Bringing Home The Bits

(or, your guide to the world of TV terms & acronyms in 2017)

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Hey, What's On Tonight?

- Well, for starters…
- The television in your family room
- That old portable TV in the kitchen
- The Gen 1 iPad in your teenager's bedroom
- The smartphone on the table next to you
- The laptop that you left on in your office

Hey, What's On Tonight?

- Well, for starters…
- The television in your family room (1080p HD)
- That old portable TV in the kitchen (maybe 240 lines*)
- The Gen 1 iPad in your teenager's bedroom (1024x768)
- The smartphone on the table next to you (1920x1080)
- The laptop that you left on in your office (2550x1536)

Guess what? They're ALL televisions now!

** - On a good day*

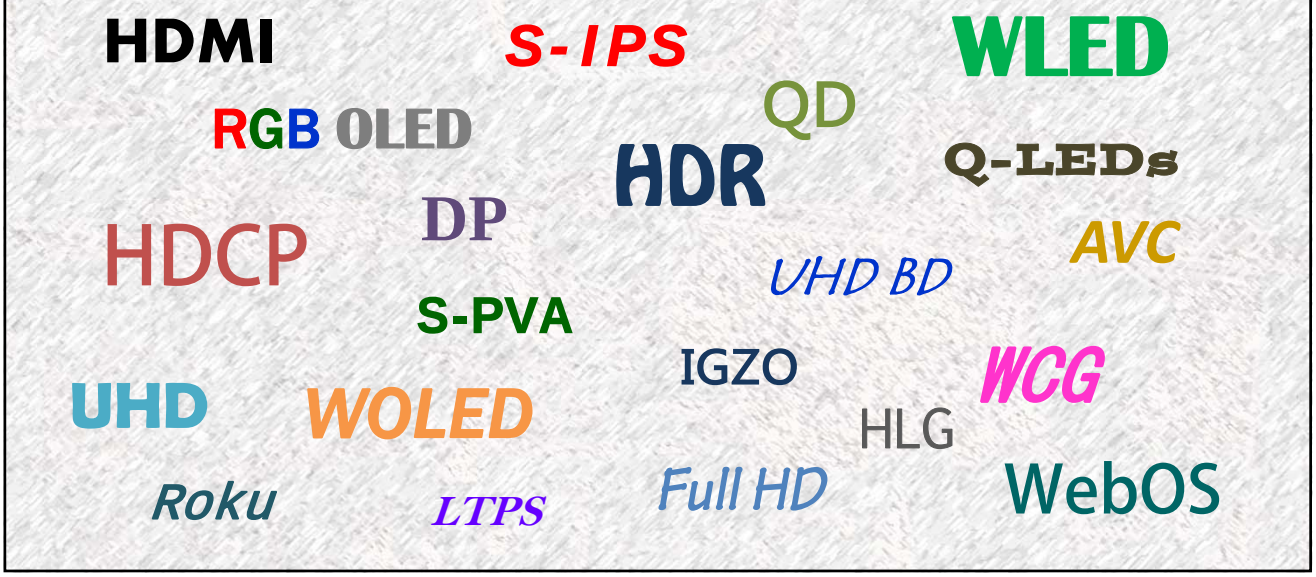
The TV Timeline

- TVs used CRTs into the early 21st century
- The first plasma TVs introduced in 1993 (1024x1024)
- The first LCD TVs introduced in late 1990s (1280x768)
- First true HD plasma TVs in 1997 (1366x768)
- First 1080p plasma TVs appeared circa 2005
- First 1080p LCD TVs appeared circa 2006
- First UHDTVs sold in 2012 (84" LG Display panel)
- Production of plasma TVs stopped in 2013 (20-year life span)

The TV Timeline

- The first DVD players sold in 1996 (Japan)
- Netflix opens its doors in 1997, starts streaming in 2007
- First scheduled HD TV broadcasts in 1998 (1080i)
- First Super Bowl broadcast in HD (720p) in 2000
- HDMI 1.0 announced in 2002
- The first iPhone was introduced in 2007
- Blu-ray wins HD disc 'format war' over HD DVD in 2008
- The first tablet was introduced in 2010 (iPad)

A Language All Its Own



Useful Terms To Know

- Commonly-used names for 4K TV –
- 4K, 4K Ultra HD, UHD, UHD 4K, SUHD TV, Ultra HD, Ultra UDTV, 2160p
- Listed resolutions or modes –
- 3840 x 2160 at 24 Hz, 50 Hz, or 60 Hz
- Commonly used names for HDR10 –
- HDR Premium, High Dynamic Range, HDR, UHD Color, Ultra HD Premium, Ultra HD deep color

