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HDDs are here to stay

Library of Congress – 2025 Designing Storage Architecture

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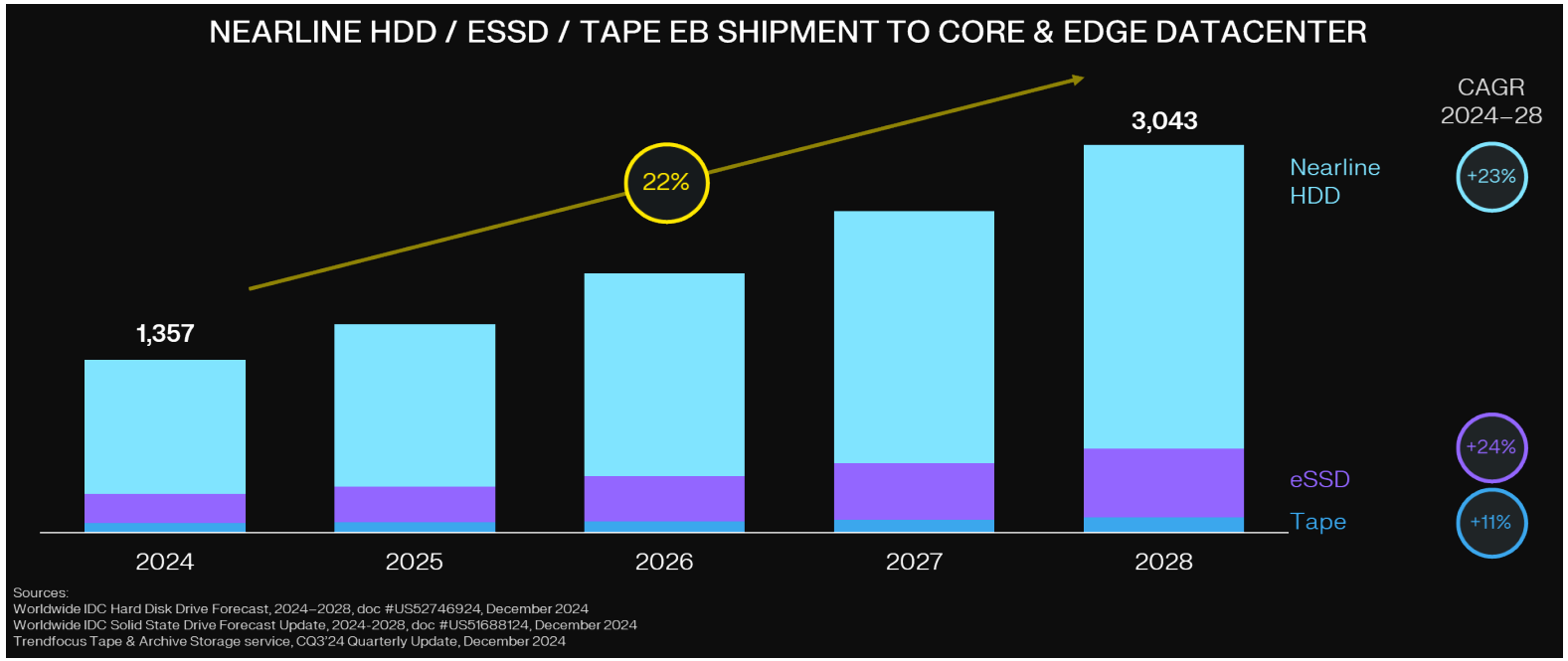
Insatiable storage demand; most in HDD

- Medical, scientific, smart cities and vehicles, sports, etc. seeking to save ever larger data sets
- Increasingly expensive to save all this data
- AI/ML increases opportunity cost of not saving data, and increases demand to keep more data active
- Need to store more data in all tiers and data temperatures



