LCD TV Association

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“LCD TV Matters”

Volume 6, Issue 1

"A Great TV in Every Room"

Contents

Letter from the Chairman: Is 2019 the year of the Quantum Dot TV?

by Bruce Berkoff

After nearly a decade of stagnation, the TV market appears ready for a return to steady growth. IHS predicts we may see consecutive year over year increases in both area and unit volume for the first time since 2011. Back in 2011 the CRT to flat panel transition was just wrapping up, bringing to a close a period of unprecedented growth driven by replacement demand. Quite a lot has changed since that exhilarating time but one constant remains – LCD is the driving force at the heart of the TV market.

Why? LCD continues to innovate, improve – with technologies like Quantum Dot, mini LED backlights and even 8K resolution – and, most importantly, offer consumers the features that they want at affordable prices they need. As a member of the board of directors at Quantum Dot leader Nanosys, I've had a front row seat to the Quantum Dot revolution.

Vizio's latest Quantum Dot LCD offers vibrant color and incredible value (image credit: Nanosys)

The Quantum Dot display market is entering a new phase of rapid growth in 2019. In a recent report the display market analysts at DSCC projected that volumes for TVs based on Quantum Dot technology will grow nearly 70% year over year in 2019. According to DSCC, Quantum Dot TVs will continue to out-sell TVs based on WOLED technology over the next seven years (note that WOLED has never matched Quantum Dot TV in volume). With over $230 billion in invested capex for LCD capacity (about ten-times more than any other technology), LCD TV will continue to be the vast majority of TVs sold for many years, if not decades, into the future. China is ramping many gen 10.5/11 fabs over the next few years, making their already large capacity even larger, and guaranteeing that inexpensive 85" LCD TVs will be at every Costco in the United States by 2020.

First, until the fourth quarter of 2018, Quantum Dot TVs had been priced comparably to OLED sets, limiting volume to the super premium niche. In 2019, Quantum Dots sets are being priced competitively to standard LCD sets. Today, consumers have a wide array of choices when shopping for a Quantum Dot TV with TV SKUs priced from $379 to $9,999.

Second, an increasing number of brands including Vizio, Hisense, TCL and others will join Samsung in launching mainstream Quantum Dot products in the US this year.

Third, next generation Quantum Dot technologies such as Quantum Dot-OLED hybrid displays are making rapid progress towards commercialization and these will become the premium market revenue driver for display brands. These emerging Quantum Dot technologies offer new avenues for growth with DSCC predicting more than 750,000 Quantum Dot-OLED displays will be shipped in 2021.

There are three key changes driving sudden growth in Quantum Dot TVs

Vizio's 2019 TV lineup exemplifies this trend. The new flagship P Quantum X is quite simply the best LCD TV I've seen in over 20 years in the industry. But that's not the only great thing about the company's new lineup. The brand has gone "all-in" on Quantum Dots for 2019, waterfalling the technology across its M, P and P Quantum X lines. With price points starting as low as $399, there's something wonderful here for consumers at every level. Since Vizio is the only true "American" brand of TV left in our country, it makes me very proud to see this California company focused on both image quality and consumer value and hit a home-run with the Vizio P Quantum X.

Vizio's 2019 P-Series Quantum X has already received a number of awards including Best of CES 2019 awards from both CNET and Digital Trends and an Editor's Choice Award from DigitalTrends. "The new flagship P Quantum X is quite simply the best LCD TV I've seen in over 20 years in the industry". – Bruce Berkoff

New-to-the-USA TV brands Hisense and TCL have followed suit, bringing premium tech including Quantum Dot and miniLED backlights to previously unheard of price points.

TCL, one of the fastest growing TV brands in the US, upped its game in 2019 with an innovative new line-up of TVs that attacks the high end of the market. The new sets include technologies like microLED backlights, Quantum Dots and a new app that allows consumers to calibrate their TV with their smartphone called iPQ Engine. The iPQ Engine will allow consumers to apply simple and, importantly, automatic TV color calibration to improve accuracy by measuring the TV's performance using the camera in a smartphone.

Most consumers never change their TV's settings from factory default. They take it out of the box, hang it on the wall and never think about it again. An app that makes it easy for consumers to set-up and improve the performance of their TV may help to drive consumer interest in high performance TVs with improved color, contrast and resolution.

Vizio 2019 P Quantum X connected to an iPhone running Apple's AirPlay2 to stream content directly from the device, another great example of mobile apps adding value to the big screen experience. Photo Credit: Copyright Bruce Berkoff 2019"

The technological wizardry associated with Quantum dots do more than just make bigger and better displays, they will enable incredible breakthroughs in agriculture and bio-medical health applications. Technology is creating an amazing new world for our children and Quantum Dots will help lead the way into that better future.

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Family photos appear more accurate and lifelike on a 2019 Vizio P Quantum X

Bruce Berkoff has a long history and a wealth of global experience in the technology industry, having held key marketing (CMO) positions at several leading display and solar related companies around the world. As Chairman of the LCD TV Association his charter is to help "inform, promote, improve, and connect" the entire LCD TV supply chain and their related ecosystems, and remains an active speaker in the industry. The Association has helped LCD technology gain marketshare in the TV space from single digits to over 95%, while also working to reduce energy consumed per area over 90% (saving many nuclear power plants for ever having to be built around the world)!

