

Technion – Israel Institute of Technology

It's Not Where Your Data Is, It's How It Got There

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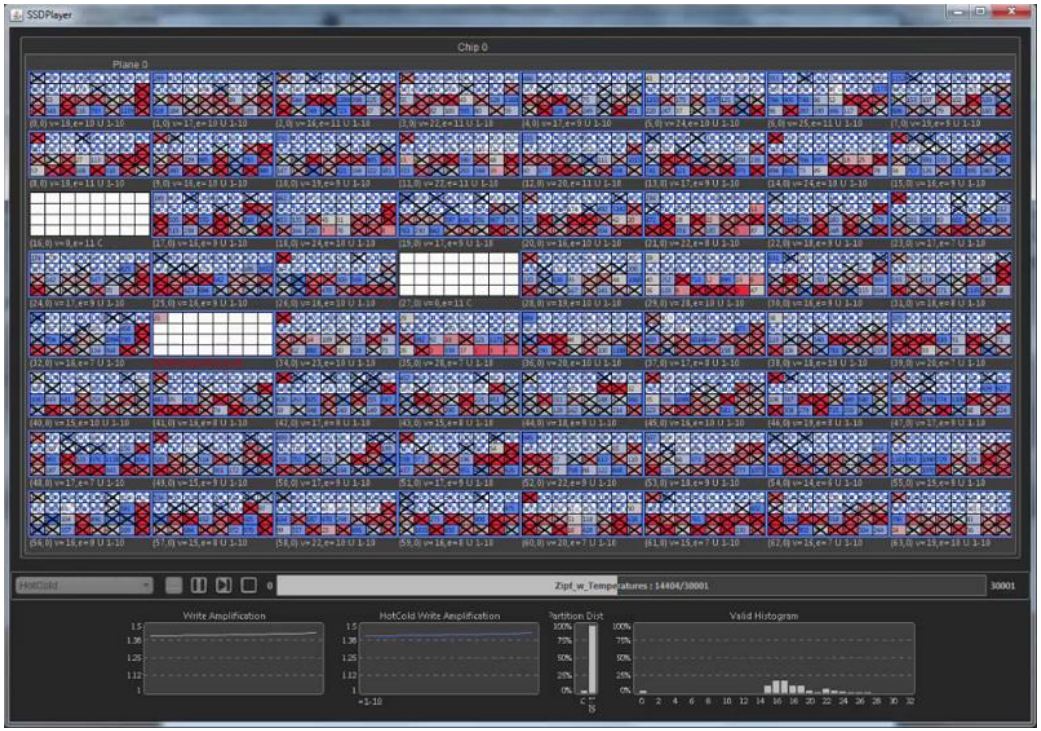


In The Past 30 Years…

- Computers looked like this:



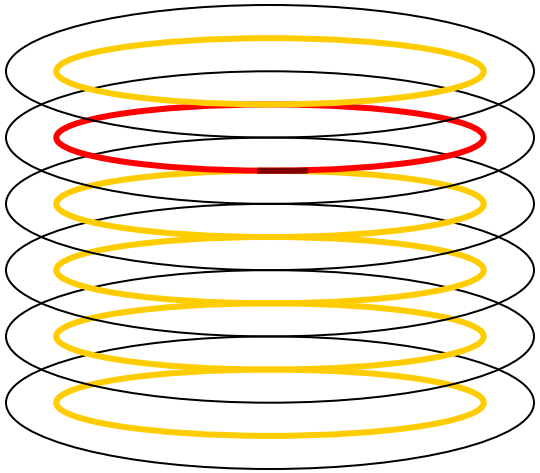
- Storage looked like this:

