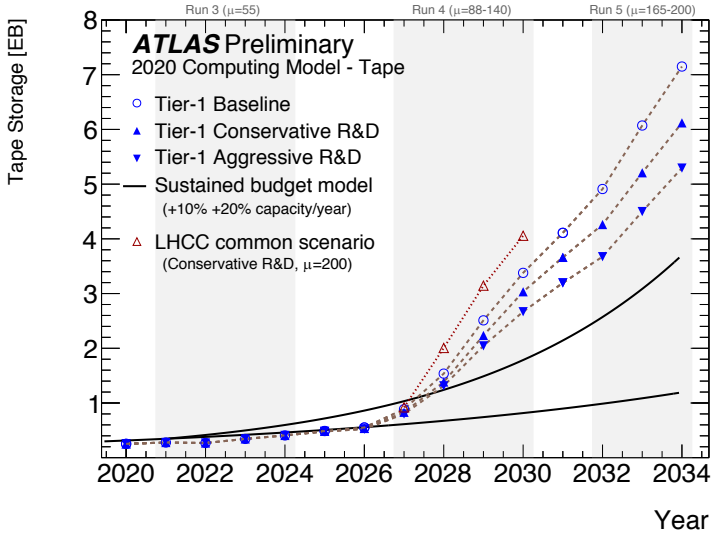
Introduction

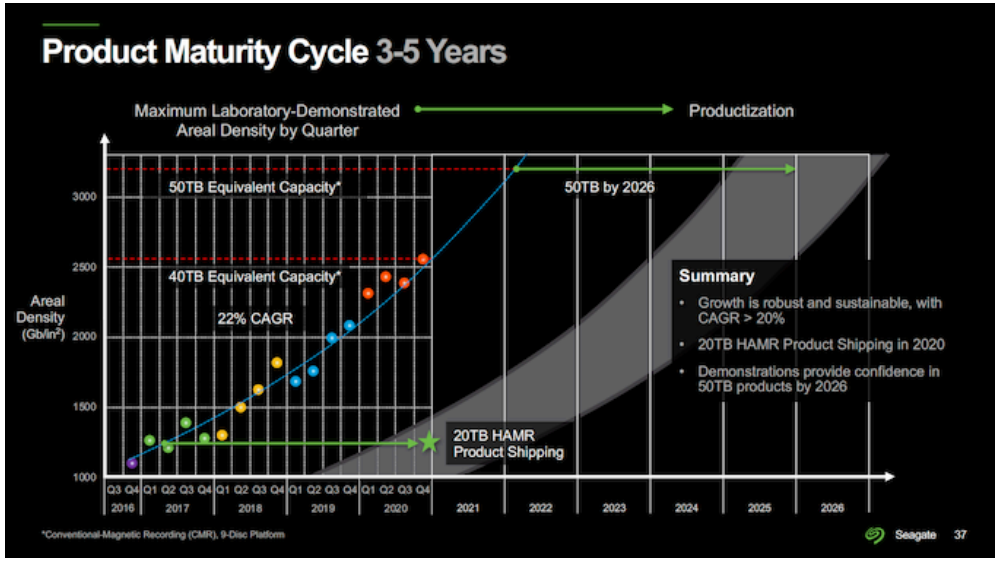
- As has almost certainly already been shown, the LHC models predict significant growth in data.
- Even with aggressive R&D this will be at the edge of what Moore's law can provide.
- We can learn a lot from industry.
  - Amazon, Google etc. store many Exabytes already.