Bruce has consulted for large global companies, and also been the CMO (Chief Marketing Officer) of CBRITE Inc., and was previously the CMO, and strategy officer, of the Energy and Display Systems group at Applied Materials (the world's factory equipment leader in display, solar, and semiconductors), involved with their display, solar, LED, OLED and battery products (ranging from PECVD, PVD, to MOCVD, etc). Prior to that he was CMO of Ascent Solar, CEO of Enuclia Semiconductor and, for over 6 years while living in Seoul, South Korea (ROK), Mr. Berkoff was the EVP/CMO of LG Philips LCD (today,AKA, LG Display, or LGD, a global leader in flat displays), helping to launch new flat display categories like wide aspect notebooks and monitors and the entire LCD TV industry. He led their efforts globally from product planning to product marketing and market intelligence & market strategy, as well as helped make their IPO as "LPL" on the NYSE a global success. (Bruce later served on LGD's BOD, as well 4 other public company BOD's and many private ones, helping to raise over $3B USD for various entities. He is also proud to be on the BOD of the global leader in Quantum Dot technology, Nanosys, which is helping to enable over $200B of LCD factories to have a longer and more profitable lifetime).

Before that, Mr. Berkoff brings many more years of experience in the high tech arena, having held various Silicon Valley-based executive roles with companies such as Philips Components, UMAX Computer Corp., Radius and Supermac, and more. He is well-known for his visionary keynote addresses, panel chairmanships and other roles at display and electronics industry events, including the Symposium on Information Displays (SID) Business & Investor Conferences, USDC (US Display Consortium) Conferences, DisplayForum Europe, HDTV Forum, Asia SID (ASID), EuroDisplays (ESID), the U.S. Flat Panel Display (US FPD) Conference, the Flat Information Display (FID) Conference and the Consumer Electronics Show (CES) in Las Vegas, as well as moderating sessions and panels at marketing forums by Frost & Sullivan, etc. Mr. Berkoff holds undergraduate and graduate degrees in physics and biophysics from Princeton and the University of California, Berkeley, respectively, and also has display-related patents granted in the U.S. and China. Via his boutique consultancy (Berkoff & Associates, LLC), specializing in strategy, strategic marketing, PR & IR, product marketing & development, technology, market intelligence, roadmaps and forecasting in areas ranging from high-tech to green-tech to food-tech, Bruce has worked with companies ranging from start-ups to global leaders including LG, Philips, Foxconn, InFocus, and more. His domain has also begun to move into AI, Robotics, DataScience, Biotech/MedTech, & Agri-tech too.

LCD TV News

compiled by Veritas et Visus

Sharp to re-enter U.S. TV business

Sharp will re-enter the TV business in the U.S., the company confirmed in a statement. It is establishing a new partnership with Hisense International, under which it enter the market in the second half of this year. Sharp had signed a five-year licensing deal with Hisense in 2015 but attempted to buy back the brand after its acquisition by Foxconn in 2017. It was unsuccessful in its attempts to buy back the brand rights from Hisense, and Sharp resorted to legal action, claiming various patent violations and charging that Hisense was hurting the brand by marketing lesser-quality TVs. It dropped its legal action last year. Both companies have made it known they're plotting significant initiatives to plant themselves in the U.S. Noted Sharp in its statement: "Sharp will further accelerate transformation of its business to innovate the world with 8K/4K Ecosystem + 5G and AIoT." http://www.sharp-world.com/corporate/news/190508.html

SHARP showcases world's largest 8K LC Display

Sharp Corporation unveiled the world's largest liquid crystal display monitor. The enormous, 120-inch screen showcase Sharp's 8K+5G Ecosystem, which also includes applications of 8K technology in arenas such as medical science and the arts. Sharp proposed an evolution of its industry-leading 8K+5G Ecosystem that takes

advantage of the possibilities offered by the massive high-speed data transfer capacity of 5G mobile technology. As well as the launch of a 5G service to support the data requirements of 8K UHD imaging, the comprehensive framework promises to transform consumers' lives in a variety of fields, from video production and transmission, to medical and educational applications. http://sharp-world.com/