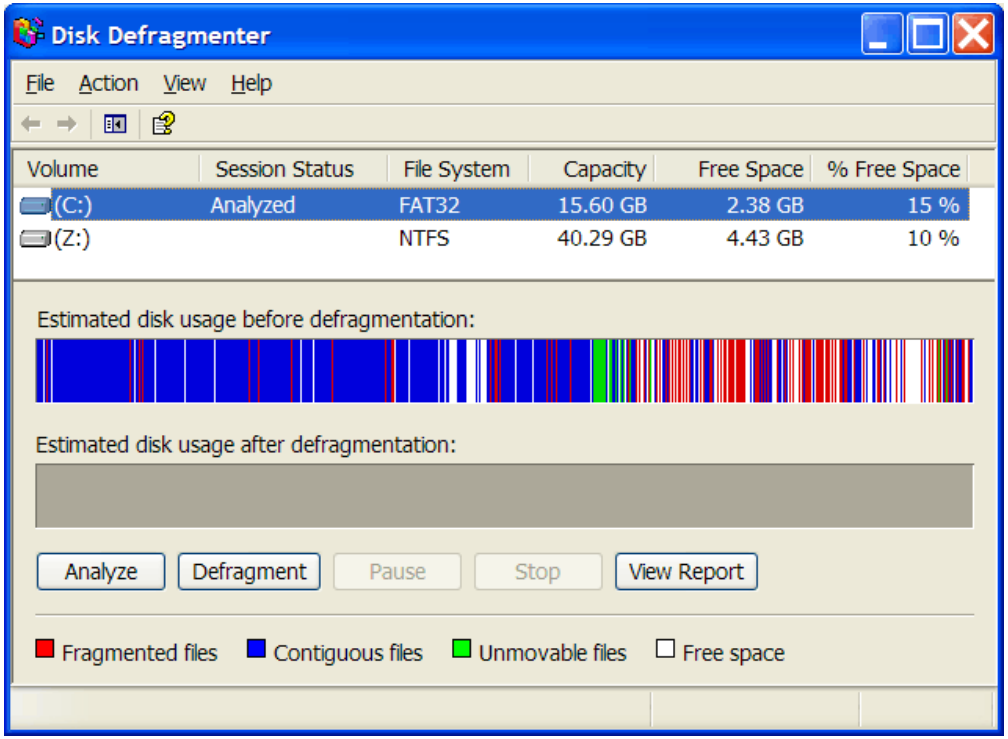


  - Sequential = good
  - Random = bad

Where Is The Data?

- Where we wrote it





In The Last 10 Years…

- Computers look like this:





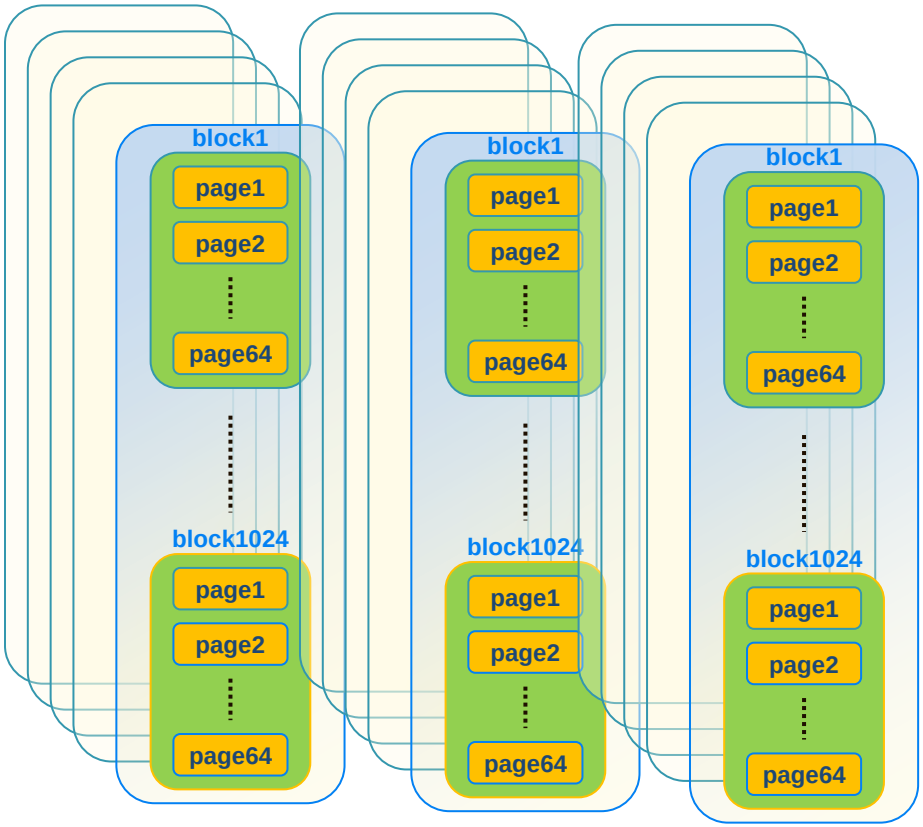

- Storage looks like this:
  - Read = fast
  - Write = pretty fast (usually)
  - Erase = really slow (when?)