Thanks to http://news.xbox.com

The More Things Stay The Same…

While DVR use is on the rise, the vast majority of TV viewing remains live, according to a new study. The research, done by time-shifting service TiVo, finds that 80 percent of all broadcast TV viewing still takes place live. 18 percent is shows time-shifted up to three days and the final 2 percent is programs time-shifted in four to seven days. On cable, the live viewership number is even higher, 91 percent. 9 percent watch DVR shows, and 1 percent watch on four- to seven-day playback. When you look at only primetime, the percentage of DVR'ed shows rises, with broadcast up to 74 percent and cable rising to 88 percent. **(MediaLife 11-16-2016)**

The More They Change…

Young adult Millennials (18-34) make up 43% of the U.S. cordless video market, defined as those who never have had cable, satellite or fiber optic TV service, or "cut the cord" on these services, according to GfK MRI. 30% of U.S. Millennials are "cordless," while in comparison just 16% of Baby Boomers are "cordless." Furthermore, Millennials are 44% more likely to be cord-free than the average US consumer and don't make much use of media channels other than the Internet – they're heavy streamers and heavy binge viewers, but light on overall TV watching. **(Telecomp 01-30-2017)**

Game Reset

Technology	2013	2014	2015
CRT	3.1%	1.4%	0.5%
LCD	92.3%	95.7%	99%
PDP	4.5%	2.8%	0.0%
OLED	0.0%	0.0%	0.5%
Total	100.0%	100.0%	100.0%

Top 5 Worldwide TV Shipments By Technology
Source: IHS March 2015

Game Reset

Rank	Brand	Q1 – Q3 2016
1	SAMSUNG	33.5%
2	VIZIO	17.9%
3	LGE	15.5%
4	SONY	8.6%
5	TCL	4.3%
6	HISENSE	2.3%
	OTHERS	17.9%

Shipment of 4K TVs 48" and larger
Source: IHS Shipment Tracker November 2016

U.S. TV Brands (Size Is Everything!)

SAMSUNG
HITACHI Inspire the Next
VIZIO
JVC
RCA
SONY
TCL
创意感动生活 The Creative Life
Hisense
Haier
SHARP
PHILIPS
INSIGNIA
LG Electronics

Game Reset

- The overwhelming majority of TVs sold today (along with tablets and smartphones) use LCDs
  - Exceptions: LG/Sony OLED TVs, Samsung smartphones/tablets
- LCD panels are commodities – most are made in China
- Three companies can produce 100% of a TV's components – LG (LG Display), Samsung, and TCL
- Everyone else is 'shopping around' and buying from OEMs
- Not much difference between most LCD TV models (price?)

King Of The Hill

Samsung 85-inch 8K (7680x4320) LCD TV with Quantum Dot Backlight

LCD Benchmarks

- Available in televisions as large as 85 inches, flat & curved
- Moving away from Full HD to UHD panels as manufacturing costs have equalized between the two resolutions
- Price of finished UHDTVs has dropped as low as $9/inch
- Most TVs use vertically-aligned (VA) LC compounds
- LG Display panels use in-plane switching (IPS) LC compounds
- Peak brightness (SDR) is 300 – 400 cd/m^2
- Most common backlight - white LEDs with RGB filters (WLED)
  - Edge illumination – LEDs on one edge with optical waveguide plate
  - Direct illumination – LEDs directly behind LCD "stack", thicker panel

LCD Benchmarks

Samsung 85-inch HDR 4K TV

Hisense 65-inch HDR 4K TV

LG Display 65-inch 8K TV

Konka 65-inch and 85-inch 8K TVs

LG Tiled 4K monitor

Samsung 37-inch HDR monitor

LCD Terminology

- LCDs are transmissive displays – limitations on viewing angles
  - Contrast flattens, color de-saturates, brightness drops
  - Doesn't matter which type of LCD panel you use
- PVA (Patterned Vertical Alignment) and MVA (Multi-Domain Vertical Alignment) are the most common LCD panel types
  - You will also see Super PVA, Premium MVA, Advanced MVA/PVA
  - Samsung, Sharp, Innolux, AUO, BOE, CSOT, TPV make them
- IPS (In-Plane Switching) not as widely used
  - You will also see Super IPS, Advanced IPS, Enhanced IPS
  - LG, Sony, Panasonic, AUO, Samsung make them

LCD Enhancements

- LG Display announces U-IPS ("ultra") at CES 2017 for better off-angle viewing, improved color saturation
- LG Display also announces "Nano Color" LCD tech for HDR – uses nano particles to improve color quality and expand gamut
- Samsung, TCL, Hisense adopt quantum dot (QD) technology
  - Provides much brighter images (1,000-2,000 cd/m^2), wider color gamut
  - Installed as a film layer in the LCD 'stack'
  - Uses blue LEDs, instead of white (red/green from QDs, blue from LEDs)
- Samsung claims to improve viewing angles on S-PVA panels
- Display industry in real danger of running out of superlatives