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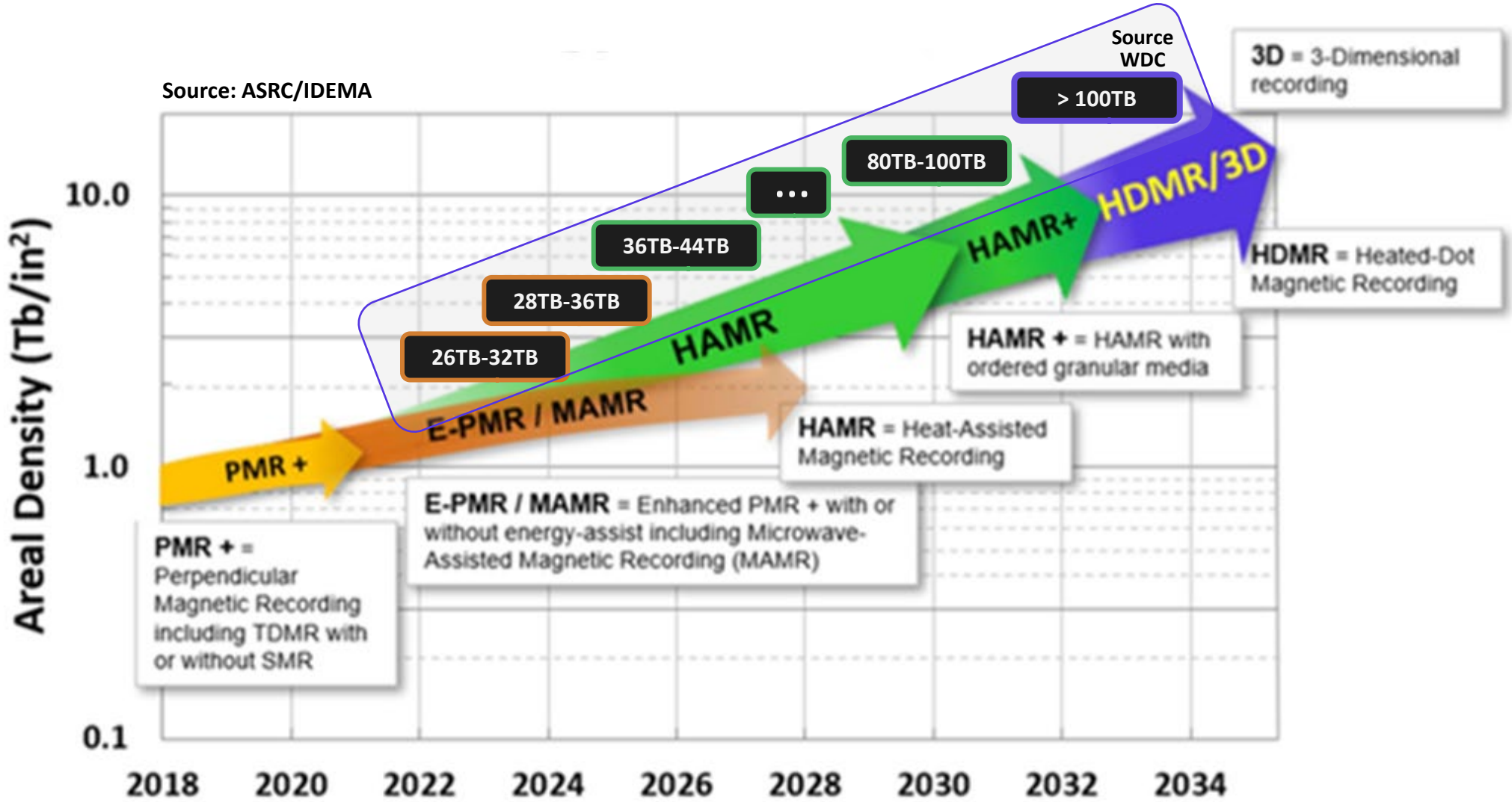
HDD bits continue to shrink



