

The background of the slide is a detailed stone relief carving. It features a central medallion with a face, surrounded by intricate scrollwork, floral motifs, and other classical architectural elements. The stone has a warm, yellowish-tan hue.

# ***Methuselah Remembers***

What to Keep, How to Keep it

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# Methuselah Remembers

Days slip by like space-time between the greasy fingers of history

Young ones condemned to partial memories, recent events

Children's images, favorite stories—lost like ancient mystery

Retaining more perhaps the victors won't determine controversial arguments

Methuselah remembers, he has the record, preserved and maintained in formats that won't die!



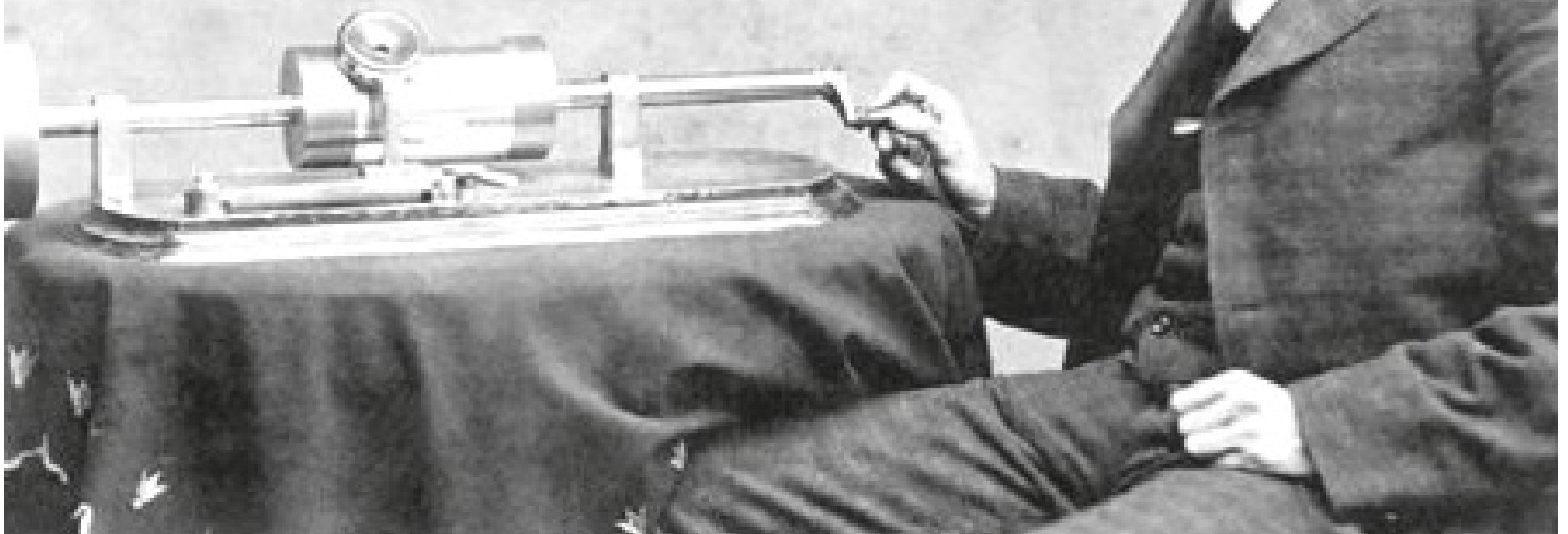
# Outline



- Drivers for Storage in the Home
- The Future of User Generated Content
- Organizing Digital Libraries
- Conclusions



# Drivers for Storage in the Home



# Demand for Storage is Extremely Elastic

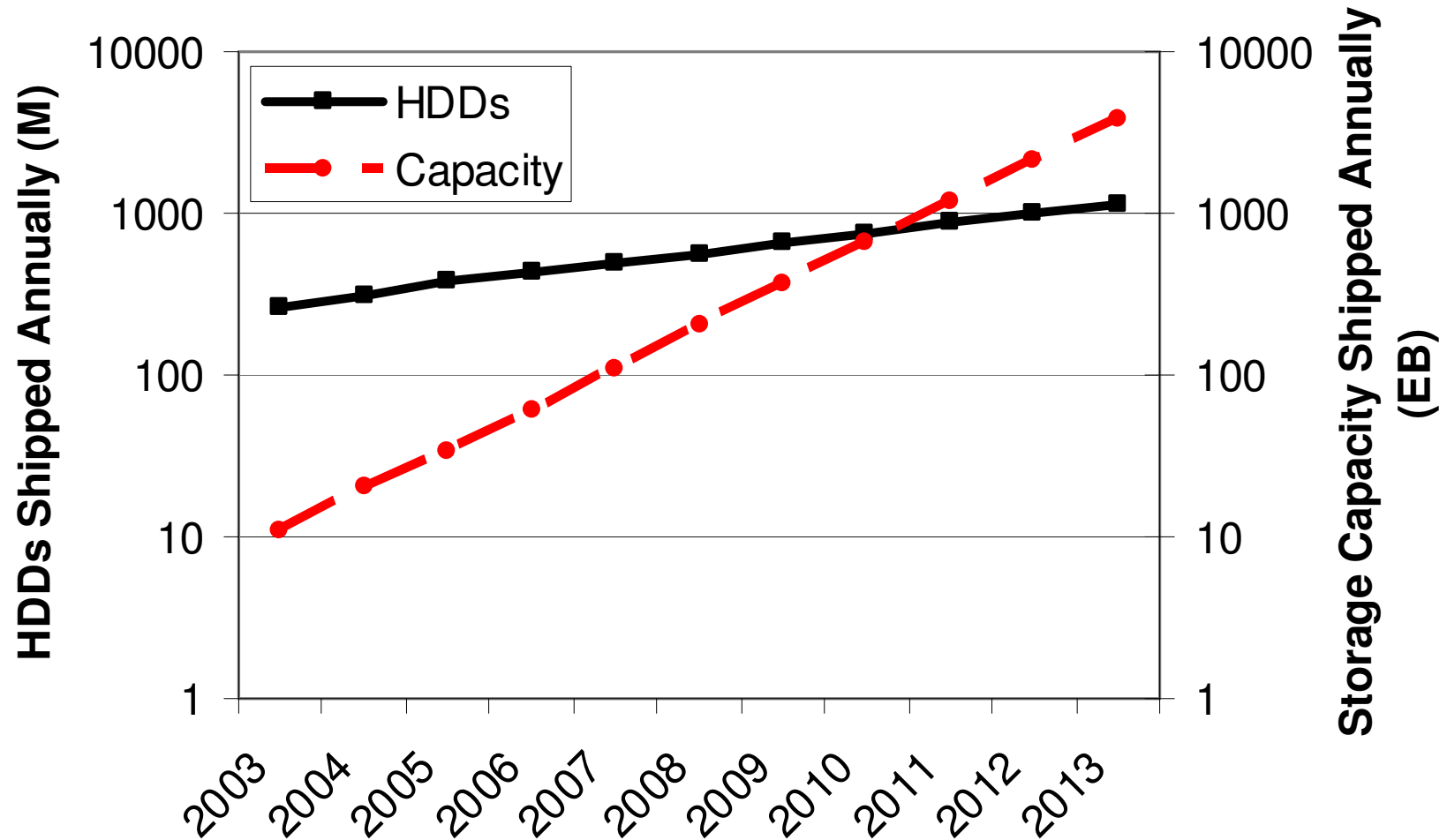
- Based upon HDD market trends over the last 5 years