The world's largest 120-inch monitor showcases Sharp's 8K+5G Ecosystem

5G and UHD 8K – a developing symbiosis – reports FCC

To accelerate the U.S. deployment of 5G, the FCC is pursuing what it refers to as the "5G FAST Plan" (Facilitate America's Superiority in 5G Technology). One of the plan's strategies is to release more spectrum into the marketplace. High-band spectrum with about 5 GHz bandwidth will be released, across 24 GHz, 28 GHz, 37 GHz, 39 GHz and 47 GHz bands. More penetrating mid-band spectrum is a work in progress, with targeted 844 MHz bandwidth, covering 2.5 GHz, 3.5 GHz and 3.7-4.2 GHz bands. Required for 5G, these spectrum bandwidths will be utilized to provide 20 Gbps download and 10 Gbps upload capacities, per base station, through technologies such as quadrature amplitude modulation (QAM), carrier aggregation (CA) and multiple-input and multiple-output (MIMO) etc. 5G technology has the requisite characteristics for new emerging services: Enhanced mobile broadband (eMBB), massive machine type communications (mMTC) and ultra-reliable and low latency communications (URLLC). These services will provide a platform for "anywhere, anytime" access to real-time broadcast media, for both content contribution and content distribution (5G and Ultra High Quality Content Creation and Distribution, Broadcasting & Cable). Quality of Service (QoS) and resilience in 5G networks will fundamentally improve the end user's Quality of Experience (QoE), which is the most important factor in determining a viewer's engagement and loyalty, especially for high quality content, such as UHD 8K. Defined as "a measure of the delight or annoyance of a customer's experiences with a service," QoE focuses on the entire service experience, not just QoS offered by 5G. With more than 33 million pixels and 68 billion possible colors, per frame, UHD 8K contains a vast amount of digital bits to be programmed into patterns of art, story and knowledge. In fact, UHD 8K creates almost a "3D" effect, approaching human eyesight for pixel density, field of view and color gamut. It offers an experience akin to "looking out through an open window," and evokes stronger sensory experiences for QoE . Technology change is the driving force for viewers' habits and UHD 8K offers a window of opportunity to bring viewers back to big screens.

	Pixel Density	Field of View	Color Gamut
Human Eyesight	10,200 x 7,800	120 Degrees	100%
UHD 8K	7,680 x 4,320	100 Degrees	57.2%
HD	1,920 x 1,080	30 Degrees	38.7%

UHD 8K approaches real-life experiences

The demand for a high-speed, low-latency transmission network provided by 5G is perfect for UHD 8K. At 120 Hz frame rate, 12 bit color depth and 4:4:4 sampling, the UHD 8K data rate is 143 Gbps. With HEVC encoding, 200 Mbps bit rate can be achieved. Future video compression standard Versatile Video Coding (VVC) is 40% more efficient than HEVC, further reducing the bit rate of UHD 8K and approaching the minimal 5G network capacity of 100 Mbps, per device. Clearly, UHD 8K is a use case and driving force for 5G commercial investment, and is likely to be deployed as an initial 5G application. Furthermore, the architecture of the 5G network ensures QoS and QoE for UHD 8K distribution. Viewers' engagement and loyalty will in turn improve ROI of both 5G networks and UHD 8K content creation. The mutually beneficial relationship between 5G and UHD 8K makes them a true symbiosis in the making. Broadcasting doesn't exist in a vacuum – it coexists with its environment and 5G and UHD 8K technologies are that future and relevant environment. To be viable, broadcasters must co-evolve and transform with them (VSON Manages Network Complexity). To manage the complexity of this transformation, a viable system approach should be taken. In the viable system (VSON) approach, the 5G network and broadcast network are two services in the operation of VSON. We may call this particular application of VSON a "converged media system" (CMS). CMS provides an end-to-end solution for UHD 8K video consumers, from content creation to distribution. We immediately recognize the important roles of policy, control, orchestration, monitoring, and intelligence in the process of the transformation. In other words, this industrial transformation is not a small feat: it takes a system to transform a system. https://www.fcc.gov/5G

Samsung Display formally announces its $10.8 billion investment in QD-OLED TV production

Samsung Display formally announced its decision to invest ₩13.1 trillion (around $10.85 billion USD) in QD-OLED TV R&D and production lines. The investment plan will span 6 years (2019-2025) and the first step will be to convert an LCD production line in SDC's L8 fab in Tangjong, Korea to QD-OLED production. The Tangjong line will reportedly be converted from 125k monthly substrates of LCD production to 30k monthly QD-OLED substrates, and mass production will begin in Q1 2021. the long run SDC plans to convert all its 8-Gen LCD lines (360,000 monthly substrates) to QD-OLED production. http://www.samsung.com

Sharp unveils new 80-inch 8K LCD

Sharp is releasing the second generation of its 8K displays with the newly launched 8M-B80AX1U 80-inch UHD LCD model. Sharp says that its 8K UHD technology can reproduce hard to see details on the new display. The

8M-B80AX1U meets the 8K UHD standard (7,680x4,320 pixels), allowing for pixel resolutions 16x that of Full HD and 4x of 4K. The display offers 800 cd/m2 – up to 4,000 cd/m2 at peak level – which is more than the brightness of Sharp's first generation of 8K displays. It also has more than five times more local dimming backlight zones for greater contrast between bright and dark areas. There is also 10-Bit Extended Color Range that increases the range of possible color values in each pixel up to 1.07 billion colors. Other features include reduced motion blur during panning or movement and has 4x HDMI inputs to display native 8K content. The 8M-B80AX1U is now available. http://www.sharp-world.com

