

Grand Alliance

D I G I T A L H D T V

25th Anniversary Retrospective On Our Impact

Glenn Reitmeier
May 24, 2018

We Did It! ... We Created A Big Splash

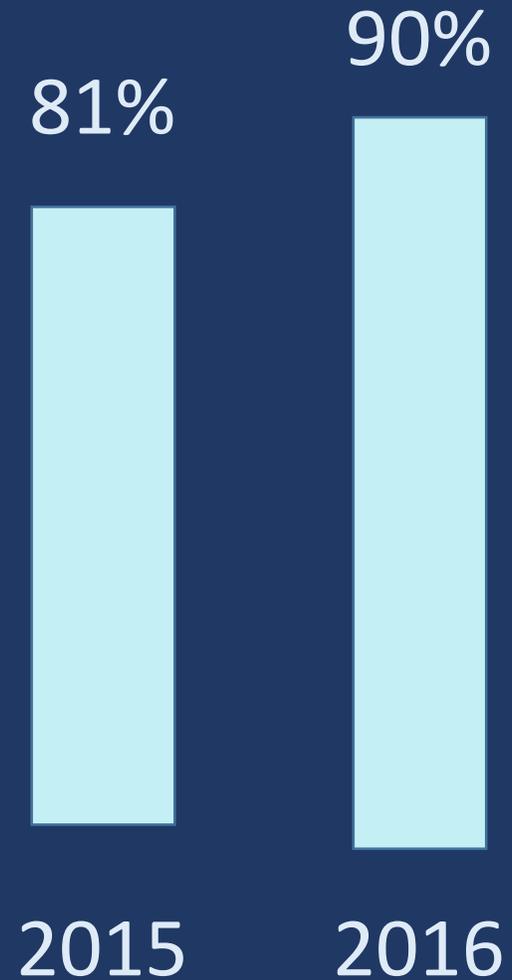
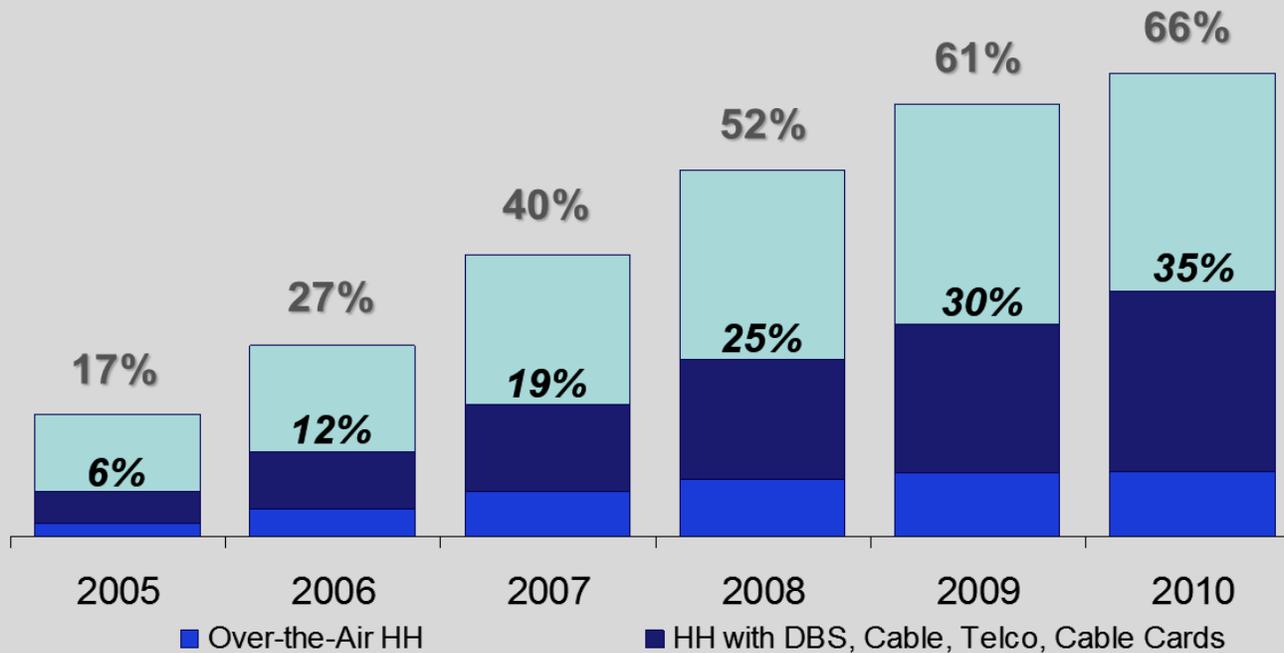


