Discussion Session

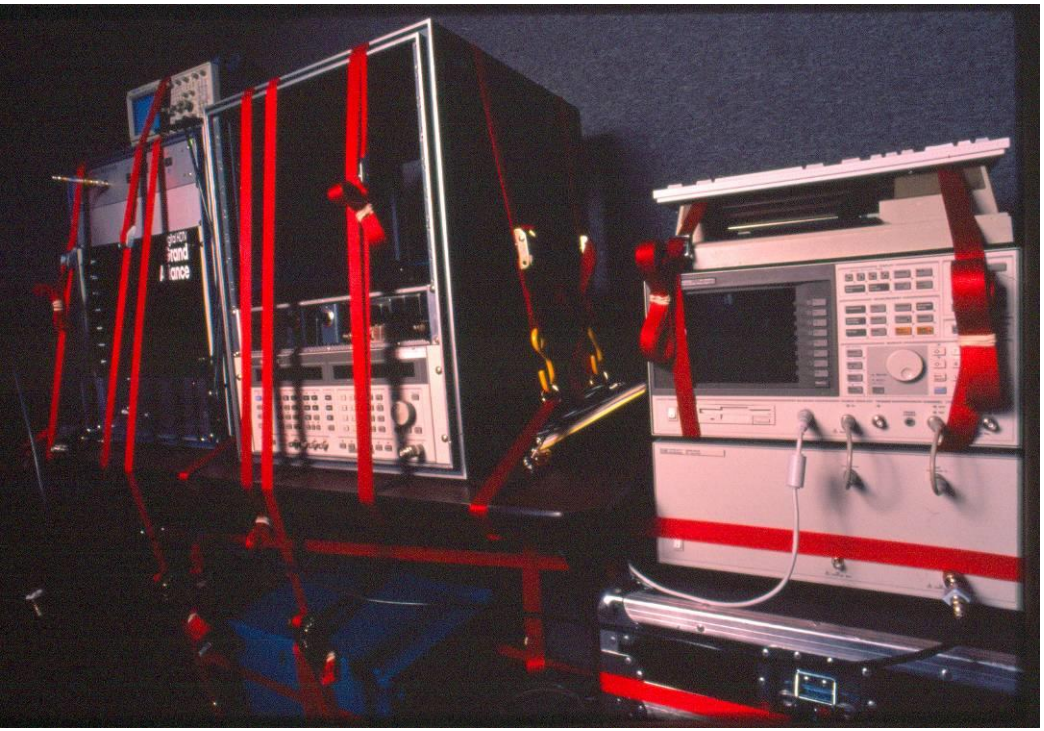
Wow -- Things Have Sure Changed!

Glenn Reitmeier

May 9, 2008

Compression Encoding

Receivers




TV
CONVERTER BOX
COUPON PROGRAM
1-888-DTV-2009
www.MYDTV2009.gov


DIGITALSTREAM

HDTV – Plasma & LCD

- Flat displays rule
  - rear-projection dying
- 1080p dominant in >42” & up
  - Panasonic: 17 1080p models, 4 720p
- Bigger, Thinner, Cheaper

HDTVs now in >50% of US HHs

Displays

1991

2008

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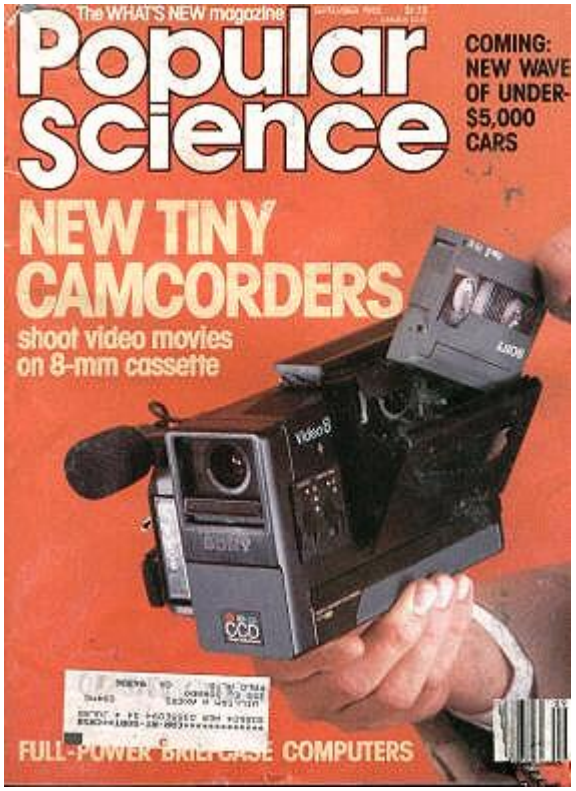
In The Future - OLEDs