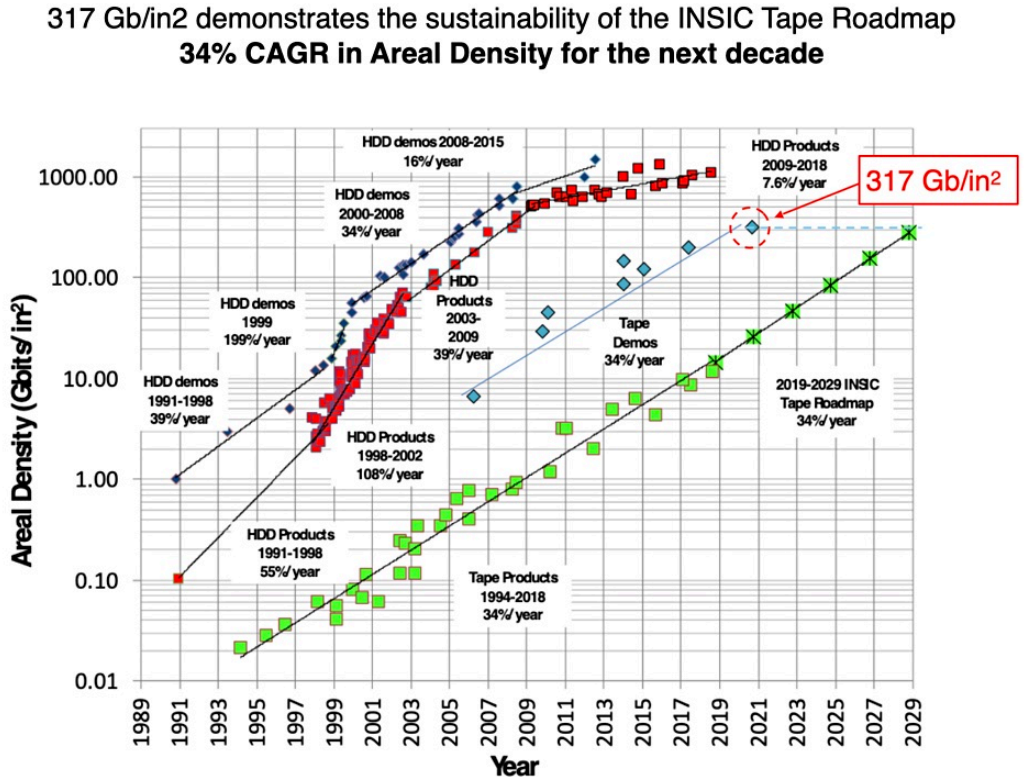
Disk Roadmap

- SSD are taking over in the consumer world and for data intensive workflows.
  - Focus on performance rather than capacity.
- HDD remains critical for data centre use cases.
  - Data does not in general get deleted, so larger fractions are becoming “cold”.
  - Clear roadmap for higher capacity HDD.



Tape Roadmap

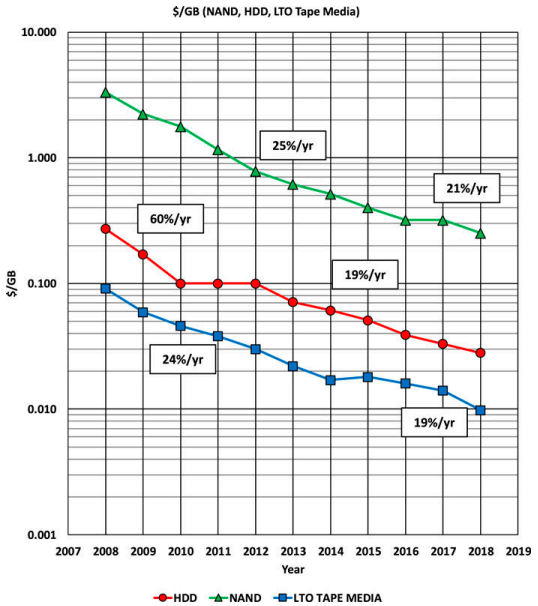
- Oracle unexpectedly pulled out of the market in 2017.
- Tape has been declared dead many times, but development continues at a rapid rate.
- Tape has a few strong selling points:
  - No power costs to store data.
  - Tape media lasts a long time (~30 years)
  - New: The air gap means it is immune to ransomware attacks!
- In December 2020, IBM demonstrated a 580TB Tape.



http://www.insic.org/wp-content/uploads/2019/07/INSIC-Technology-Roadmap-2019.pdf

Storage costs

- This year I was quoted ~10 times the cost for SSD compared to HDD storage.
  - Tape is ~1/3 the cost of HDD.
- I believe all 3 technologies will be vital for HL-LHC.