ABI: 4K TV thriving, but 8K will gain ground

Despite the dearth of high-res content, 4K TV will grow to become the mainstream TV format over the next few years, with worldwide sales reaching 233 million, a CAGR increase of 13%, according to ABI Research. The research firm also predicts that market acceptance for 8K TV will mirror that of 4K in which declining prices of TV models will spur consumer acceptance. Samsung, LG, Sony and TCL have all launched 8K TV sets, which, depending on the display size, are currently priced between $5,000 - $70,000. Content for 8K sets is far scarcer than for 4K, ABI notes, with only Japanese broadcaster NHK currently providing 8K content via its "Super Hi-Vision" format. Korean Broadcast Corp. (KBS) and European streaming provider Rakuten have both announced tentative plans to offer 8K content sometime in 2019. 8K also requires much larger files and bandwidth and ABI

thinks that the next generation VVC format (versatile video coding) – which offers 34% higher efficiency over HEVC – will "play a vital role" when standardization is completed in 2020. https://www.abiresearch.com

2018 TV shipments saw decade's best growth says Futuresource Consulting

2018 was a banner year for worldwide TV shipments, according to a market report from Futuresource Consulting, earning the highest rate of growth for the decade at 6%. In total, 227 million TV units were shipped worldwide in 2018, equating to a trade value of $85 billion. Futuresource identified a number of factors that contributed to this surge, including the drop in prices for technologies like 4K and a rise in production in South East Asia. TV shipments in BRIC (Brazil, Russia, India and China) have helped lay the groundwork for this growth, as many households are upgrading their primary TVs. This has helped make up for flat or declining shipment numbers in Western Europe and North America; Eastern Europe, however, saw a 6% increase. While North America was essentially flat (a decrease of 0.1% in units shipped) it still saw shipments of more than 42 million units, which is close to its peak of 2011. 4K UHD TV shipments are expected to command more than half the market in 2019 as there is increasing standardization in TV sets 40-inches and above. Futuresource forecasts that the global installed base for 4K UHD TVs will exceed 960 million by the end of 2023. Meanwhile, the next bump in resolution, 8K, is just about ready to start taking off. Shipments for 8K sets are expected to be just 0.1% of the market in 2019, but likely to see a growth to 2% by 2023. While Samsung and Sharp have been the major proponents for 8K models, most brands are likely to soon offer an 8K set of their own, while 8K content availability is also expected to make progress, though still with a ways to go. https://www.futuresource-consulting.com

GfK: TV has biggest impact on consumer purchasing

When it comes to the top type of media that influences consumers at purchase time, traditional television remains king, according to the 2019 Purchase Funnel study conducted by GfK. The study found that 96% of in-market consumers first find out about a product from media, with 85% saying that media directly influences their purchases. TV was the most important driver of this awareness for 56% of consumers; all other media combined trailed at 40%. The influence of TV is also able to bridge the age gap, with 85% of adults and 91% of millennials saying TV advertising influenced their online searches. TV ads also spur action, as 78% of opinion leaders said they responded with some kind of action after seeing TV ads. In addition, the report found that both adults and millennials believe local broadcast TV news and local newspapers are the most trusted sources of news, while social media is the least. http://www.tvb.org/Default.aspx?TabID=2367

FCC proposes to boost DBS regulatory fee again

The FCC has proposed to continue raising the DBS regulatory fee to get it closer to the fee cable operators pay and wants to know whether changes in the fee process passed by Congress in the RAY BAUMs FCC reauthorization act affects that decision. That is according to the FY 2019 regulatory fee Notice of Proposed Rulemaking adopted this week by the FCC. The FCC has to collect $339 million in regulatory fees to cover its operating expenses. The FCC is proposing to raise the cable fee from 77 cents to 86 cents, and DBS from 48 cents to 60 cents. Fees are based on how many full time employees (FTEs) it takes to regulate a particular service. The FCC's Media Bureau has to collect $67.02 from cable, IPTV and DBS in 2019 and proposes to assess Cable and IPTV at the same per-sub rate, but DBS is treated differently, or at least has been. Satellite broadcasters used to be assessed a smaller, per-license fee, but the FCC in 2015 changed that to the same per-sub fee basis it uses for cable and IPTV, and began lowering cable fees and raising satellite. That per-sub satellite fee began at 12 cents per sub, but the FCC has been raising it annually to move closer to the cable/IPTV rate, increasing it to 27 cents, 38 cents, 48 cents, and the new, proposed, 60 cents. It has been cutting the cable rate at the same time, from 96 cents in 2017 to 77 cents in 2018, but it is proposing raising it to 86 cents unless it decides to increase DBS to match cable and IPTV. https://docs.fcc.gov/public/attachments/DOC-357091A1.pdf