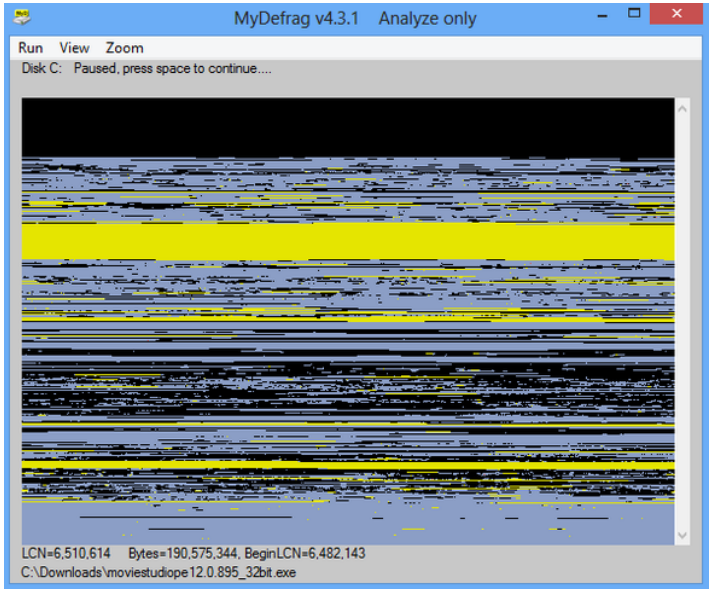




Where Is The Data?

- Could be anywhere…

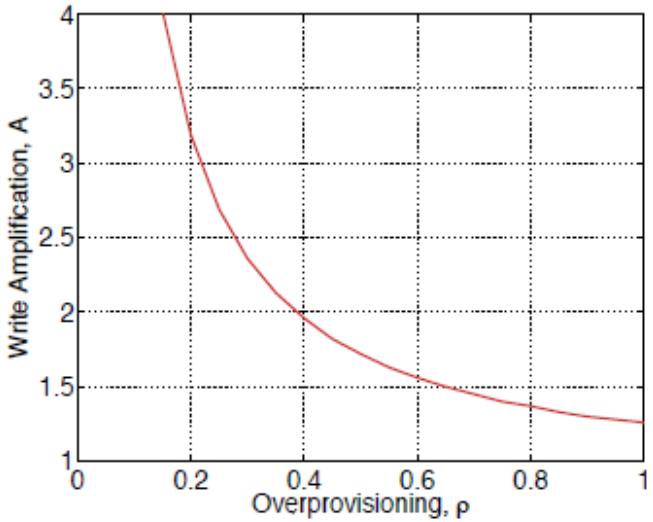




Why Do We Care?

We care **how** data moves (not **where**)

- Performance
- Durability



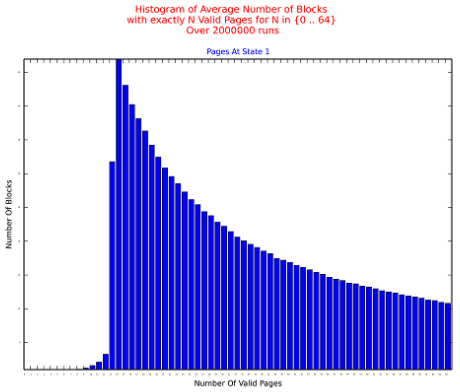
For example:

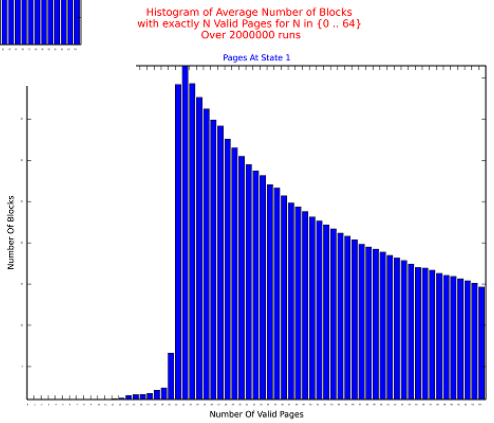
- $Write\ Amplification\ (WA) = \frac{user\ writes + internal\ writes}{user\ writes}$
- Larger overprovisioning → lower WA → less erasures

Example

- Write amplification is an overall measure
- How can we tell what caused it?