LCD Enhancements

Nanosys red/green QDs


LG Display U-IPS demo

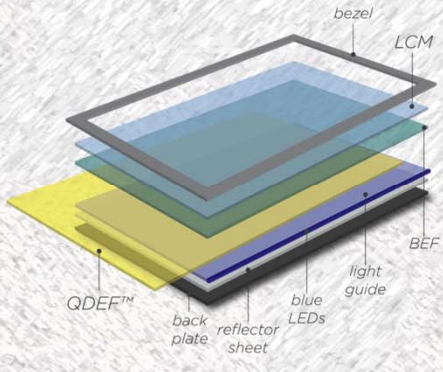

Samsung improved PVA viewing angle demo


LG Display Nano Color demo


Hisense 4K QD demo

Quantum Dot Film

- Quantum Dots are inorganic metal compounds
  - Emit stable, narrow wavelengths of light when stimulated by photons
  - Wavelength of light (color) determined by size of QD (larger = red, smaller = green)
  - QDs can be added as a film layer, using blue LEDs exclusively as backlight and to stimulate R,G, or built into light pipes for edge lighting
  - Best color – Cadmium Selenide (RoHS?)
  - "Green" technology – Indium Phosphide



Quantum dot enhancement film (Nanosys)

What's Ahead For LCD?

- Higher resolution (5K, 6K, and 8K panels are being manufactured)
- Different aspect ratios (16:9, 2.3:1, 15:10, 16:10)
- Migration to QD-enhanced backlighting, away from WLED
- Brighter panels with improved contrast and viewing angle
- Eventual phase-out of Full HD panel production (TVs)
- Adoption of QD technology for computer monitors
- Increased offerings of super-wide LCD monitors (immersion)
- But we're reaching the limits of what we can do to improve LCDs…

Challenger To The Throne

LG 77-inch 4K (3840x2160) OLED TV, measuring 6mm thick

OLED Terminology

- Available in televisions as large as 77 inches, flat & curved
- All but one model of OLED TVs are UHD (3840x2160) resolution
- Significantly more expensive than LCDs – about $36/inch (on sale)
- Peak brightness lower than LCDs – about 800 cd/m^2 small area
- Use indium gallium zinc oxide (IGZO) TFTs for switching
- Excellent contrast even under high levels of ambient light
- OLED "stack" is much thinner than LCDs (as thin as 2.5mm)
- Wide color gamut (DCI P3), very low black levels (<LCD)

OLED Terminology

- OLEDs are emissive displays – no limits on viewing angles
- Can be manufactured using two methods:
  - White OLED emitters with red, green, and blue filters + white (WOLED)
  - Separate red, green, and blue emitters (RGB OLED)
- All OLED TV panels currently made by LG Display (WOLED)
- Samsung uses RGB OLEDs in Galaxy tablets, smartphones
- OLEDs can be built on transparent and reflective substrates
- Colors age at different rates – dark blue half-life is about 5,000 hours, while red and green have longer lifespans

OLED Benchmarks

LG 77-inch OLED Wall

Panasonic 65-inch 4K OLED TV

Kopin 2K NTE OLED Display

Skyworth OLED Exhibit

Samsung Smart Watches with OLED Faces

LG Transparent OLED Monitor

There's Gold In Them Thar Panels

Seven China-based panel makers have been expanding existing or setting up new AMOLED production capacities, with total annual capacity estimated to increase from 272,000 square meters in 2016 to 7.864 million square meters in 2020 at a 2016-2020 CAGR of 131.9%. In comparison, Samsung Display and LG Display had combined annual production capacity of 4.945 million square meters for AMOLED panels in 2016 which will increase to 15.130 million square meters in 2020 at a 2016-2020 CAGR of 32.3%. **(DigiTimes 02-07-2017)**

What's Ahead For OLED?

- Super-thin, flexible displays for specialized markets, such as automotive and transportation, personal electronics
- OLEDs have been manufactured with 8K resolution (Sharp)
- OLEDs can be bent into concave or convex shapes (immersion)
- Excellent choice for near-to-eye displays (contrast, brightness)
- For consumer TV, OLED is the logical successor to plasma:
  - Deep black levels, saturated colors at any viewing angle
  - Very high switching speeds (HFR), high dynamic range (HDR)
- Only limitation is peak brightness and differential aging of blue!