Capacity Increase (2003-2008)	189 EB
Revenue Increase (2003-2008)	\$13.6 B
ASP Decline (2003-2008)	17.6%
\$/GB Decline (2003-2008)	\$1.72

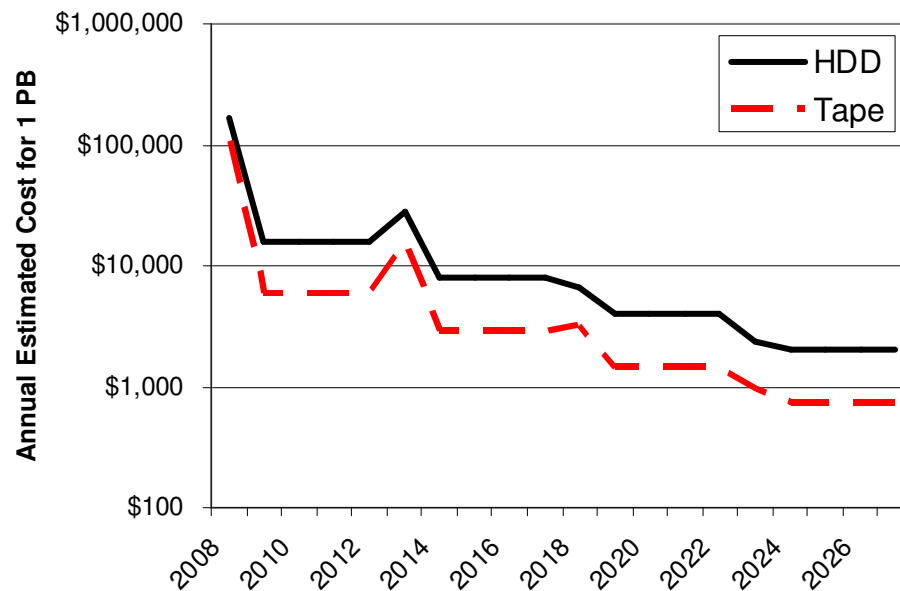
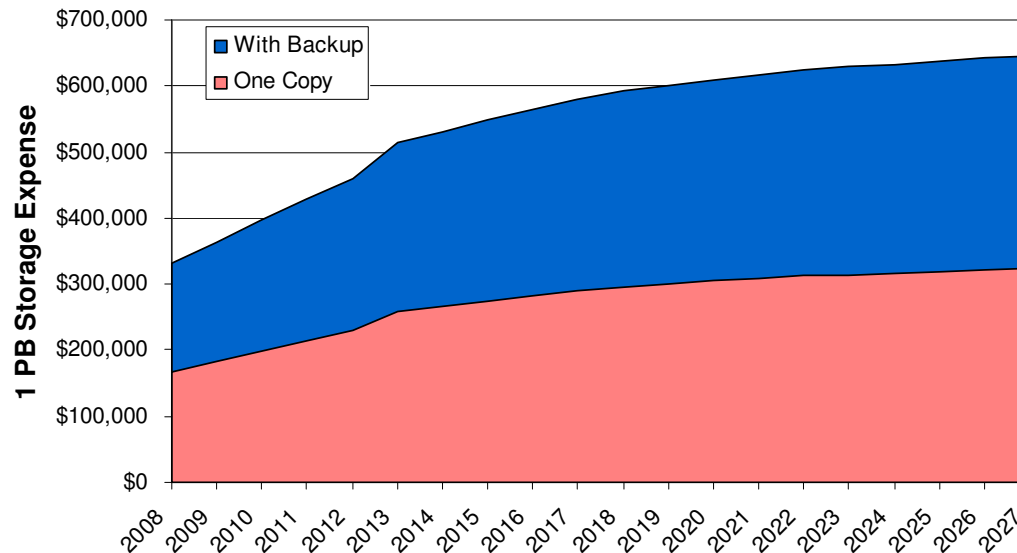
Ratio Capacity Increase/ASP Decline	10.77	Exabytes/\$ price decline
Ratio Drive Shipments to ASP Decline	16.75	M units per \$ decline in ASP
Ratio Capacity Increase per \$/GB Decline	110.07	Exabytes per \$/GB decline
Exabytes per % \$/GB Decline	2.08	
% Capacity Increase to % \$/GB Decline	1,890%	
Ratio Drive Shipments per \$/GB Decline	171.22	M units per \$/GB Decline
M Units per % \$/GB Decline	3.23	
% M Unit Increase per % \$/GB Decline	123.4%	