Over 233 million 4K TVs to ship in 2024, with 8K on the horizon

As worldwide TV household penetration is quite saturated, the flat panel TV market has been driven by consumer adoption of TVs with higher resolution, larger screen size, and connected and integrated applications and services. While flat panel TV makers have announced 8K TV sets, it is the 4K TV market that will continue to grow to cement its place as the mainstream TV format over the next few years. ABI Research, forecasts that 4K flat panel TV shipments will grow at 13% CAGR to reach 233 million in 2024. Flat panel TV makers including Samsung, Sony, LG, and TCL announced the introduction of 8K flat panel TV models, which are priced between USD$5,000 and USD$70,000 depending on the display size. However, the lack of content and distribution models are more significant barriers than cost for 8K TV adoption at the moment. Aside from 8K channels provided by Japanese broadcaster NHK, there are no other 8K broadcast channels currently available, although Korean Broadcasting Corporation (KBS) is working toward an 8K broadcast. While streaming service provider Rakuten recently announced its interest to provide 8K content in late 2019, service providers overall are not ready for 8K content, nor is there much incentive for content providers due to limited 8K TV set adoption at present. 8K content also needs larger data files, which creates challenges in content distribution and data management. Versatile Video Coding (VVC), which achieved 34% higher efficiency over HEVC, is currently in the process of standardization. VVC will play a vital role in driving the 8K TV market when the final standardization completes in 2020. 8K is likely to gain momentum as the ecosystem evolves. https://www.abiresearch.com

Hisense shows off 5K, 21:9 display

Hisense showcased new 21:9 displays. Hisense recently exhibited its 'Movie Wall', a 21:9-format display with 5K resolution (5120x2160). While it runs on the same VIDAA smart TV interface found in the company's other 2019 models and boasts a similarly QLED-enhanced level of picture quality, perhaps the most eye-catching thing about the Hisense Movie Wall is the aspect ratio. It sports a 21:9 aspect ratio and 442 zones of local dimming. It also supports both Dolby Vision HDR and Dolby Atmos, the latter enhanced by a set of two shoulder-mounted sound-bars built into the frame of the TV. http://global.hisense.com/

Hisense Movie Wall, 21:9 aspect ratio, 5120x2160 pixel format

Samsung predicts fast 8K TV adoption driven by 5G networks

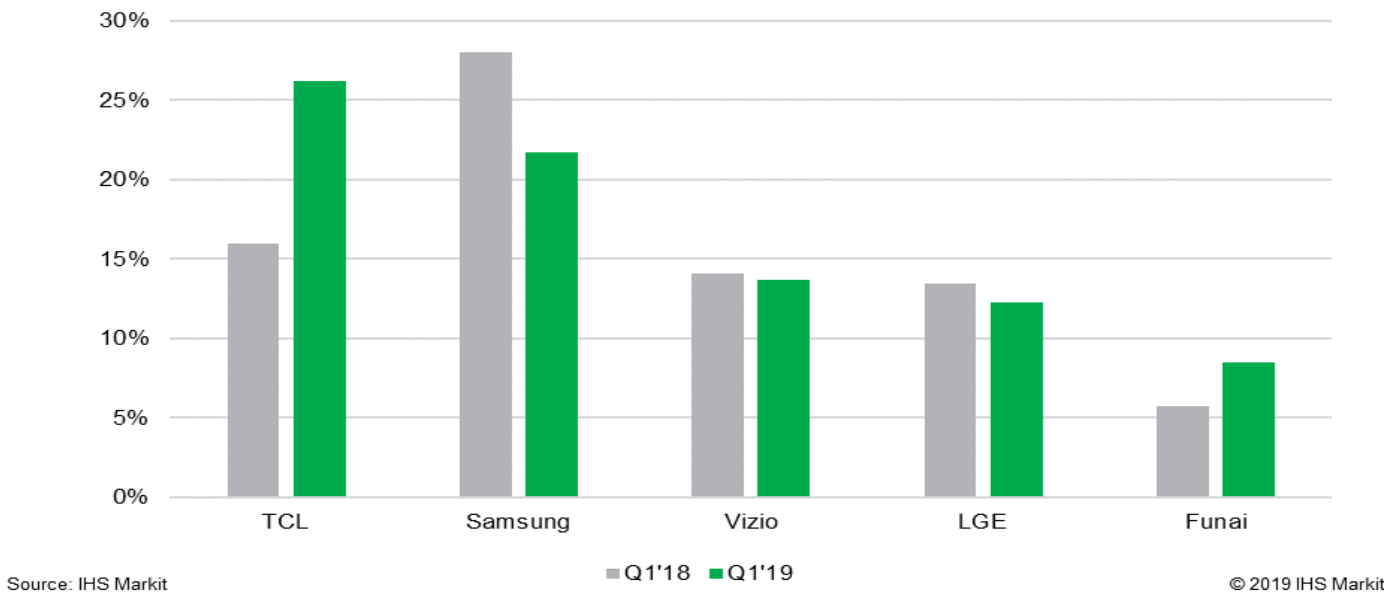
Samsung is backing a fast adoption of 8K TVs over the next few years – quicker than the move from HD to 4K – driven by super-fast 5G mobile networks that demand better screens and better quality video. Samsung is positioning itself as the market-leader when it comes to 8K ahead of what the company expects to be a short and sweet move from 4K to 8K. The move from 4K to 8K was said to be “two years ahead” of the comparative move from HD to 4K, with Samsung saying the 7-year transition period to 8K begins... now. Perhaps no surprise considering the company already launched its 2nd-gen 8K QLED TVs earlier this year. On the subject of 8K

content, Samsung pointed out the first test 8K broadcasts had already been carried out by NHK in Japan – with the next big test set to be 8K broadcasts of the 2020 Olympics – and predicted 8K streaming would come to big players such as Amazon and Netflix by 2020/21. That second content wave will then be followed by a third "mass market" wave, driven by 5G. Samsung was also keen to highlight the ability of its 8K AI up-scaler when showing HD and 4K video on 8K panels, filling any 8K content gap. https://www.samsung.com