To Recap…

- If you buy a television or computer monitor today, it will very likely use LCD imaging technology
  - SDR Full HD and UHDTVs use WLEDs with color filters
  - HDR UHDTVs use Blue LEDs with red & green quantum dots (QDs)
  - Chances are, you will upgrade to a 4K (UHDTV) set
  - And you will pay $9/inch to $20/inch for your new 4K TV (size)
- Or, you can select a television with OLED technology
  - All UHD OLED TVs support HDR & WCG
  - They use WOLEDs with RGB color filters, plus white pixels
  - But you will pay at least $36/inch, and probably more (55" on up)

Stuff To Know About Inputs

- HDMI – High Definition Multimedia Interface
- Used around the world on TVs, mobile devices, players
  - Introduced in 2002 –V1.4 in 2008 (supports 3D) 10.2 Gb/s
  - Version 2.0 announced in 2013 (data rate raised to18 Gb/s)
  - Version 2.1 announced at CES 2017 (data rate raised to 48 Gb/s)
  - Mobile version – Mobile High-definition Link (MHL)
- Compatible with USB 3.0 Type-C Alternate Mode
- Full-size (19 pin), Mini, and Micro (5-pin) versions
- V 2.1 compatible w/ Display Stream Compression (DSC)

Stuff To Know About Inputs

- DP – DisplayPort (Introduced in 2006)
- Not popular with TV manufacturers, but common on laptops, PC video cards, some mobile devices
  - Current version (1.2) introduced in 2009, increase to 21.6 Gb/s
  - DisplayPort 1.3 announced in 2014, increase to 32.4 Gb/s
  - DisplayPort 1.4 announced in 2016, supports HDR, 4:2:2, 4:2:0
- Compatible with USB 3.0 Type-C Alternate Mode
- Full-size (21 pin), Mini, and Micro (5-pin) versions
- V 1.3 compatible w/ Display Stream Compression (DSC)

Stuff To Know About HDR

- There are four HDR formats proposed or in use – Hybrid Log Gamma, Dolby Vision, Technicolor, and Samsung, in addition to the basic HDR10 (static metadata) format
- No one manufacturer supports all of them
  - LG will support HLG, Dolby Vision, Technicolor, HDR 10 on their 2017 UHDTV models
  - LG, Vizio, TCL support Dolby Vision
  - Samsung supports tone mapping, HDR 10
  - Basic HDR TVs compatible only with HDR10 (static metadata), including low-cost Chinese models (Hisense, Haier)

Stuff To Know About UHD BD

- Ultra HD Blu-ray is here…sort of…
- More than 100,000 players sold in U.S (12/16/2016, BDA stats)
- UHD players currently available from Samsung, Philips, Panasonic
  - LG announced a UHD BD player at CES 2017
  - Panasonic has two new UHD BD entry-level models
  - OPPO offers an upscale UHD BD player
- No UHD BD player from Sony – only players that upscale to 4K
  - PlayStation 4 Pro does support 4K streaming content
- Microsoft Xbox One S supports UHD Blu-ray with HDR10
- UHD/HDR content limited by HDMI 2.0 interface speeds

Stuff To Know About Features

- UHDTVs should have at least two HDMI 2.0 inputs
  - Can support 3840x2160p/60 with 8-bit RGB or 10-bit 4:2:0 color)
- And your HDMI 2.0 inputs must support HDCP 2.2
  - High-bandwidth Digital Copy Protection
  - Latest iteration (which has been hacked) applies to 'premium' content
  - Locality check must establish valid connection within 20 ms
- 'Smart' models will support Netflix, Amazon Prime, Hulu, etc.
  - You will see a variety of brand-names for 'smart' TV Web interfaces including WebOS (LG), Smart TV (Samsung), Smart TV Apps (Vizio)
  - You will also find Android TV on many TVs (Sony BRAVIA)

Watching On Other Devices

- Tablets & smartphones
  - All of them can decode H.264
  - VP9 supported on Android phones
  - Most equipped with LCD screens; Samsung, Lenovo, Hisense, Asus use RGB OLEDs
  - Premium models offer Full HD (1920x1080) resolution
  - Handful of 4K phones now (Sony Xperia Z5 has a 4K display)
  - No HDR mobile devices (yet)

Samsung Galaxy Tab


Apple iPhone 7

The Second Screen

A new study commissioned by PayPal found 58% of video consumers watch content on a mobile phone, followed by a tablet. The self-serving study of 10,000 respondents found more than 50% of American viewers prefer Netflix over other SVOD services; 75% pay for streaming channels versus 41% who purchase downloads. After Netflix, 14% watch Amazon Prime Video, followed by YouTube (9%), VOD (6%), Hulu (6%) and HBO Now (2%), among others. Male respondents overwhelmingly (74%) prefer streaming comedy, compared with drama (80%) for women. **(Home Media 02-03-2017)**

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