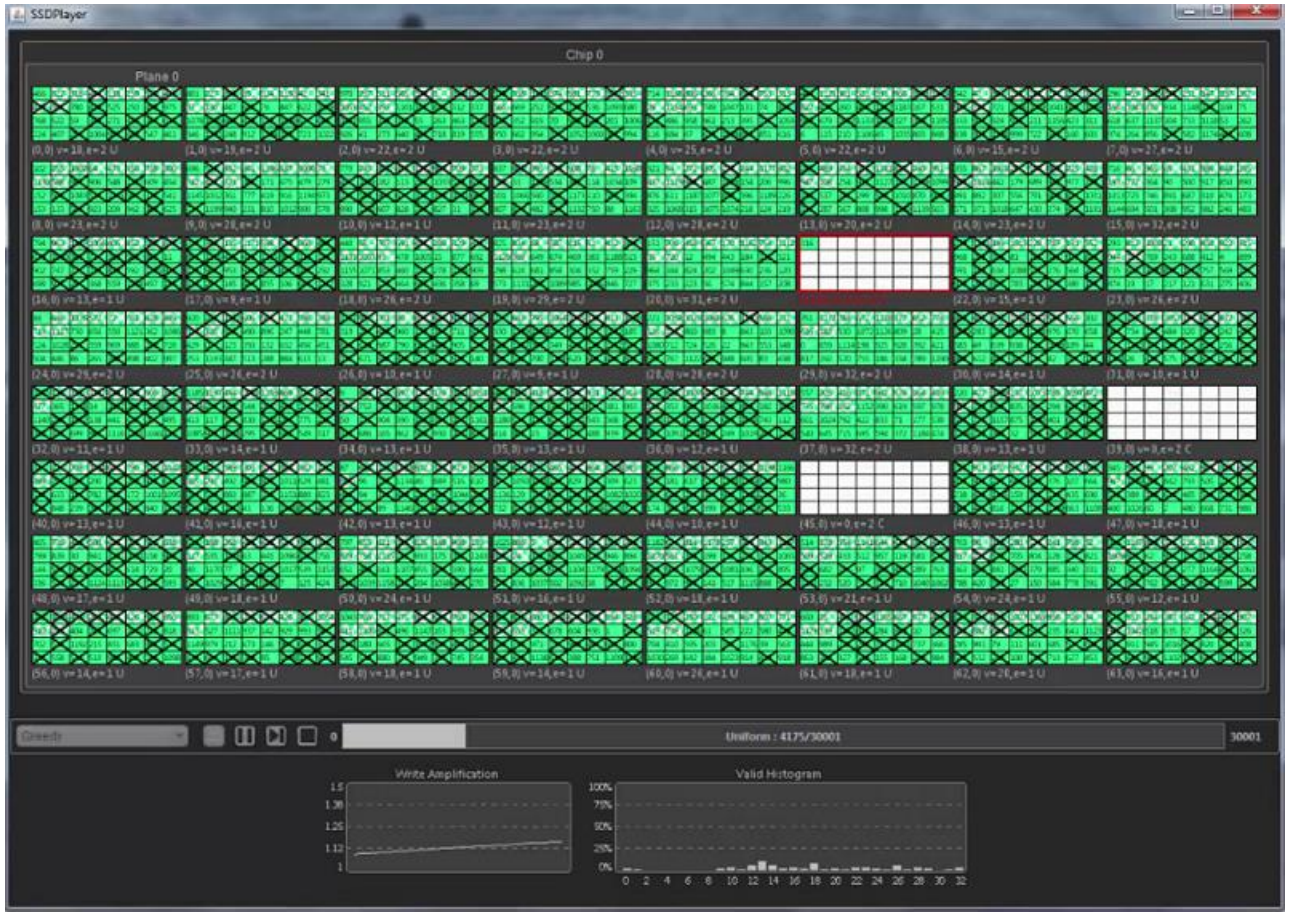
Chip 0 Plane 0										
Block 0:	~~94~~	53	~~95~~	42	~~61~~	86	62	~~16~~	2	…
Block 1:	26	37	~~79~~	~~22~~	30	17	~~48~~	94	4	…
Block 2:	28	63	44	70	26	~~46~~	42	51	47	…
Block 3:	75	67	~~45~~	12	72	88	90	~~37~~	19	…
Block 4:	91	80	18	34	91	~~91~~	45	51	45	…
Block 5:	54	~~56~~	70	~~34~~	49	87	~~59~~	~~54~~	82	…
…										
Chip 0 Plane 1										
Block 0:	97	81	~~42~~	75	13	12	84	69	~~86~~	…
Block 1:	94	70	~~48~~	~~22~~	~~81~~	48	89	24	100	…
Block 2:	~~69~~	28	86	42	58	88	16	~~38~~	68	…
Block 3:	80	51	~~69~~	99	~~35~~	99	54	84	42	…
Block 4:	8	~~65~~	13	16	96	52	90	42	23	…
Block 5:	32	14	89	~~79~~	13	~~61~~	~~29~~	77	31	…
…										