- Super high contrast
- Ultra-thin
- Low power

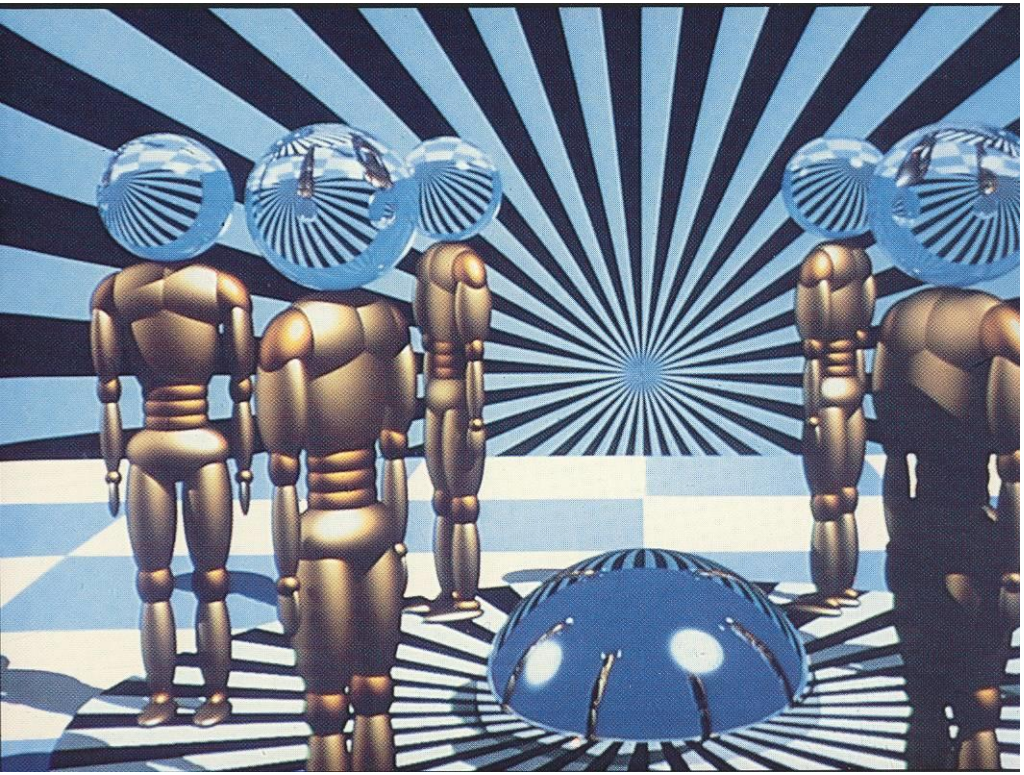
WOW!!