IHS Markit: TCL surges to the top of the North American TV market

Chinese brand TCL surged to the top of the North American TV market for the first time ever during the first quarter of 2019, as unit shipments boomed by 112 percent year-over-year. TCL's share of North American TV shipments rose to 26.2 percent during the first quarter of 2019, up from 16 percent during the same period in 2018, as reported by IHS Markit. This put TCL one position ahead of previous market leader Samsung, whose shipment share declined to 21.8 percent, down from 28.0 percent one year earlier. Vizio ranked third in the North American TV shipment ranking, with a 13.7 percent share. TCL's strong performance contributed to a record quarter for the North American TV market, with shipments rising nearly 30 percent year-on-year to reach a historic high of 9.3 million units. Despite TCL's rise, Samsung maintained a commanding lead in terms of revenue, accounting for a 36.9 percent share, more than double the total of any other company. Samsung's revenue leadership reflects its focus on TVs with larger sizes and higher price points.

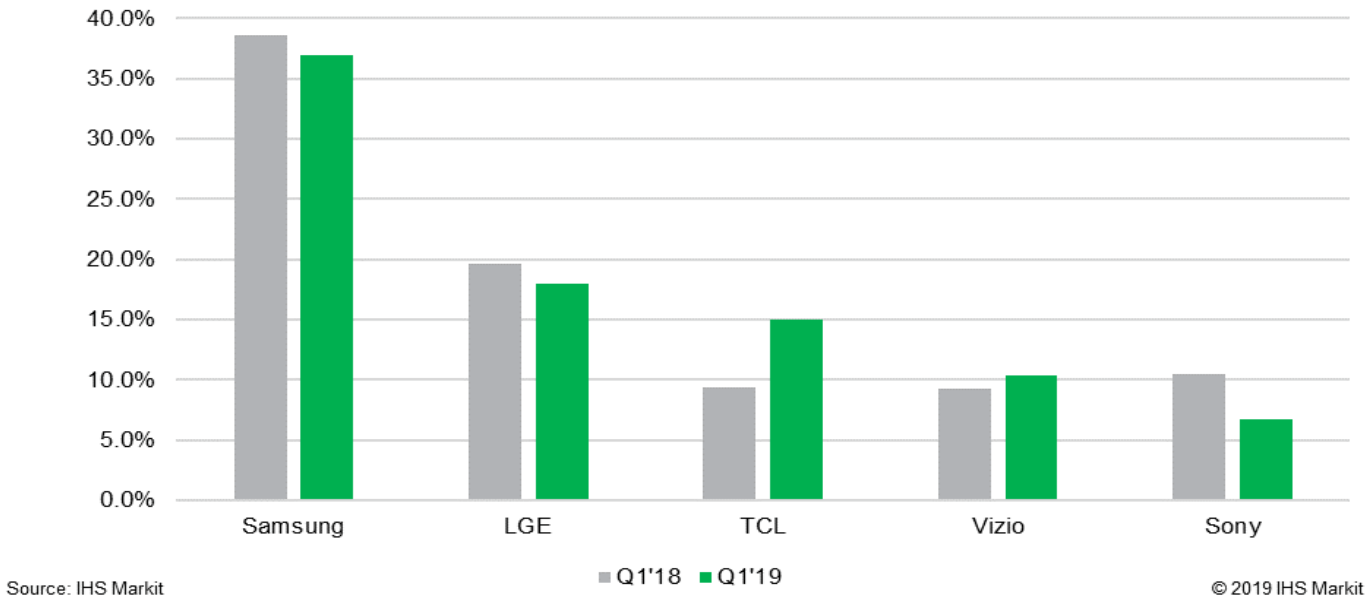
Shipment growth was boosted by an acceleration of retail price erosion, especially for larger sizes. However, the rise in TV shipments in North America was mostly driven by sets with screen sizes smaller than 55-inches. The erosion in LCD-TV average selling prices (ASPs) in North America reached a high level of intensity in the first quarter. In fact, the first quarter marked the first time that the average price-per-inch of an LCD-TV fell below $10. The overall average price of a 65-inch LCD TV declined to nearly the same level as during the fourth quarter of 2018, when TV prices dropped because of holiday season sales. The 55-inch average price was near $500, lower than during the fourth quarter of 2018. Amid this high level of LCD-TV ASP erosion, OLED TV shipments have now fallen year-over-year for the second straight quarter.