HDTV Adoption – *all* TVs are HDTVs

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

DVR

DBS

**Digital
Cable**

a t s c

Digital HDTV
Grand Alliance

DVB

We Created A
Very
Big Splash

Digital TV



US - 119M TV Households

vast majority digital

53M cable

32M satellite

12M telco IPTV

Europe - 99M pay-TV HHs

Worldwide pay-TV revenue is > \$1.1B

As pay-TV grew, over-the-air broadcast declined to <10% US HHs around 2010

OTA-only HHs now 17M

Antenna sales growing

“cord-cutting” trend

~20% of US broadband internet sub HHs use OTA

DVR

DBS

Blu-ray

Digital
Cable

DVD

Digital
Cinema

a t s c

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Home Video

1977 - **VHS** VHS/Beta war ... last unit 2016



2002 - in 6 years, >70% adoption in US HHs
CDs took 14 years, Cell phones 18 years, PCs 25 years

2002 - China made 30M players, ~70% ww total

2003 -  BD/HD-HVD war ... 2007 2.7M players

2013 - “Frozen” sold 3.2M discs in one day

2013 - “Despicable Me 2” >46M discs (US)

2018 - although in step decline, disc sales \$4.7B

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



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DVR

DBS

Blu-ray

Digital
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Flat-Panel
Displays

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HDTV and Flat-Panel Displays Symbiotic



OLED

8k 7680 x 4320

LCD / LED

High Dynamic Range

Wide Color Gamut

LCD

4k UltraHD 3840 x 2160

DMD/DLP

FullHD 1080p 1920 x 1080

720p 1280 x 720

Plasma

480p

1995

...2008

...2018

Displays



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

Glenn Reitze

In The Future - OLEDs



- Super high contrast
- Ultra-thin
- Low power



WOW!!

Glenn Reitze



Next... H.266

HEVC H.265

Video
Steaming

Cable
Modems

Cloud
DVR

VOD

DVR

AVC H.264

DBS

Video
Downloads

Digital
Cable

DVD

Blu-ray

Digital
Cinema

MPEG-2

a t s c

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Video Streaming Over The Internet

4G (2000)
kbps

DOCSIS 3.1 FD
10 Gbps / 10 Gbps (2017)

DOCSIS 3.1 (2013)
10 Gbps / 1 Gbps

DOCSIS 3.0 (2006)
Channel Bonding 1 Gbps / 100 Mbps

DOCSIS 2.0 (2001)
40 Mbps / 30 Mbps

3G (2000)
> 200 kbps

Cable Modems
DOCSIS 1.0

40 Mbps / 10 Mbps (1997)

TS/QAM
Digital Cable

8/16 VSB
ATSC
Grand Alliance

2G (1991)
~40 kbps

HEVC H.265 (2013)
HD @ 3 – 4 Mbps

AVC H.264 (2003)
HD @ 6 – 8 Mbps

HDTV = MPEG-2 @ 19 Mbps
ATSC
Grand Alliance

Cable Modems – Broadband Internet

Over 66M Cable BB internet subs (telcos have 32M)

Cable invested > \$230B in networks since 1996

There are 1.7 million miles of Hybrid Fiber Coax in the US

2015 - Comcast ISP subs > TV subs

2017- video streaming revenue > Physical Media sales

Digital Revolution – Many Astounding Advances and short life cycles with rapid obsolescence

Discussion Session

Wow -- Things Have Sure Changed!