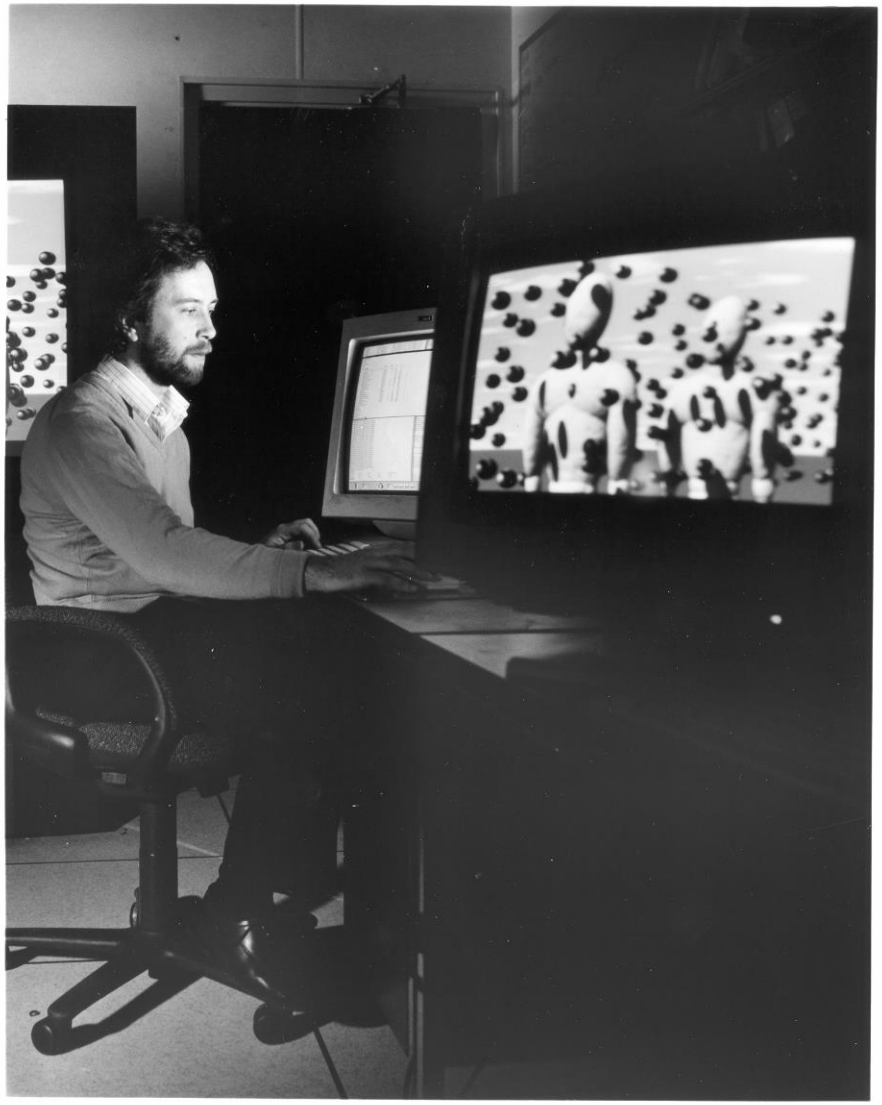
Camcorders Then



Camcorders Now

Graphics Then





Graphics Now

Blu-Ray wins DVD battle

- Single format sparks consumer adoption
- Likely last physical-based, video-specific format
  - File-based, flash memory the future of playback
- Internet connectivity comes to Blu-Ray

Technology Catalyst - Storage

- Processing – Moore's law
- Communications – increasing fast, but still the bottleneck
- Storage – faster than Moore's law…



	Flash Memory	Portable HDD	Standard HDD
2006	4 GB = 1 DVD = 4 PVs	20 GB = 4 DVDs = 16 PVs	300 GB = 60 DVDs
2008	16 GB = 4 DVDs = 16 PVs	80 GB = 16 DVDs = 64 PVs	1 TB = 180 DVDs = 36 HD
2012 est.	256 GB = 50 DVDs = 200 PVs	1 TB = 180 DVDs = 36 HD	16 TB = 2880 DVDs = 576 HD

- Compression will also continue to advance, magnifying effective storage capacity
  - DVD can hold up to 9 GB, using MPEG-2 compression. Advanced video compression (MPEG-4 AVC or WM9) can achieve comparable quality at about half of the MPEG-2 file size

Impact: Consumer Devices

- **STB / DVR / MCPC in 2011:**
  - **500 HD movies**
  - **or 1,600 hours of SDTV (1/2 year of all prime time from all 4 major networks)**
  - **EST? VOD? ad skip? Illegal downloads?**
- **Portable Devices**
  - Memory / slots and Media everywhere
  - **Does Content Delivery Follow?**

SanDisk
STORE YOUR WORLD IN OURS™

gruvi

Porto Media

- **CPRM download to compact flash**
- **In-store kiosk**

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Consumers Get It…

USA TODAY

Storage takes starring role in tech gizmo sales pitch

By Michelle Kessler, 3/26/2006

USA TODAYSAN FRANCISCO — As consumers fill gadgets to bursting with digital photos and music, storage is becoming a selling point for tech products.

Storage capacity used to be an obscure feature that interested only technophiles. But now — thanks in part to the growing popularity of digital music and video, photography and games — consumers are demanding it. And tech companies are responding:

- Samsung has unveiled a music-playing cellphone with 8 gigabytes (GB) of storage — enough to hold about 2,000 songs. The phone will be available in the second half of the year.
- Sony this month revealed that its long-delayed PlayStation 3 video game system will have 60 GB of built-in storage, enough to store about 13 DVD-quality movies. Each game disk will have an additional 50 GB — enough for games with eye-popping graphics.
- Google this month posted a presentation on its website outlining plans for an online storage service called GDrive. It would allow consumers "infinite storage" of their e-mail, Web pages and other data. Google later said the release was an accident and declined to comment further.

"Storage is no longer in the background," says independent storage analyst Tom Coughlin. "It's not just nice to have; it's a must-have."

Two different coalitions of tech and entertainment companies are developing new types of DVDs that can hold far more data than today's. They're both expected to become widely available this summer, creating a war similar to the VHS-Betamax battles of the 1980s.

Speed, not storage, once was a huge problem for tech products. But now technology has improved so much that aggravating lags — such as programs that take forever to load on a PC — are no longer the norm. That's prompted consumers to pay attention to other features, Coughlin says.