North America TV sets unit shipment share (sorted by Q1'19)

Worldwide TV shipments recovered in the first quarter, rebounding from a 1.6 percent decline in the fourth quarter of 2018 to a positive 2.1 percent growth rate compared with a year prior. The surge in shipment growth was almost entirely due to the surprisingly strong shipment growth in North America, despite very strong increase in the fourth quarter of 2018. This strong growth offset another quarter of steep shipment decline in China and Latin America.
In China, the world's largest TV market, Xiaomi remained in first place for the fourth consecutive quarter, reaching a record shipment share of more than 19 percent in the first quarter. This represents the highest single quarterly market share posted by any Chinese brand in China in more than six years. Xiaomi achieved this growth through

disruptive market pricing and a direct-to-consumer business model that reduces distribution channel costs and passes the savings along to consumers. Xiaomi had the lowest ASP in China of any Chinese TV brand during the first quarter. http://www.ihsmarkit.com/



North America TV sets revenue share (sorted by Q1'19)

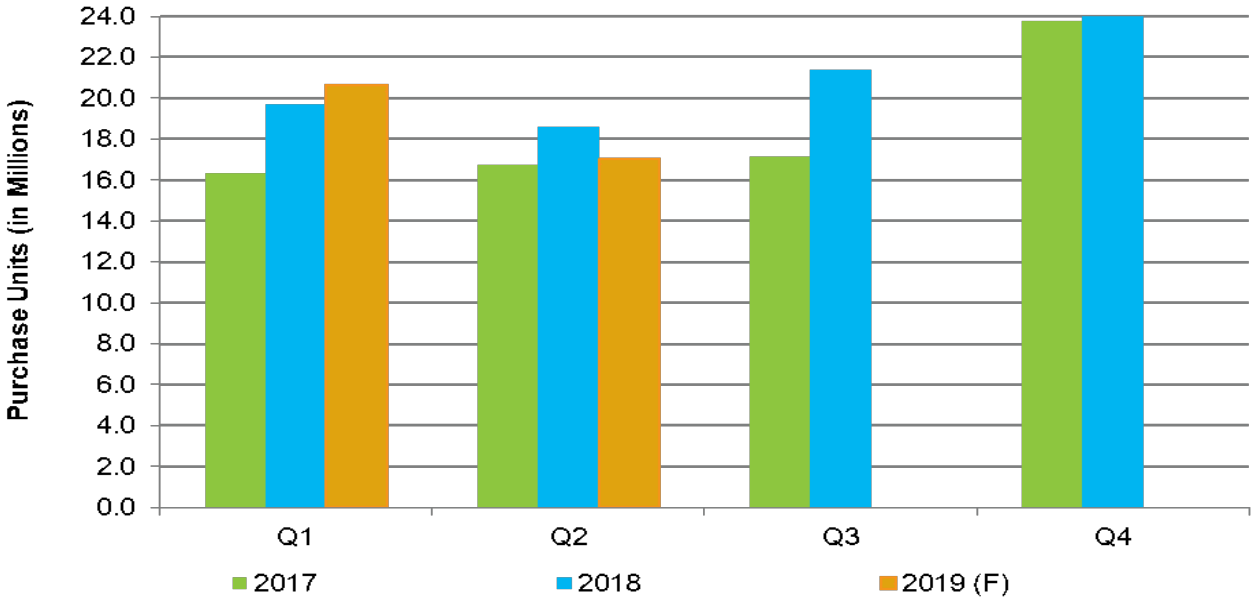
TV makers to cut display panel demand, IHS Markit says

Amid rising concerns over the intensifying trade war between the U.S. and China, South Korean and Chinese TV makers are cutting panel orders in the second quarter, according to IHS Markit. The reduction in panel demand is intended to cut inventory that was carried over from previous quarters, as reported by the IHS Markit TV Display & OEM Intelligence Service. The South Korean and Chinese TV makers are expected to stock up on display panels in the third quarter to prepare for the year-end shopping season. In addition to concerns about TV demand and falling profit margins, the intensifying U.S./China trade war has made the TV makers more hesitant about issuing firm demand forecasts.

- **Korean orders decrease modestly:** South Korean TV brands' panel purchasing volume is forecast to decline modestly to 17.3 million units in the second quarter of 2019, down 3 percent from the previous quarter or a 1 percent decline from one year ago. This is indicative of weakness in panel purchasing following a decline of 2 percent in the first quarter on a Q/Q basis and no change on a Y/Y basis.
- **Chinese firms adopt more conservative purchasing plans:** China's top-five TV brands already bought more panels than expected in the fourth quarter of 2018 after winning further price concessions for the first quarter of 2019 in exchange for placing volume deals with strategic panel suppliers. These brands had stronger-than-forecasted purchasing volumes in the first quarter of 2019, amounting to 20.6 million units, a decline of 13 percent Q/Q or a 5 percent increase Y/Y. However, after strategically over-building some inventories, these Chinese brands are in no rush to refill their panel stockpiles in the second quarter. Their purchasing plans for the second quarter have become more conservative, anticipating a decline of 17 percent Q/Q and 8 percent Y/Y. This compares to the previous forecast of a decline of 11 percent Q/Q and 2 percent Y/Y.
- **Fast-changing conditions prompt new buying plans:** The deals for upcoming promotional activities in the North American, Chinese and European markets in the second half of the year will represent an important factor influencing TV makers' purchasing and pricing negotiations. TV makers will start to refill their panel inventories starting in the latter part of June or early July. These companies are taking all possible measures to enhance their competitiveness and win more business.