# Annual HDD Shipment and Shipped Storage Capacity



# Cost for Storing 1 PB for 20 Years



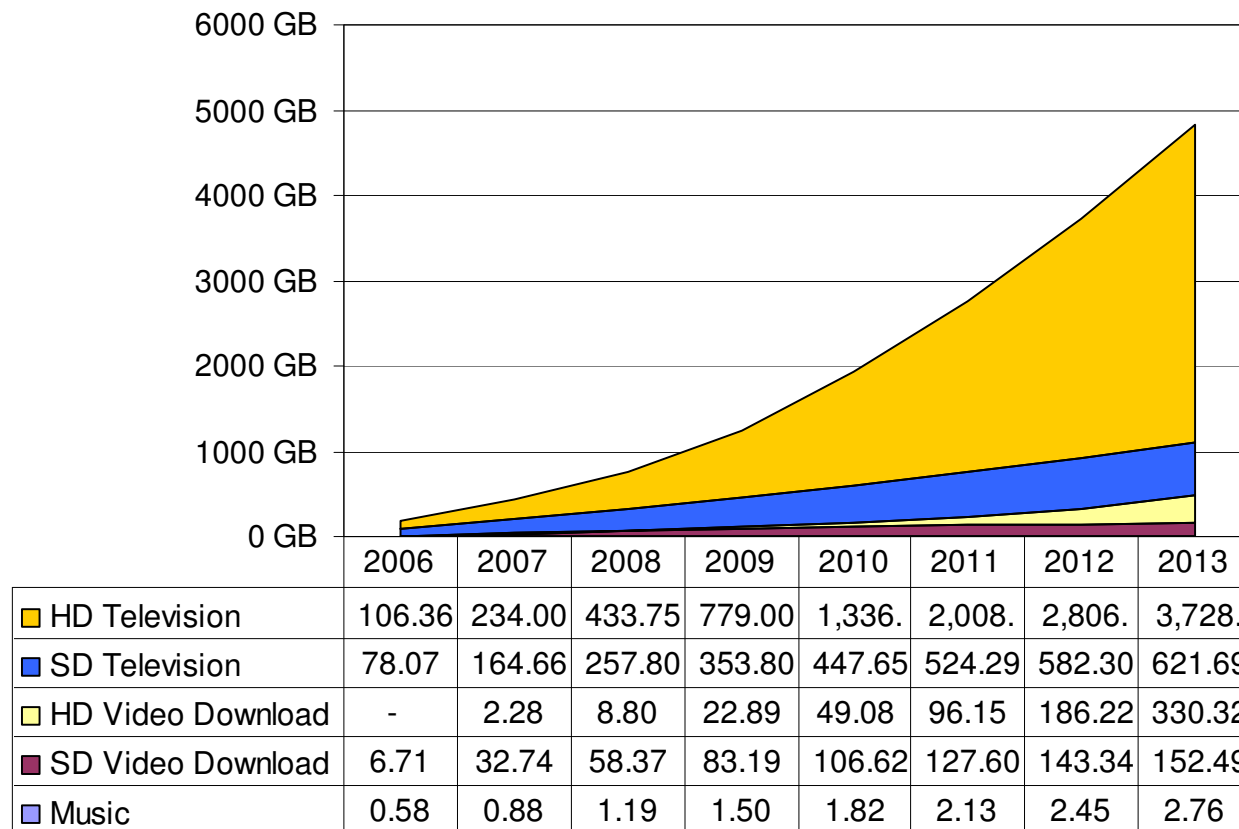
- As a guess say in 2008 1 PB of storage using 1 TB HDDs with proper environment, racks, HVAC, etc. cost about \$166,000 up front and \$16,000 per year to maintain.
- When you update this say in 5 years you would have another \$28,000 in capital and \$8,000 in annual operating expenses.
- It might be that this trend could continue with ever lower costs with time.
- Of course the costs can vary a lot depending upon many factors and sources.
- Over 50% of the total cost of preserving the 1 PB of content is in the first year.

# Storage and streaming bandwidth for music and video formats

Format	Bandwidth (Mbps)	Storage Capacity/Hour (GB)
<b><i>MUSIC FORMATS</i></b>		
MP3	~0.128	~0.576
Loss-less Compressed CD	~0.700 min.	~0.315
CD Quality	1.400	0.630
DVD Audio	9.600 max.	4.320
<b><i>VIDEO FORMATS</i></b>		
Format for iPOD (MPEG-4)	~0.750	~0.337
DVD MPEG 2	11.080	2.700
MPEG 4	~1.400	~0.630
SDTV	~8.000	~2.000
Blu Ray/HD DVD	36.550	3.750
HDTV	~19.300	~8.890
Ultra-HDTV	~295.000	~133.000



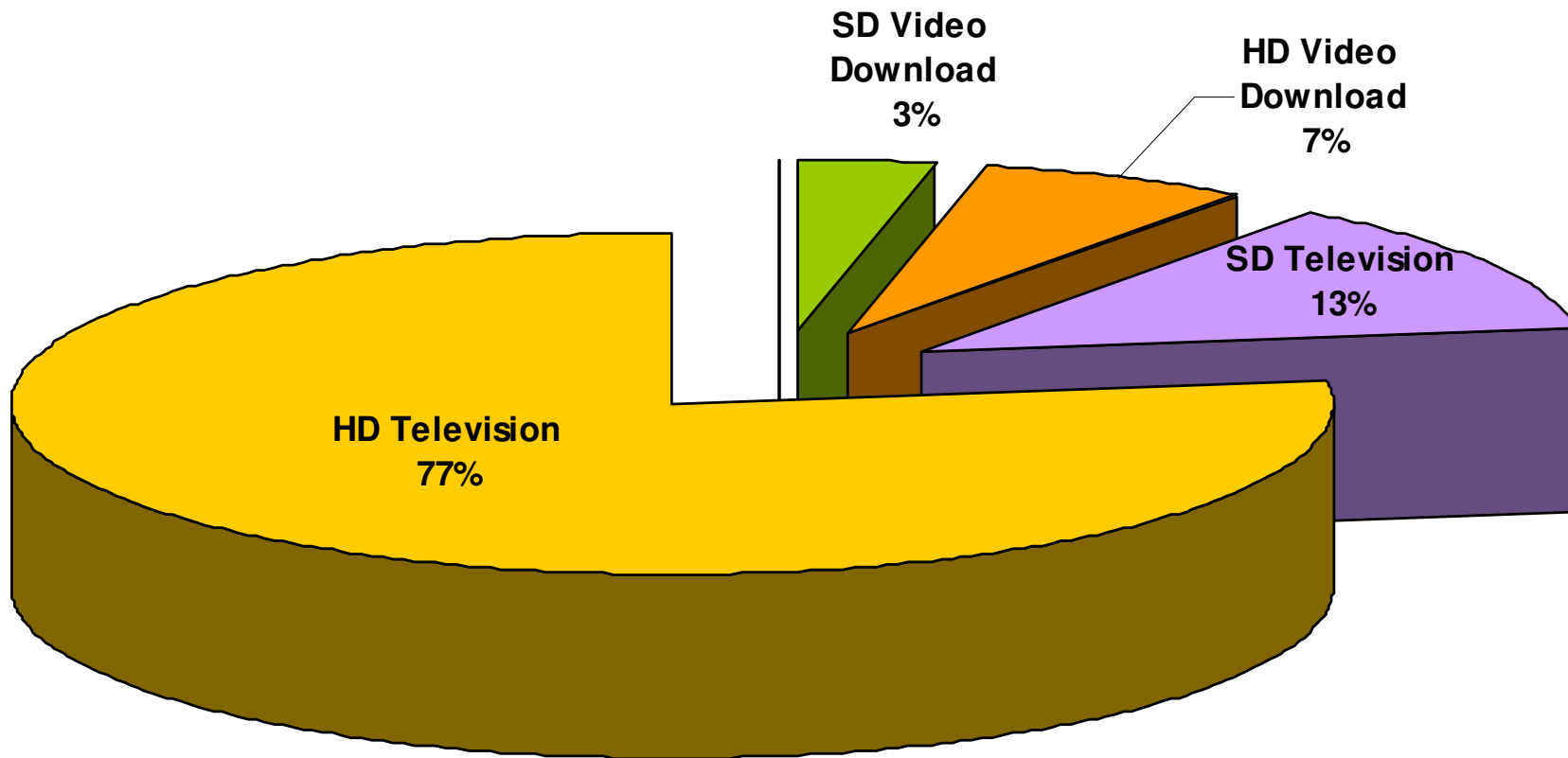
# Home Entertainment Accumulated Digital Content per Average Household