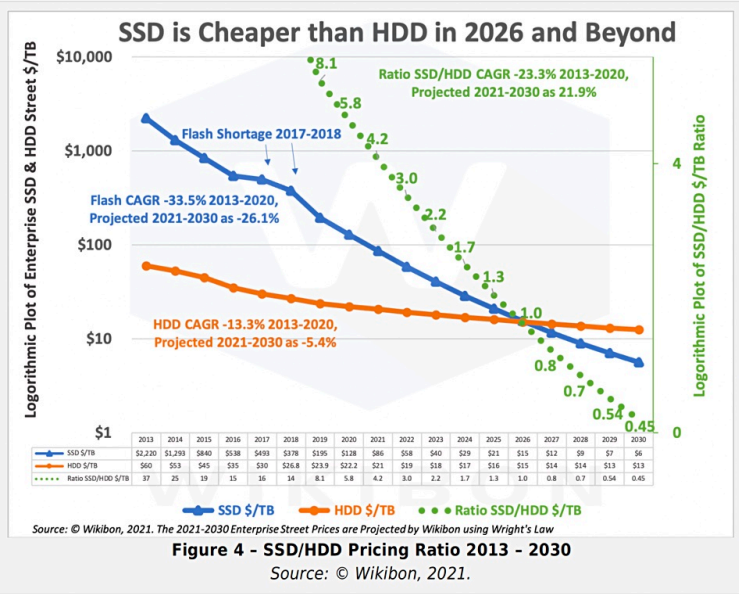
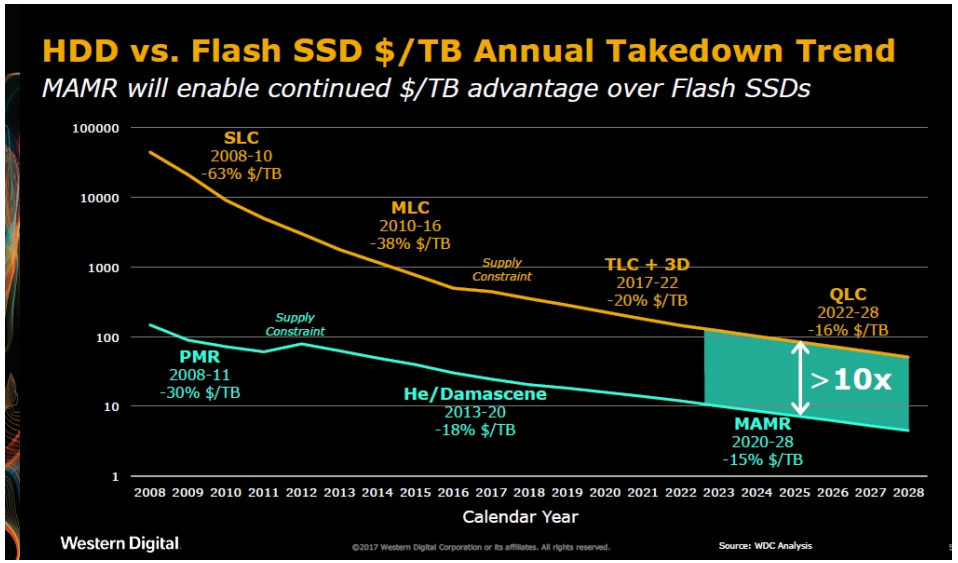


Figure 4 - SSD/HDD Pricing Ratio 2013 - 2030

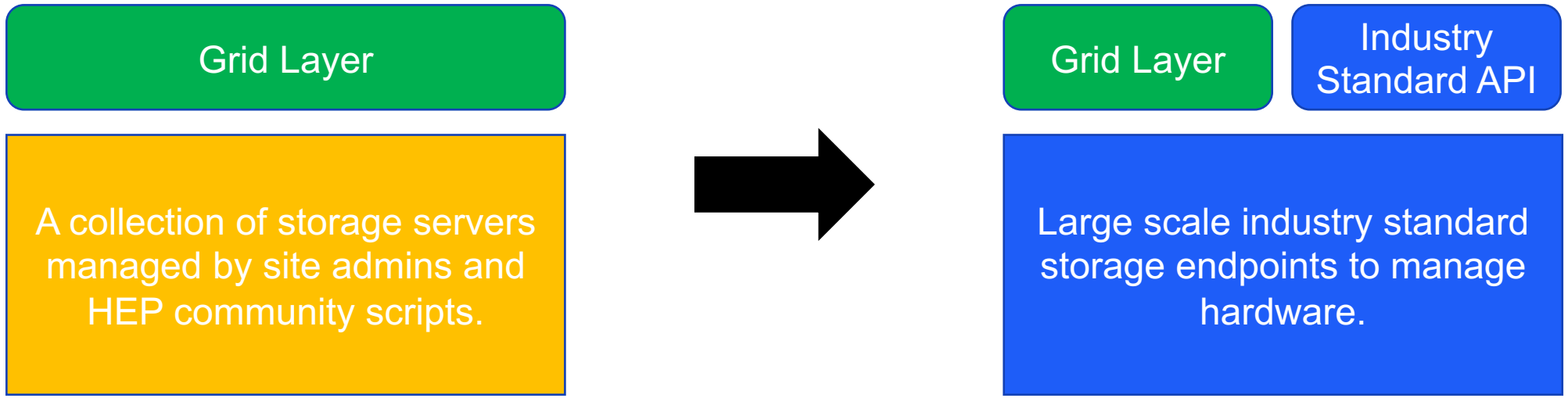
Source: © Wikibon, 2021.