The cheaper and more plentiful storage gets, the more stuff consumers decide to store, says electronics analyst Ross Rubin at researcher NPD. In 1998, a digital music player with 32 megabytes (MB) of storage cost about $200. Today, that can buy a 2-GB player — about 64 times as big.

Digital photos and music were first, but digital video won't be far behind, Rubin says. Already, young companies such as CinemaNow and Movielink let consumers download films from the Internet. Before long, "you could have a library of movies in your car that you could show to your kids in the back seat," Rubin says.

That will force tech companies to spend more on storage in coming years, Coughlin says. Although prices are falling overall, more storage is going into each device. Already, about 50% of the manufacturing cost of a digital video recorder, such as a TiVo, is storage components, he says. "It's what people

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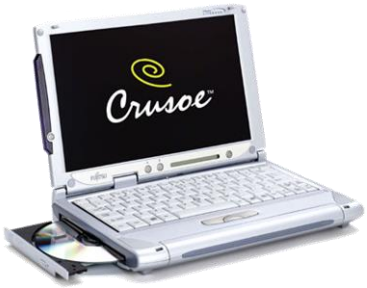
Technology Catalyst – Laptop PCs

- *In 2005, both unit sales and dollar volume of laptops exceeded desktops for the first time!*
- **Generally have an almost-HD-resolution LCD screen**
- **Enough processing power to decode HDTV**
- **Laptops becoming more appliance-like, more portable…**
- **Higher resolution, lower power consumption, better batteries coming…**

More Portable

Smaller



Smaller

Thinner

Smaller

Technology Catalyst – ATSC Tuners

Microtune Shrinks TV Tuners to Fit Inside Lifesaver Hole

Feb 2005 - Microtune, the company that makes tiny TV tuners that are hidden inside more devices than you can shake a stick at, keeps shrinking its tuners more and more. Now the company has outdone itself. Its MT2131 delivers higher performance at 65% the size of everyday tuners, and will certainly soon find its way into a variety of PVRs, TV adapters, and multimedia cards. They call this little hotshot “three-in-one” because it can handle garden-variety NTSC TV signals, ATSC (which encompasses all the HDTV standards), and then digital cable-ready (DCR) standards, too. All this TV tuning goodness for $3 apiece? Remarkable. Coming soon to a video-capable device near you…

Thomson

Jan 2006 - The JENSEN MPC4000 (suggested retail price $299) will be available in the spring. The tiny digital receiver is an innovative approach to linking the PC with digital and analog TV signals via an integrated antenna that connects the receiver to the PC through the USB port. Drivers and media software that insure quality program reception from UHF transmitted channels are included. The software also provides access to a full range of media content on the PC including audio files, videos and photo.

- any laptop becomes an HDTV
- downloads PSIP program guides
- DVR functionality

DTV Tuners – Broadcast TV

- High-end Notebook PCs with integrated ATSC tuners from HP & Dell

HP Pavilion HDX

- Dell All-In-One PC - integrated ATSC tuner

- Add-On tuners galore

HP ExpressCard Tuner

Pinnacle PCTV HD Pro Stick

DOCSIS 3.0

- "Channel Bonding" combines multiple 6MHz / 256-QAM / 38 Mbps RF channels into a single combined bit pipe
- Cable's weapon in the broadband speed wars
  - Far more capacity than AT&T (vDSL)
  - Not as much potential as Verizon FTTH, but as last-mile capacity soars, network switching cost will become the limitation
- Prototypes shown by major headend/node equipment suppliers: Moto, SA, BigBand

Cable positioned to stay competitive with Verizon FTTH broadband speeds for the forseeable future

Download Speed Consequences

- Competition among MVSPs is generally good for us, BUT…
- Broadband data speeds are being driven upwards (opportunity & threat)

Quality	*Download Time (20 min episode)*		
	Today (6 Mbps)	*(40 Mbps)*	*(150 Mbps)*
"VHS Quality" 352 x 240 / 500kbps	**1.6 min**	**15 secs**	**4 secs**
SDTV "TV Quality" 544 x 480 / 1 Mbps	**3.3 min**	**30 secs**	**8 secs**
SDTV "DVD Quality" 704 x 480 / 4 Mbps	**13.3 min**	**2 mins**	**32 secs**
HDTV "Movie" 1280 x 720 / 8 Mbps	**26.6 min**	**4 mins**	**1.1 mins**
HDTV Broadcast Quality 1920 x 1080 / 19 Mbps	**60 min**	**9 mins**	**2.4 mins**

…and…

Advanced Compression halves file sizes!