- Even an average household will have Terabytes of commercial data in the next decade
- As content resolution increases the required storage capacity must increase as well

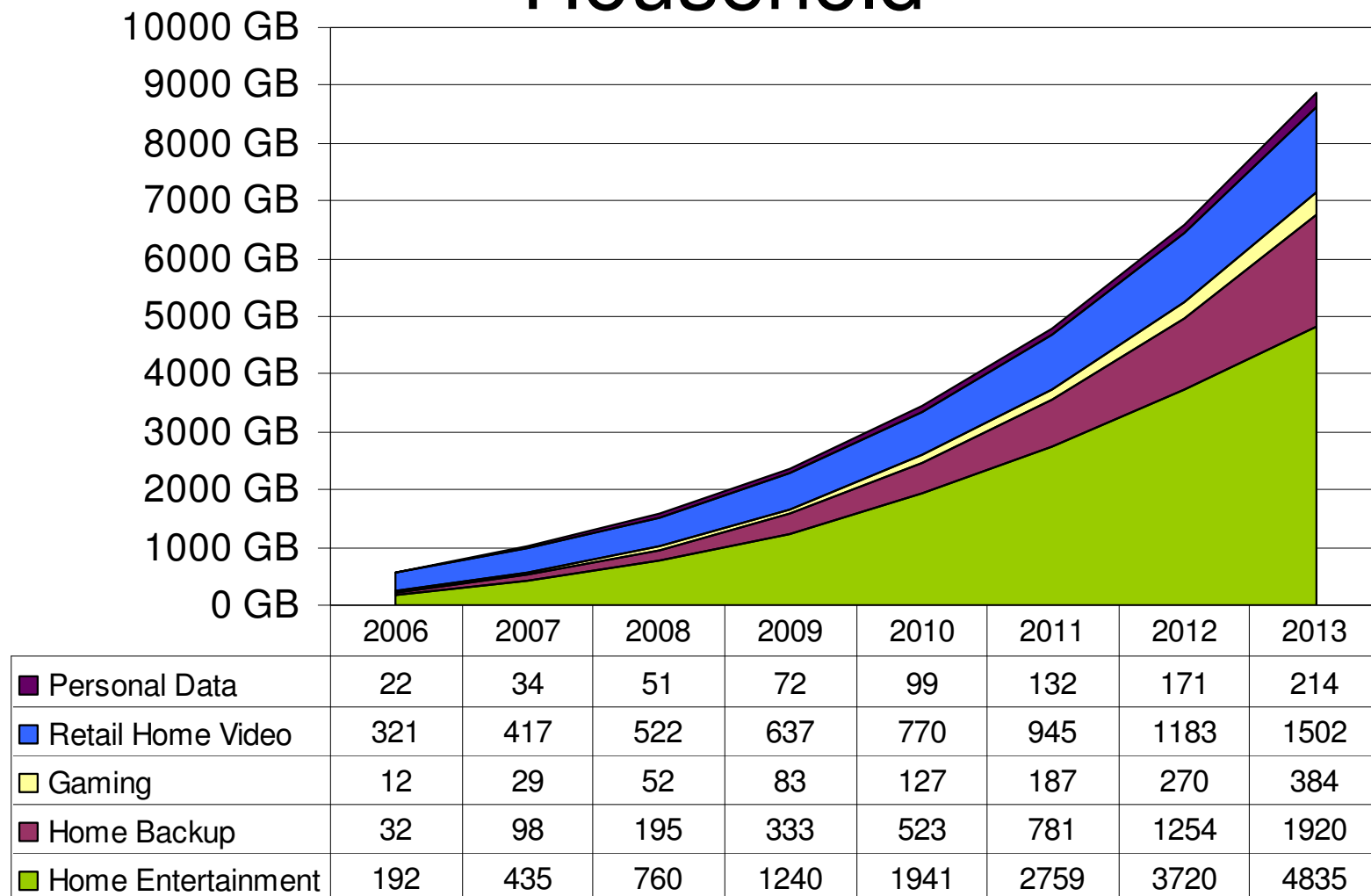
•Consumer Survey on Digital Storage in Consumer Electronics (Coughlin Associates, January 2008)

## Accumulated Digital Content in 2013 Per Average Household



•Consumer Survey on Digital Storage in Consumer Electronics (Coughlin Associates, release January 2008)