https://aip.scitation.org/doi/10.1063/1.5130404

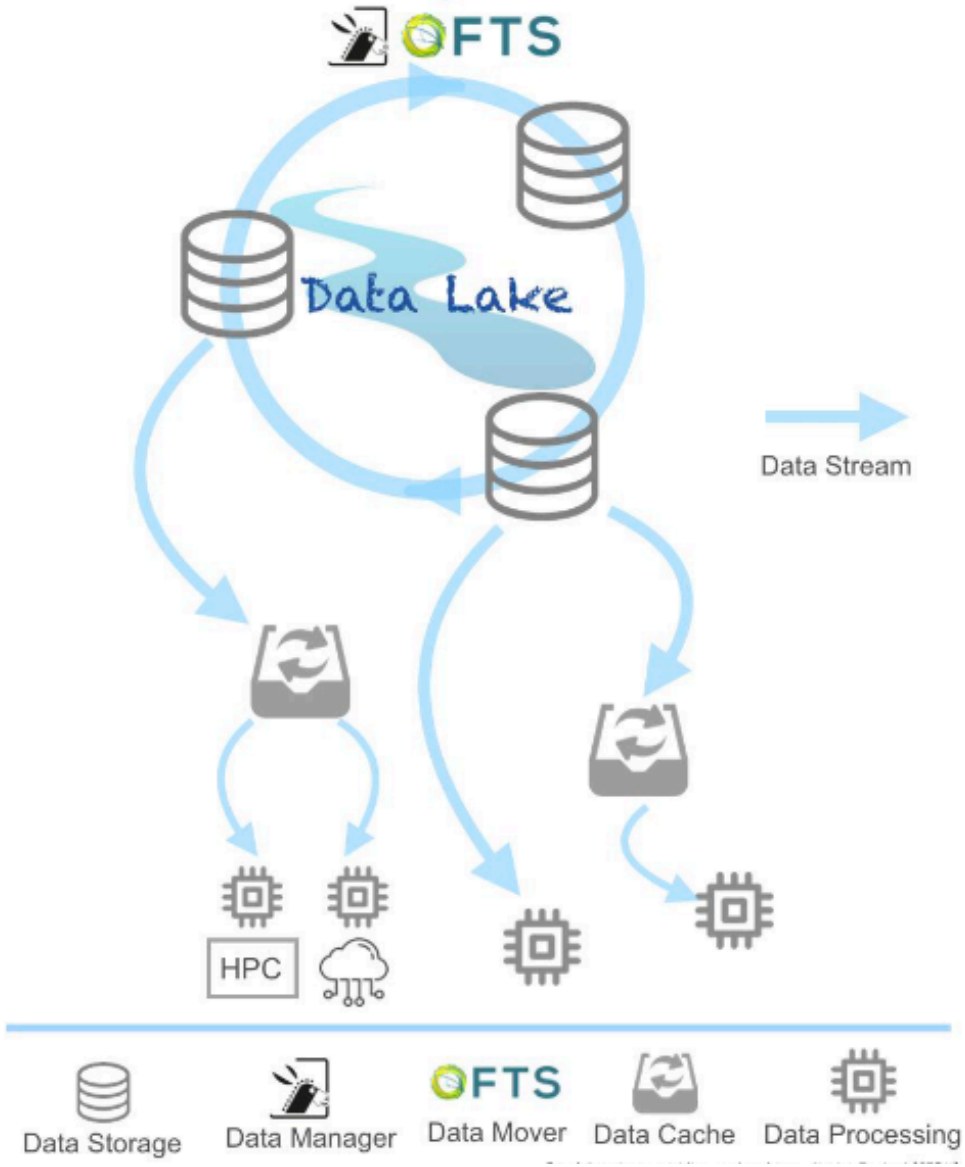
Storage software

- Two things to consider:
  - Managing the underlying storage
  - Managing the middleware
- Grid tools were designed in a different era.
  - Slowly the WLCG is replacing bespoke Grid software with industry standard tools.



Data Lakes

- The WLCG is working on a Data Lake concept.
- I would expect fewer larger scale storage endpoints.
  - Data could be accessed directly from these endpoints.
- Numerous small performant caches (SSD) for data processing.
  - Experiments and Resource providers need to work together to get data in the right place before it is needed.



UK Strengths

- The GridPP project has been in existence for 20 years.
  - Seen as a very reliable partner from an operations point of view.
  - We have many people in leadership positions within the WLCG community.
- UK has pioneered the use of Erasure Coding for data storage.
- UK has additional funding from EGI and Swift-HEP to run / develop FTS, Rucio and CVMFS services.

Science and Technology Facilities Council

Questions?