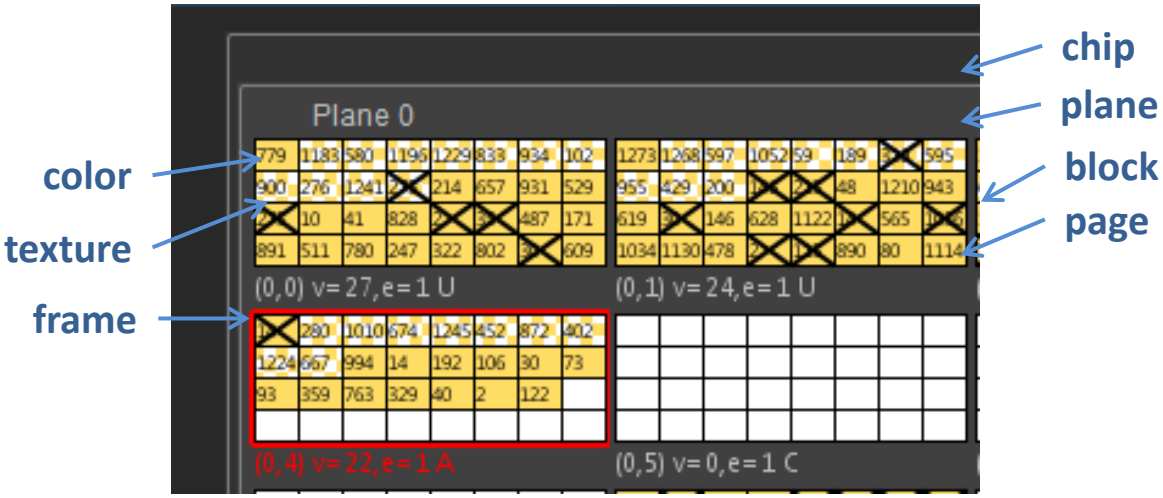
SSDPlayer

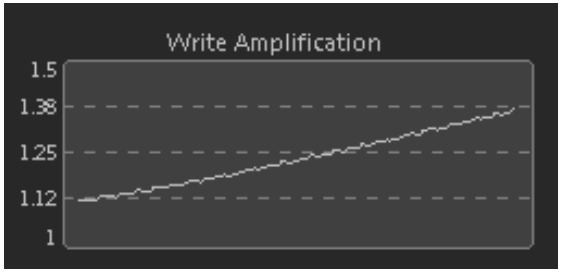
One video is worth a thousand histograms



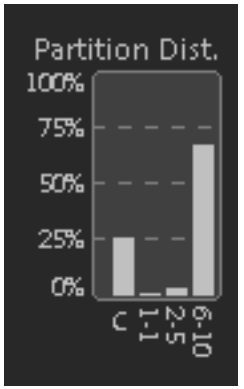
SSDPlayer Design

- General
- Simple
  - No timing
- Flexible
  - Appearance
  - Input
  - Features
- Java open source project