# Accumulated Digital Content Per Average Household

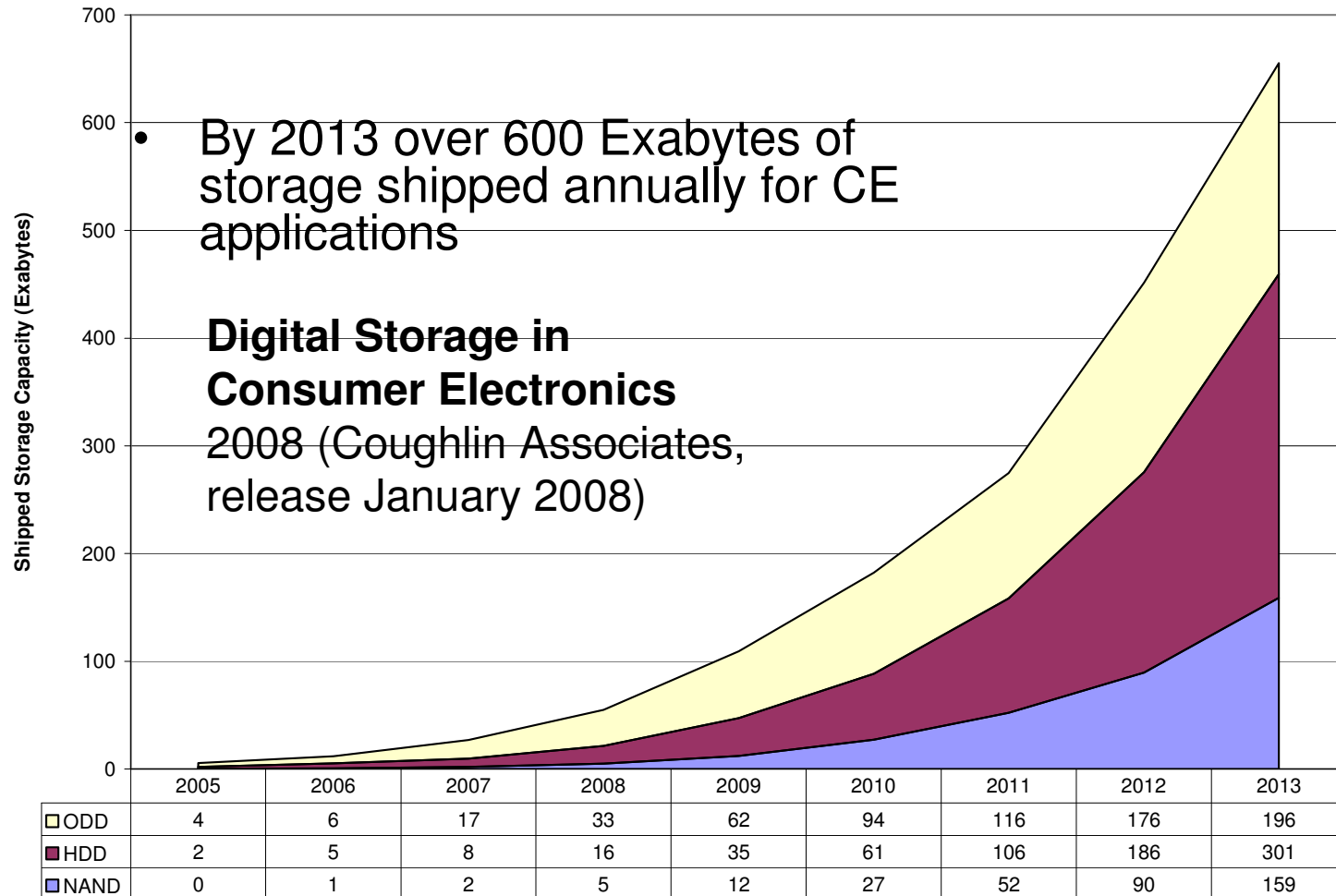


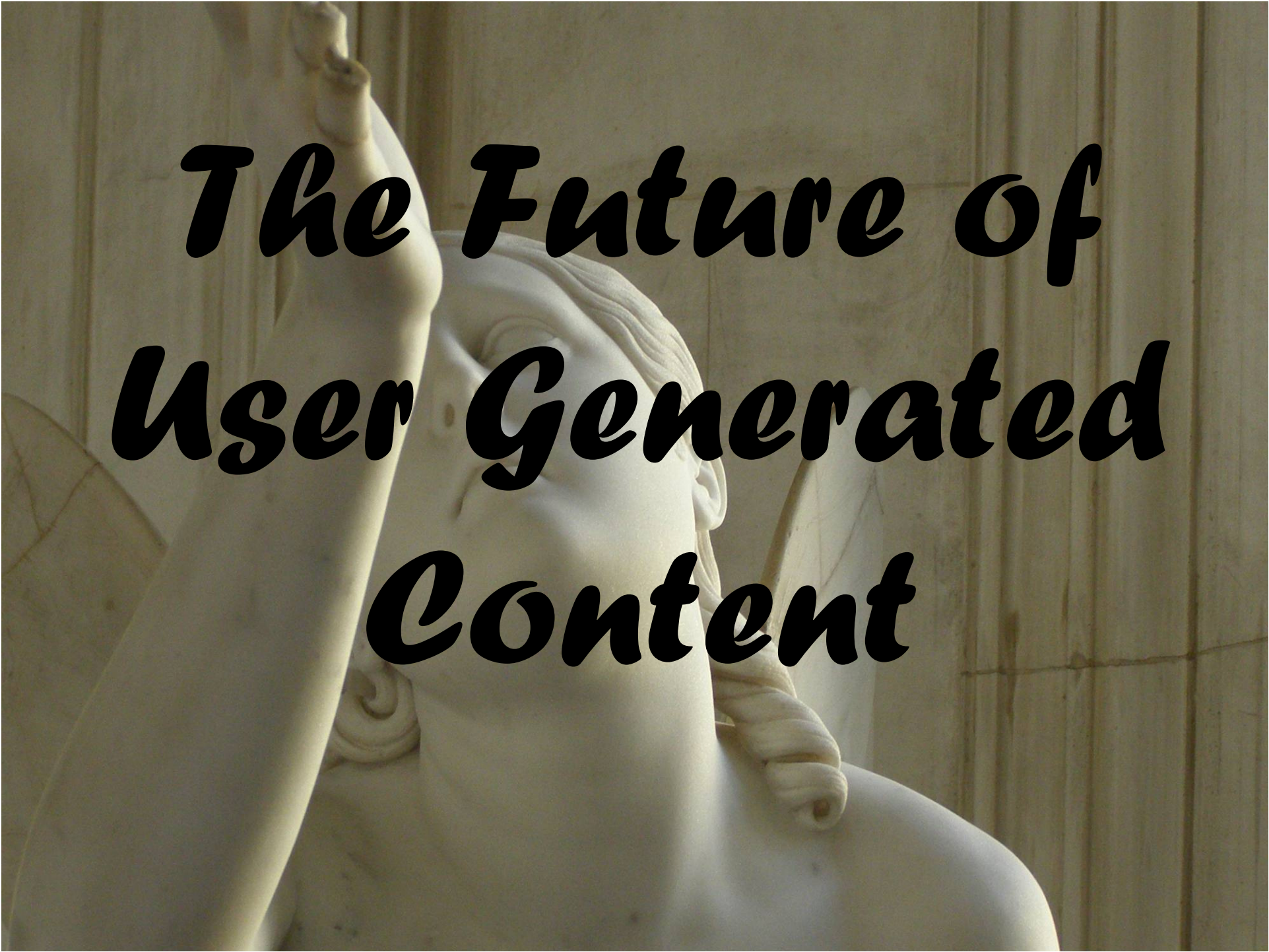
•Consumer Survey on Digital Storage in Consumer Electronics (Coughlin Associates, January 2008)

# Total Storage in American Homes in 2013

- Assume 100 M American Households, each with an average of 9 TB of storage
- This is 900 M TB of storage or 900 Exabytes of storage in US households by 2013
- Of this amount ~21 Exabytes are user generated content
- Some households will have much more than 9 TB, by the next decade there will be PB households (at least 1,000 TB)
- Total user generated content capacity will exceed commercial content by the end of this decade