Glenn Reitmeier
May 9, 2008

And the Change Is Accelerating

Glenn Reitmeier
May 24, 2018

1995

...2008

...2018

Computing and Memory

Computing Power

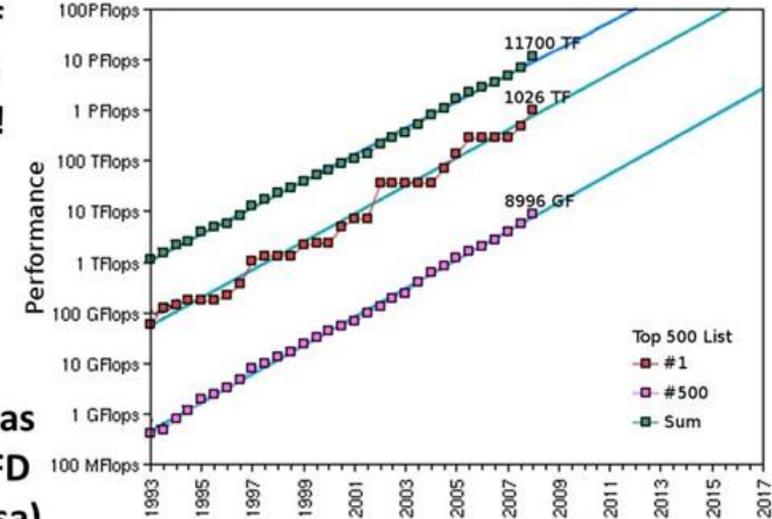
Technology Catalyst - Storage



- 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

5 Orders of Magnitude Since 1985!



Advanced Computing has Advanced CFD (and vice versa)

10 MB

•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

Green Rebraker

----- 100,000x increase ----->



SUPER SPEED CERTIFIED USB 3.0

8GB
16GB
32GB
64GB
128GB
256GB
512GB
1TB

real capacity+ 1 year warranty

1995

...2008

... 2018

Compression Encoding



MPEG-2

MPEG-4 AVC – H.264



- Software on commodity servers
- Encode “in the cloud”