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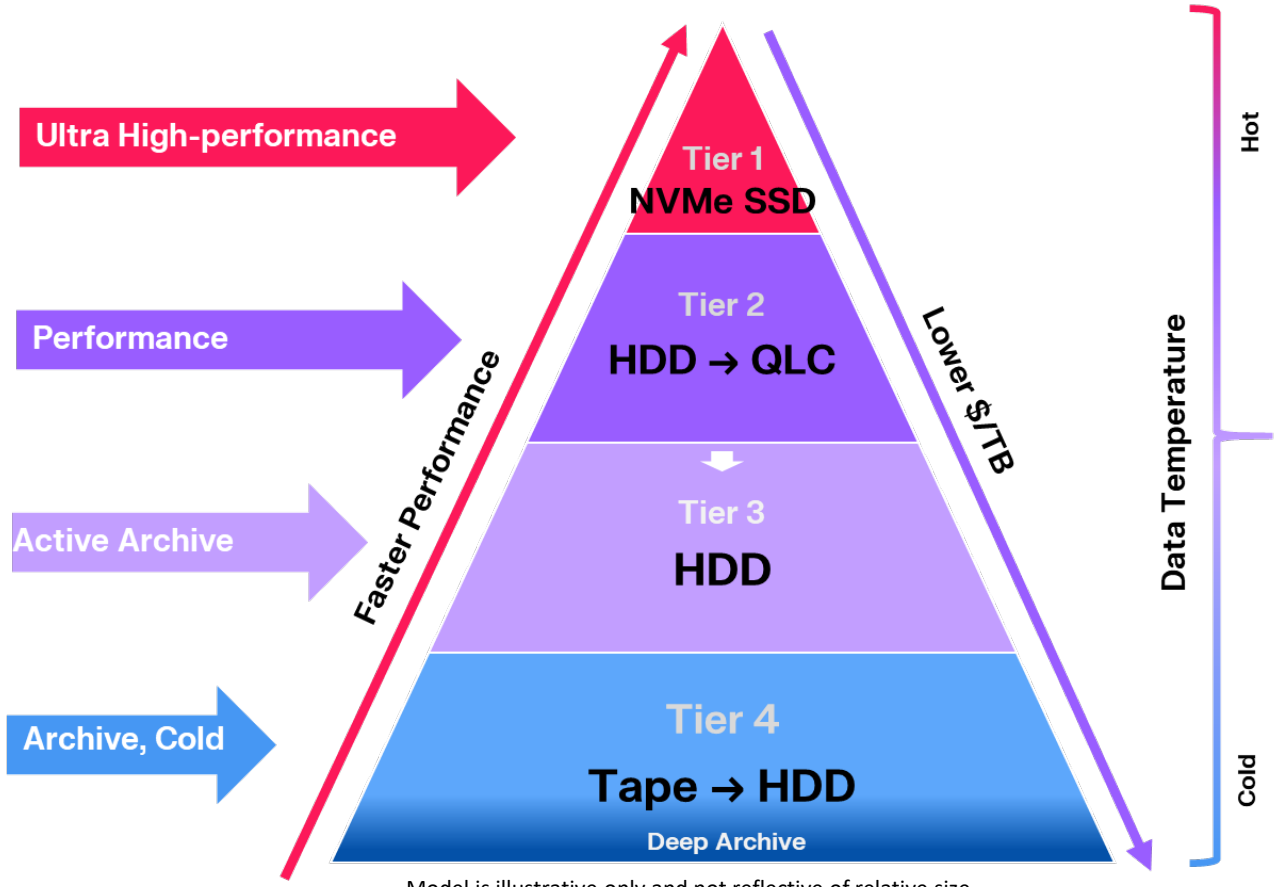
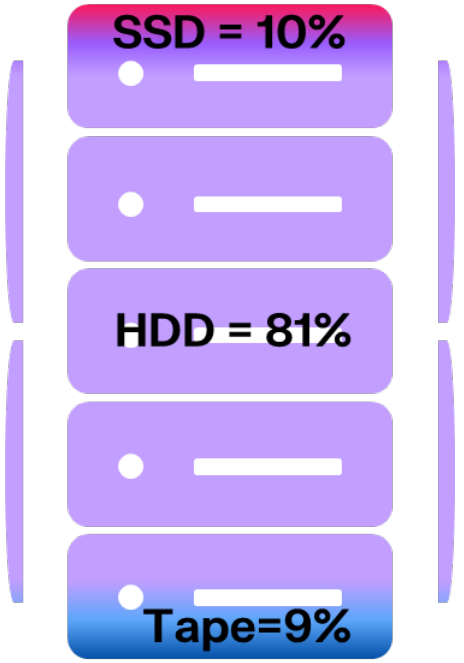
SSD, HDD, and Tape in the Datacenter

Tiered Storage Model



Model is illustrative only and not reflective of relative size

Installed Storage Capacity in the Cloud[1]
HDDs are the workhorse of the datacenter



- Versatile
  - Any mix of r/w
  - Temp independent
- Reliable
  - Routinely exceed specs/warrantee
- Available
  - Huge supply chain
- Low Cost
  - Lower capex ➔ easier inventory mgmt.
- Best TCO