# Exabytes Shipped for Consumer (OPTICAL DISK, HDD AND FLASH MEMORY)

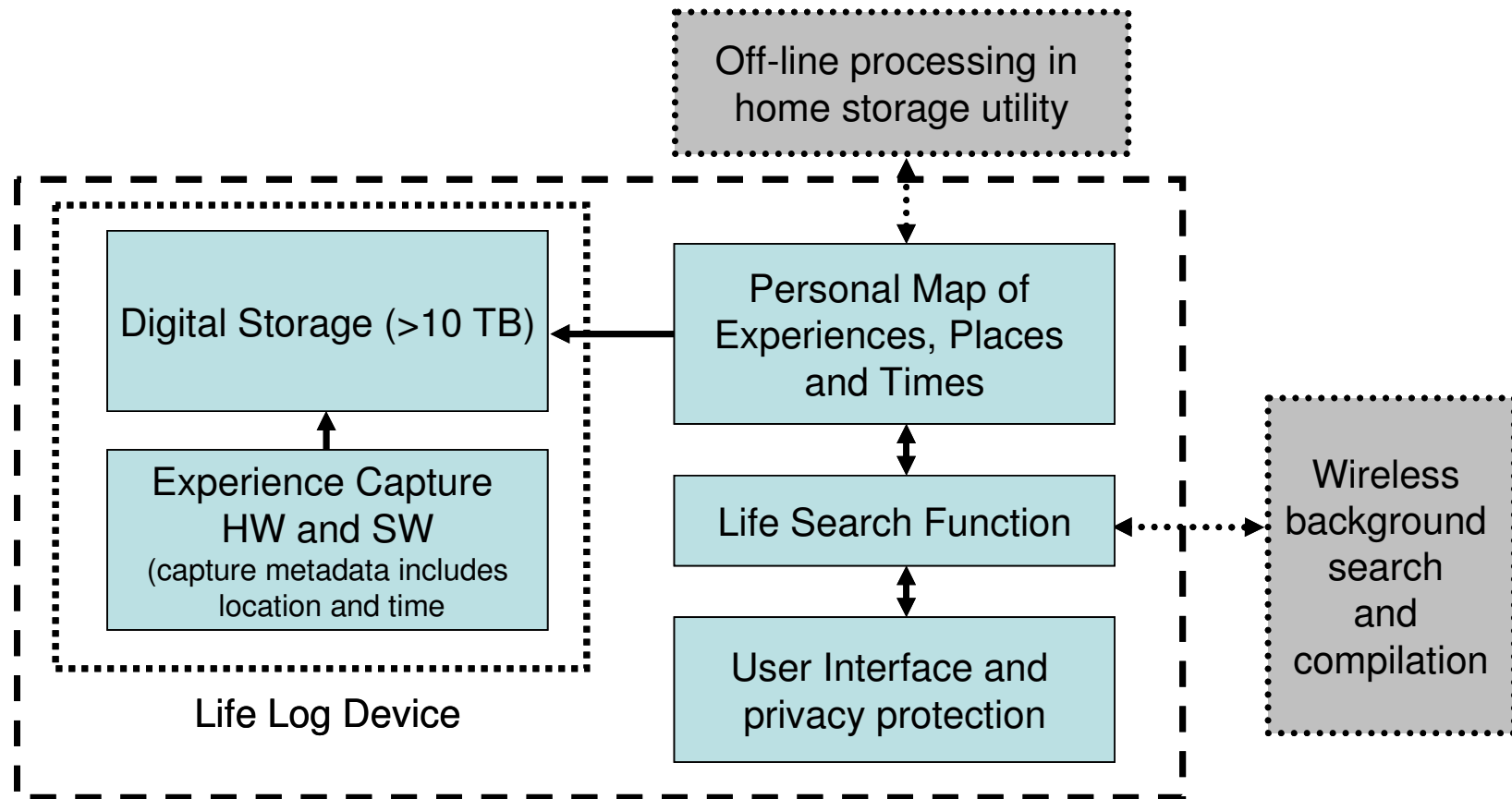


A classical marble statue of a woman, possibly a personification of Liberty or Justice, with her right arm raised high. The statue is set against a background of classical columns. The text "The Future of User Generated Content" is overlaid on the image in a large, bold, black, cursive font.

# ***The Future of User Generated Content***



# Block diagram of personal memory assistant showing major component functions



Such a device could require 10 TB of storage capacity on-board!

# Life Log 2008



**PVR-PRO WEARABLE VIDEO TECHNOLOGY**

Have you ever felt like you were missing out on an event because you had to concentrate on filming?

Have you ever wanted to video record a meeting or interview?

Have you ever needed documentation of an important event?

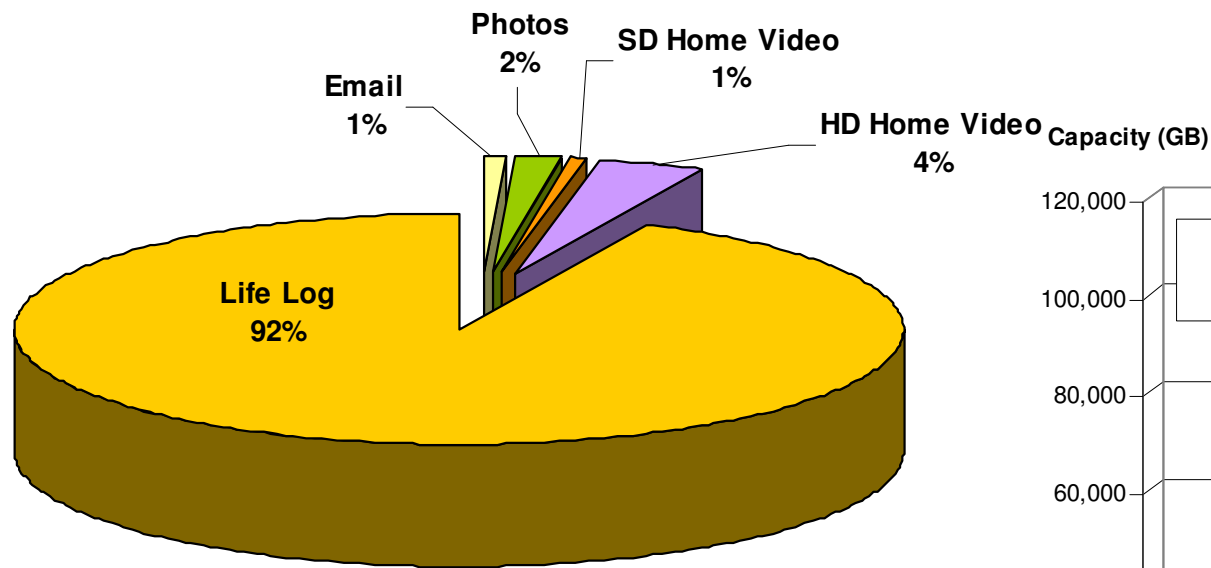
MEET **VIEVU**.