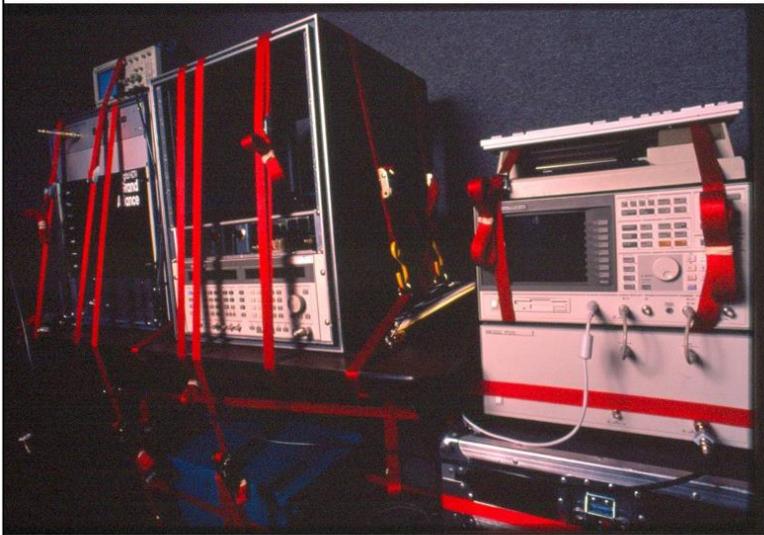


1995

...2008

...2018

Receivers



NBC UNIVERSAL



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1995

Personal Computers



...2008

...2018

Post-PC Era

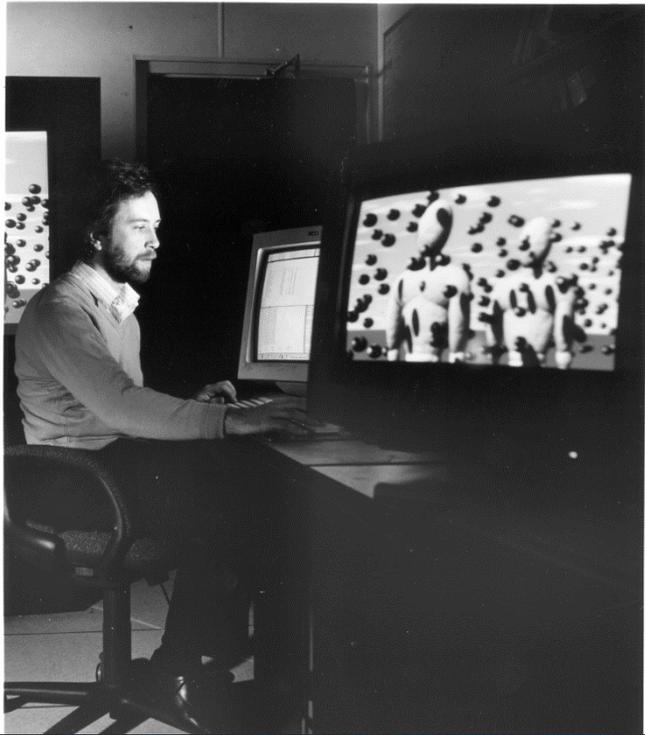


Technology Catalyst – Laptop PCs

- 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...



1995



...2008
Graphics



Full HD



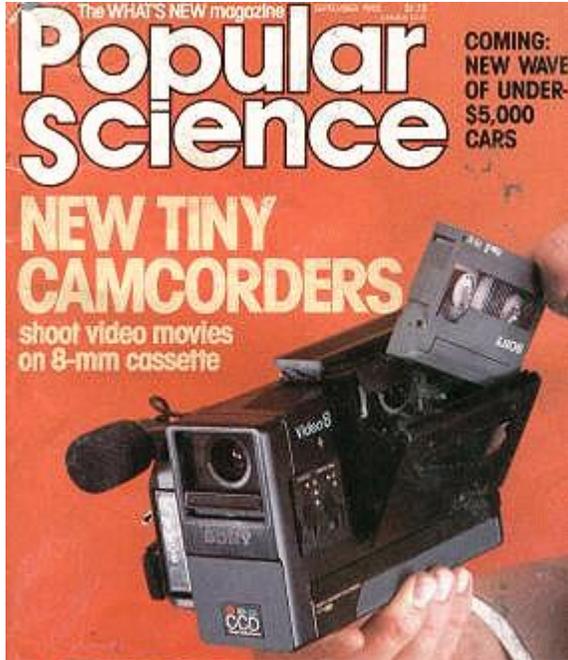
...2018



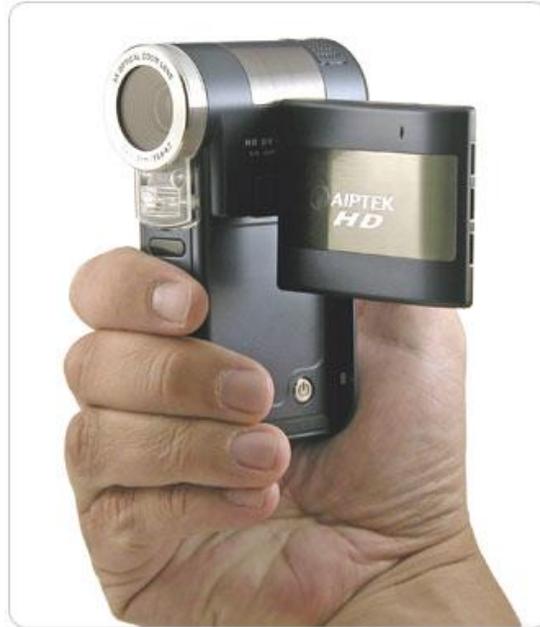
UHD HDR



1993



...2008
Cameras



...2018

Most still cameras have video recording



But cameras themselves are in decline



The Digital Revolution Has Been a Deluge of Innovation

Was Digital HDTV inevitable?

Was TV just swept along with other digital advances?

Technology historians will recognize that the HDTV Grand Alliance and the resulting ATSC standard were the *world's first* digital TV and an amazing catalyst

ATSC 1.0 in Retrospect

The HDTV Grand Alliance was a Revolution in 1993

NTSC TV – 1953 analog transmission standard
CRT tube displays



2M Pixels – 5x VGA
16M colors – 1,000,000x

Computer
DOS ... Windows 3.1



Cell Phone
Analog 2G

Wireless
Digital



19.4 Mbps
1000x faster

Dial-up
Modem
19.2 kbps



Compressed
Digital Video

VCR - analog