1. IDC Storage Sphere 2024, 2023 Actuals installed Cloud Storage

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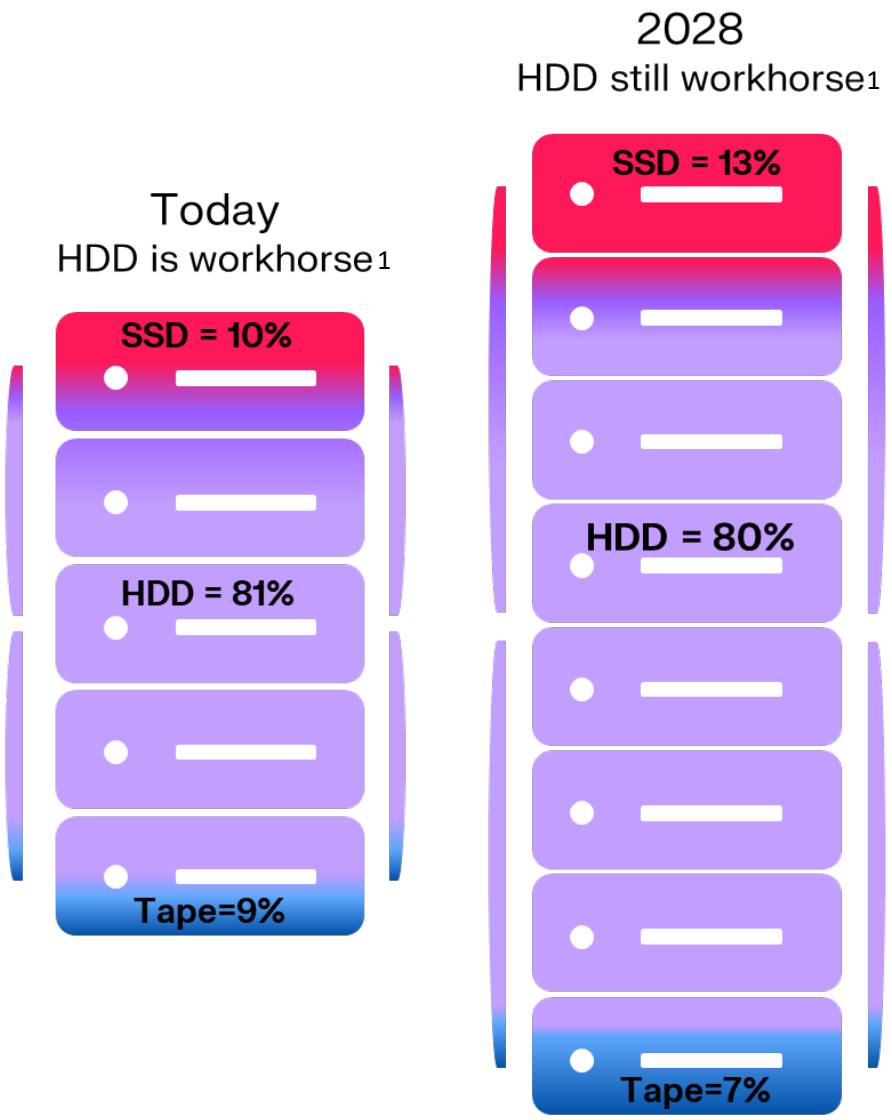
So how will mix evolve?



- Will high bit/cell SSDs replace HDD?
  - Endurance/Retention challenging for “warm” tiers
  - Sustainability challenging - **embedded carbon**[2]
  - Can market build enough SSDs at reasonable price?
    - SSD $/TB ~6X HDD today; will still be ~6X by 2030
- Will tape replace HDD?
  - AI/ML requiring more active access
  - Media storage outside data center less efficient
- And HDD continuing to innovate
  - Areal Density
  - Form Factor
  - Performance

1. IDC Storage Sphere 2024, 2023 Actuals installed Cloud Storage
2. Tannu S., Nair P., The Dirty Secret of SSD: Embedded Carbon; arXiv:2207.10793v2 [cs.AR]; https://doi.org/10.48550/arXiv.2207.10793 Energy Informatics Review (Volume 3 Issue 3, October 2023)

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