We make **WEARABLE** personal video recording devices that allow you to capture all the details of your daily life while you concentrate on what's important. Consider it your own personal **VIDEO DIARY**.

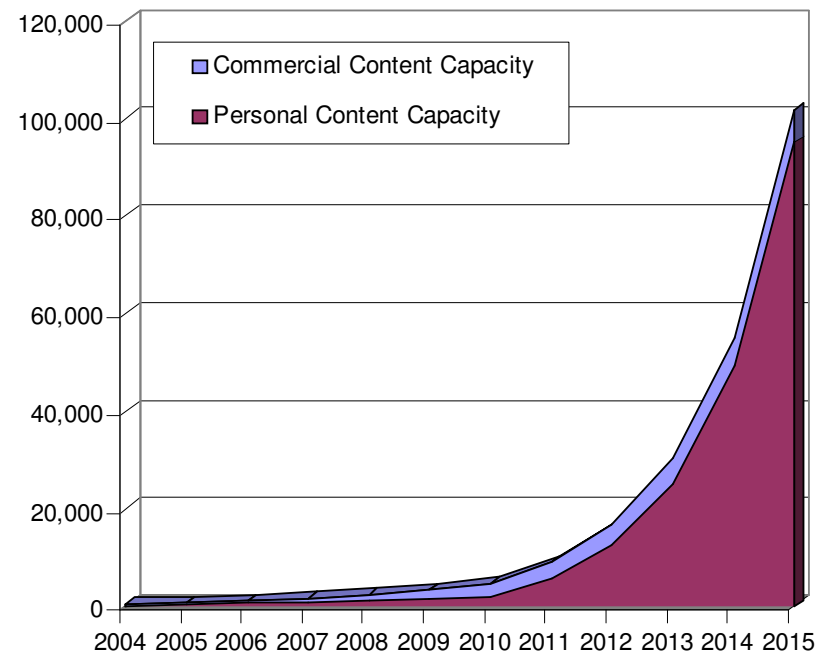
- This device only has 4 GB of flash memory at present
- This device “wants” a high capacity hard drive so it can capture higher resolution content
- Plenty of room for evolution of these types of products

# Affect of Personal Recording on Home Storage Demand

**Accumulated Personal Digital Content in 2015  
Per Top 10% Household with 1 life-log**



**Digital Storage in Consumer Electronics 2008**  
(Coughlin Associates, release January 2008)





A serene sunset scene over a body of water. The sun is low on the horizon, creating a bright, shimmering reflection that stretches across the water's surface. In the background, a range of mountains is visible under a soft, orange-hued sky. A small, dark boat is floating on the water in the lower right foreground. The overall atmosphere is calm and peaceful.

# **Organizing Digital Libraries**

# Digital Library Challenges

- Preservation from Disaster (Library of Alexandria Protection)
- Include UGC as well as commercial or state content preservation (Biggest source of content in future)
- Must be available for a long time in the future even by a civilization much reduced from ours (Dark Age Protection)





# Preservation from Disaster

- The library of Alexander contained much of the knowledge of the ancient world
- Many of the writings at the Alexandrian library were destroyed in a series of fires
- A digital library must protect the content from catastrophic disaster





# Drivers of Consumer Digital Storage

- Ease of content creation: Being built into many modern consumer devices e.g. cameras, digital recorders—Growth of User Generated Content (UGC)
- Content Sharing: Easy to multiple digital content 1,000 or more through on-line sharing.
- New methods of creating metadata automatically so content can be used easier.
- New ways to share and coordinate data around the home.

# Civilization Reboot

- The remains of libraries have been the basis of the rebirth of civilization
- A digital civilization may leave little physical or analog content that can be read without special equipment and/or software
- How can we create a civilization reboot capability with digital content?
- Need special reboot material (digital Rosetta stone)
  - Visual instructions on how to build a microscope
  - Microscopic visual language instructions and instructions on building the hardware and software to read digital content
  - Digital content, including guide to where to find more digital content
  - Many copies of this digital Rosetta stone to ensure survival

# Rosetta Disk



- The Rosetta disk is the physical companion of the Rosetta Digital Language Archive, and a prototype of the Long Now Foundation's 10,000 year library concept.
- The disk surface is etched with a message written in 8 major world languages which if magnified 1,000 times contains over 15,000 pages of language documentation
- <http://www.rosettaproject.org>

# LOCKSS

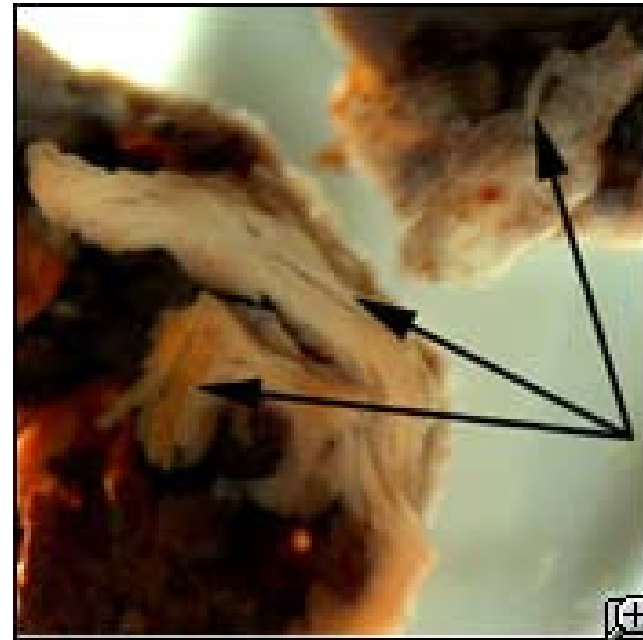
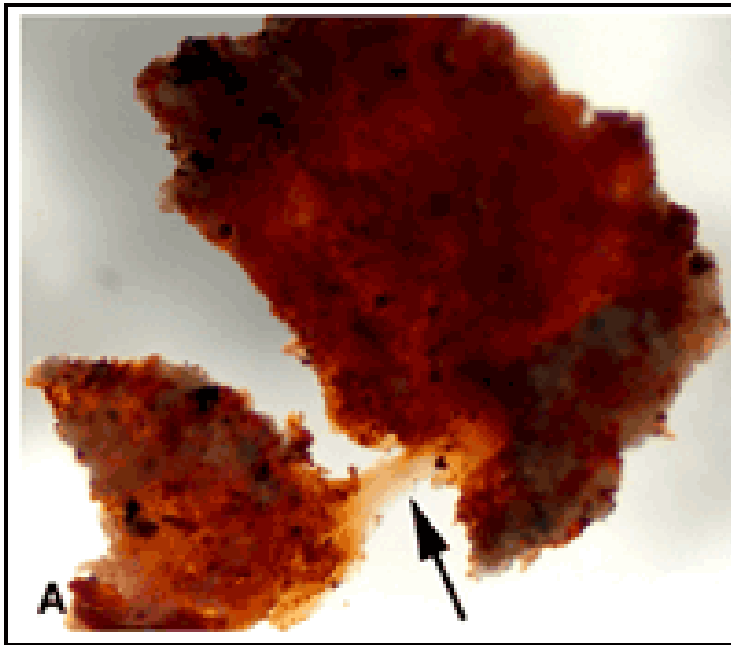
- LOCKSS (Lots of Copies Keep Stuff Safe), based at Stanford University Libraries, is an international community initiative that provides libraries with digital preservation tools and support so that they can easily and inexpensively collect and preserve their own copies of authorized e-content.
- <http://www.lockss.org/lockss/Home>