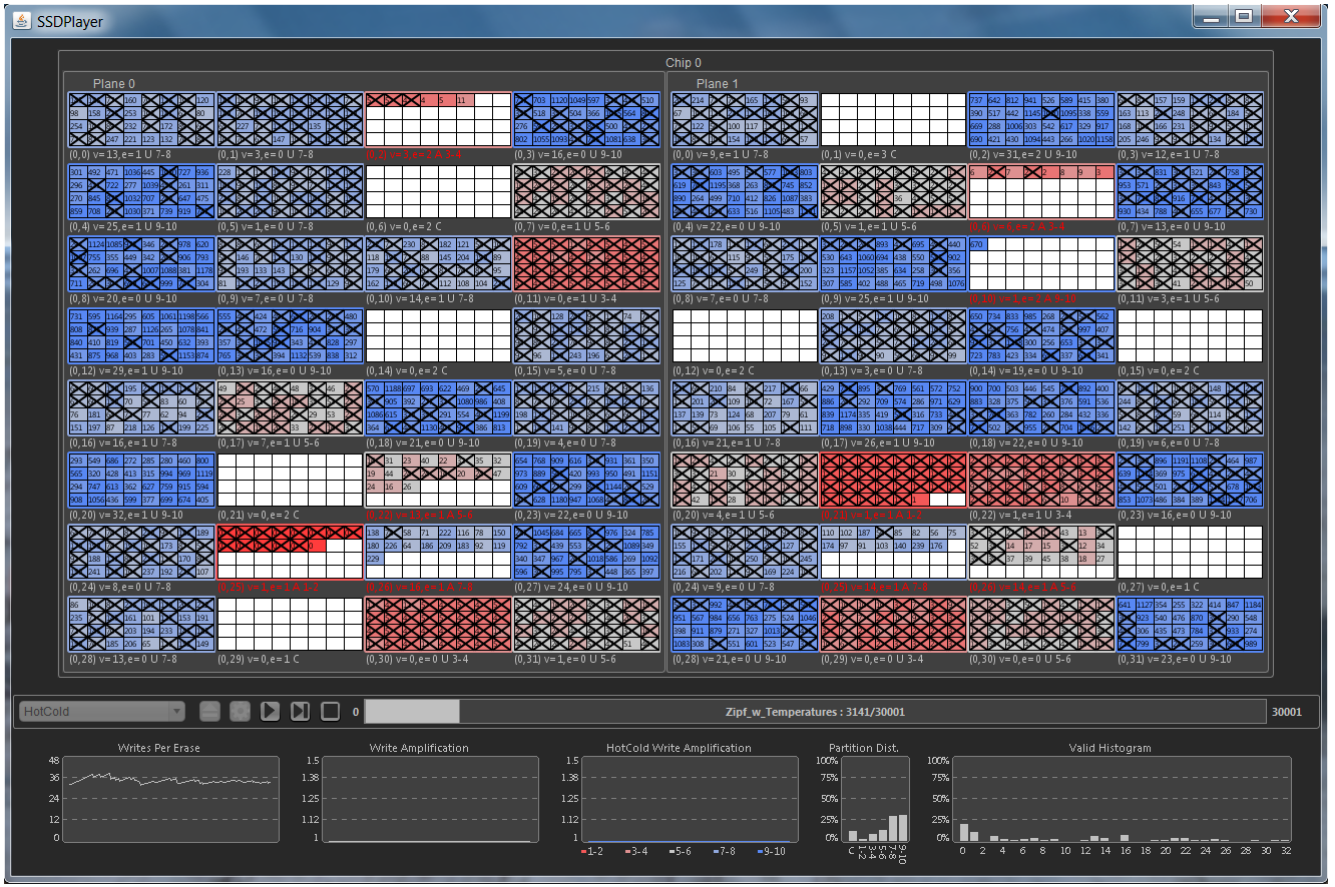
continuous histograms



states and stats

Now In Color

Skewed workload with temperature tags



Now For Real

Visualization mode: your own data and platform



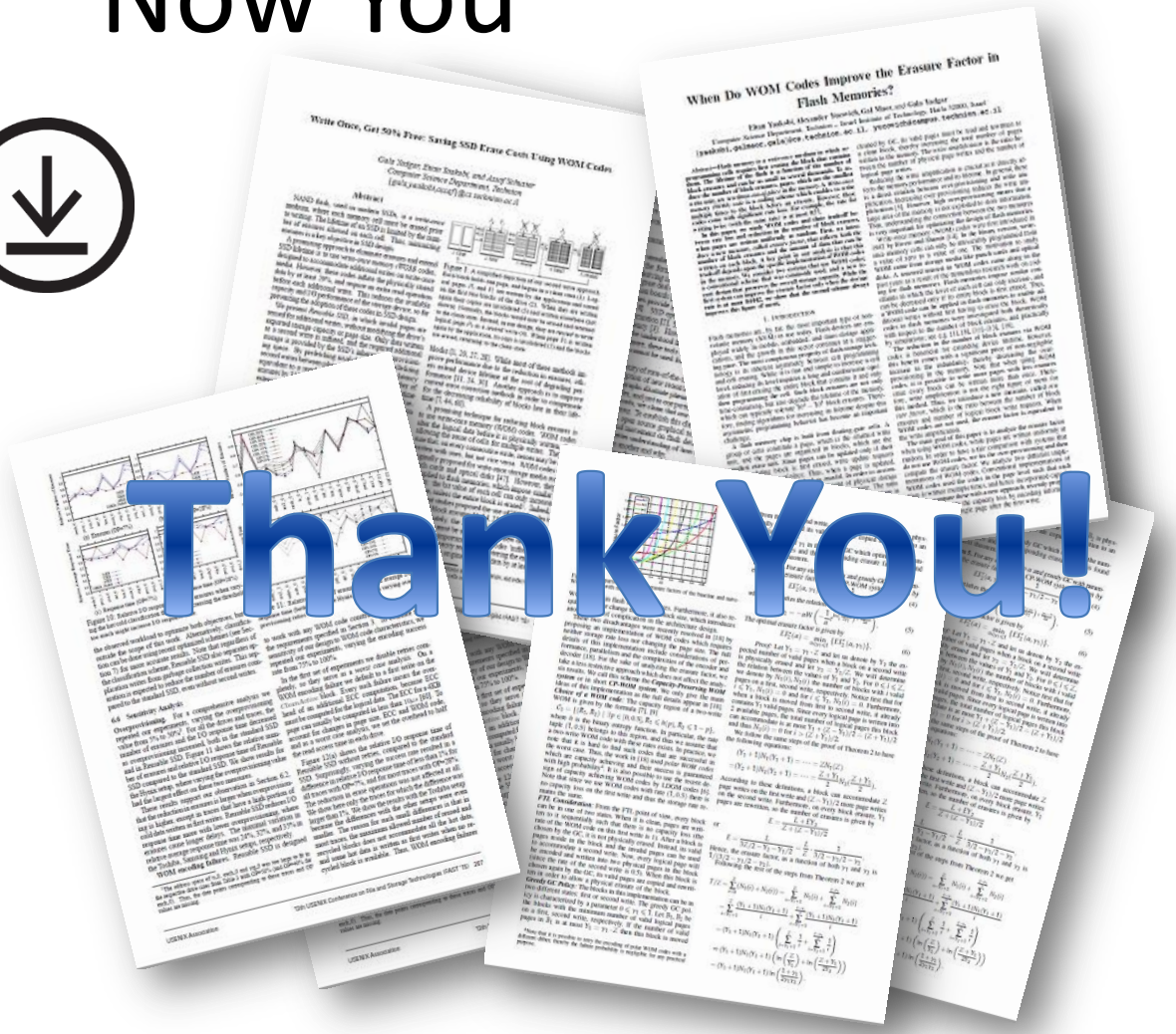
What Else?



- More flash
  - Parity and striping
  - Flash based caches
  - Bit error rate
  - …
- More layout
  - Content based optimizations: deduplication, compression…
  - File systems and databases: snapshots, versions, clones…
  - Anything that moves: shingled magnetic recording, log structured file systems…

Now You

- Download
- Play
- Tell us what you learned



http://www.cs.technion.ac.il/~gala/SSDPlayer/