6 MHz Channel Limit

DOCSIS 3.0

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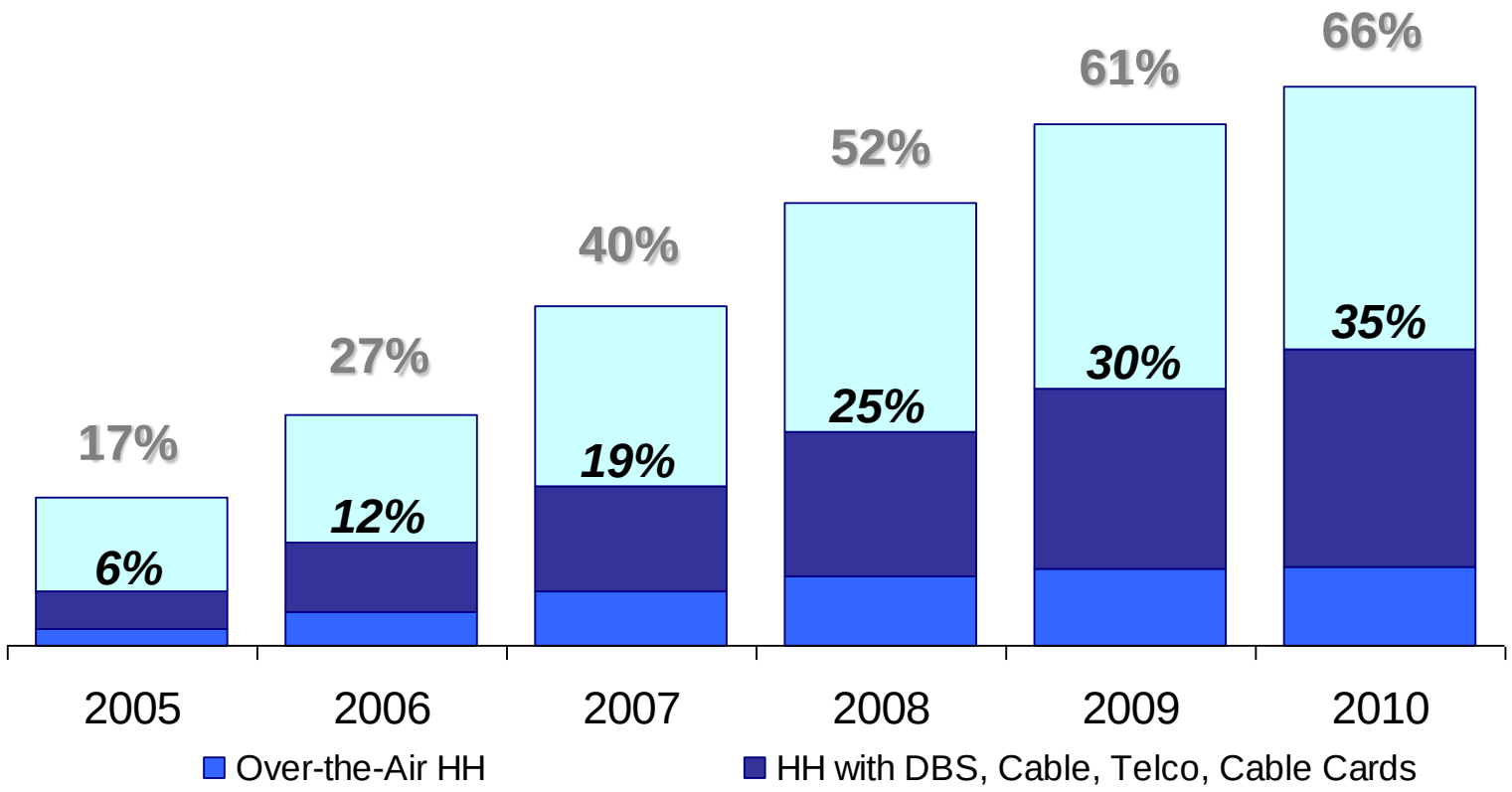
GPS goes everywhere

- GPS technology everywhere
  - Shrinking device size
  - Software Integration
  - Consumer Affordability

- Presents new local content and advertising opportunities (location-based targeting)

HDTV Adoption

Percent of US Households with HDTV capability*
*Percent of US Households with HDTV subscriptions***



* HDTV Capable households have an HDTV set capable of delivering HDTV signal but do not necessarily have the cable subscription to receive HD programming

** HDTV Subscribing households have an HDTV-capable set as well that receives HD through DBS, Cable, Telco, Cable Cards or Over-the-Air

Sources: NBCU Internal Estimates, Dec-06

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