# Metadata

- Metadata--information about a file or data object that allows easier search and use of the content
- Currently most metadata is entered manually
- Automated generation of metadata using content robots and sensors
  - such as automated GPS location recording on pictures and video
  - speech recognition and translation to text
  - image and video recognition and recording of the indexing information
  - Metadata into everyday life
- With inexpensive storage, metadata could become unlimited,
  - making the original content easier to find and use
  - enabling enormous capability to create single frame content analysis
  - also cross-correlation information between frames or even between many types of content and across multiple files
  - Enables analyzing the use of content by an individual to create unique tailored metadata

# ***Natural Information Preservation***

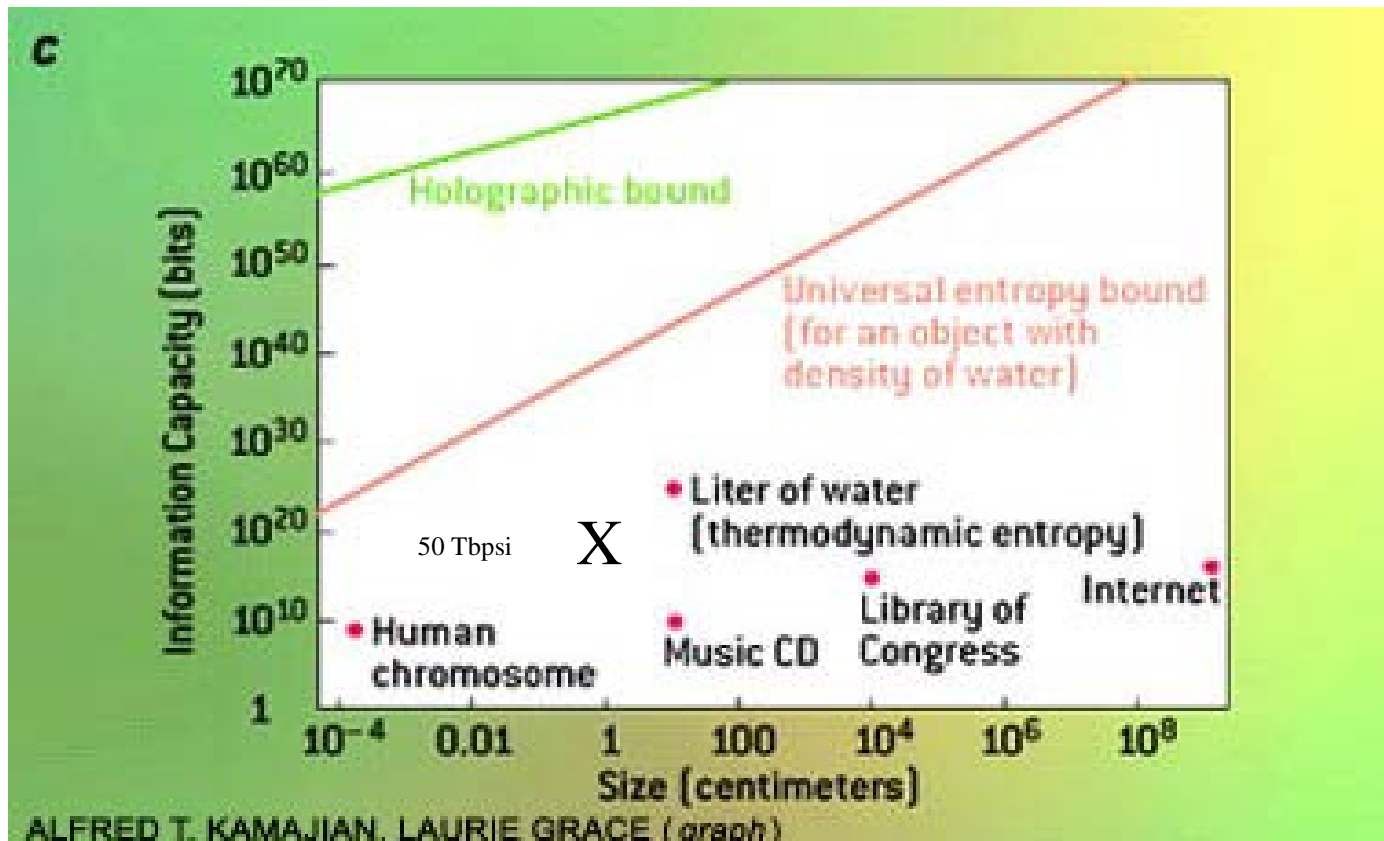
(70 M Year Old T. Rex Soft Tissue)



**Dinosaurs Had  
White Meat!**



# What Can We Know?



- Magnetic recording technology may allow up to 50 Tb/in<sup>2</sup> (50 X 10<sup>18</sup> b/in<sup>2</sup>)

Source: Information in the Holographic Universe, August 2003 Scientific American



# Conclusions



- The demand for storage for CE applications is very elastic—if they have more storage they will use it!
- User generated content will be greater than commercial content by the end of the decade.
- Future digital libraries must include some user generated content.
- Future digital libraries must protect against disasters and allow for civilization reboots.
- Automated metadata generation will be key to organizing, protecting and using digital libraries.



# Sources



- **Digital Storage in Consumer Electronics: The Essential Guide**, Newnes a division of Elsevier Press (March 2008)
- **Digital Storage in Consumer Electronics Report 2008**, Coughlin Associates
- **Consumer Survey on Digital Storage in Consumer Electronics 2008**, Coughlin Associates
- **2007 Entertainment Creation and Distribution Digital Storage Report**, Coughlin Associates
- Presentations at **2006, 2007 and 2008 Storage Visions Conferences** ([www.storagevisions.com](http://www.storagevisions.com)) and CES

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***Thanks***