Looking ahead to the third quarter, TV makers are very anxious about the demand outlook. As a result, they are unable to give a clear picture of their panel purchasing plans. This is because the TV display supply chain will be

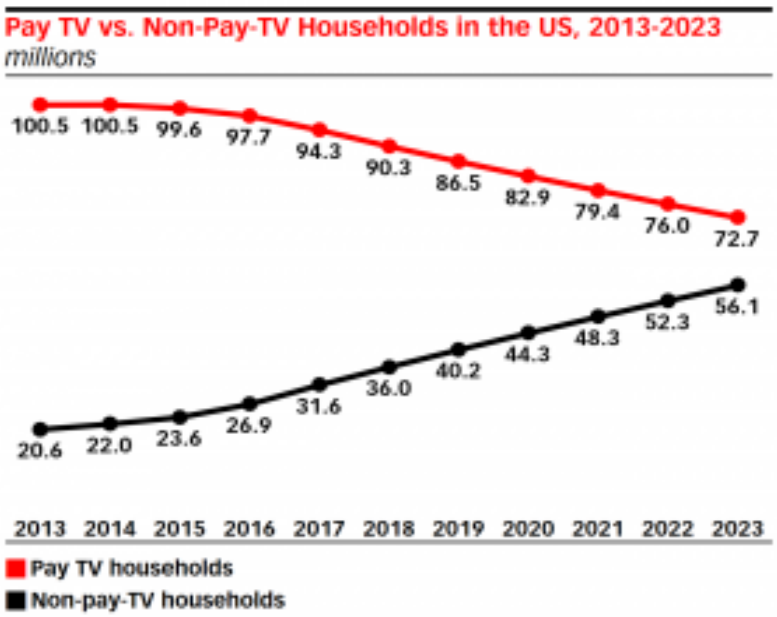
facing the new risk of tariffs on the TVs exported from China into the United States. TV makers have factored in the risk of a correction in panel demand. http://www.ihsmarkit.com/



Panel purchases by top-tier Chinese TV brands, May 2019 update

Number of cord cutting homes nearing number of pay-TV subscribers in US, reports eMarketer

The gap between pay-TV and cord cutting in the U.S. continues to narrow, and in the next few years it could disappear entirely, according to a new report from eMarketer. In 2019, eMarketer is estimating that the total number of pay-TV households in the U.S. will drop 4.2% to 86.5 million. On the flip side, the number of cord cutters is expected to grow 19.2%. If the rate of decline holds steady, pay-TV services will fall below 80 million households by 2021, while one-fifth of U.S. homes will have cut the cord. A little further down the road, the report predicts that by 2023 the number of pay-TV households will come in at 72.7 million and that 56.1 million will be without a pay-TV package. Satellite providers are expected to take the biggest hit in these declines, with an estimated 7.1% of household subscriptions ending this year. Telco and cable are expected to see declines of 4.6% and 2.4%, respectively. One of the causes for this decline, according to eMarketer, is pay-TV providers prioritizing profit over revenues. While the decline of pay-TV services continues in the U.S., other studies find that pay-TV services are still a popular choice of customers in emerging markets around the world. Additional findings in the eMarketer report include that the time spent watching traditional TV is also in decline. Total TV watching is expected to drop 3% to three hours and 40 minutes on average, with all age groups showing decline, but it is especially heavy among those 17 and under. https://www.emarketer.com



Hulu says 70% of its 82 million viewers are on ad-supported plan

Hulu sells an ad-free version of its streaming service, just like Netflix. But the majority of Hulu subscribers are on the $5.99-per-month ad-supported plan, which is half the price of the $11.99 no-commercials version. Hulu has previously disclosed subscriber numbers – announcing 28 million customer accounts earlier this month – but

hasn't broken those out by plan type. Now Hulu, which in the past month became fully ensconced under Disney's wing, has provided some context around the size of its audience base. Overall, it has 82 million viewers (meaning there's an average of 2.9 viewers per Hulu account). And of those, about 70%, or 58 million, are on the ad-supported plan. Hulu's ad business is a significant source of revenue, generating almost $1.5 billion in ad revenue in 2018. To that end, Hulu strives to make the way it presents advertising is viewer-friendly – otherwise it risks pushing those subscribers to the zero-advertising tier or losing them altogether.

As part of the goal of not irritating viewers, Hulu now caps the length of all ad breaks at 90 seconds (and in some cases less). It has long shown how much time is left in an ad pod with a countdown clock in the corner. https://variety.com/2019/digital/news/hulu-ad-supported-subscribers-70-percent-1203227954/

ATSC 3.0 to be deployed in 40 U.S. markets by end of 2020

A broad coalition of broadcast television station groups as well as public broadcasters announced that ATSC 3.0 (aka Next Gen TV) will be rolled out in 40 U.S. markets by the end of 2020. Subject to final engineering and required approvals, consents and FCC license modifications, the participating broadcasters have identified the first stations that will convert to ATSC 3.0 service in this rollout. Primary broadcast programming currently broadcast on the stations planning to upgrade will be hosted by other stations in their respective markets. Station groups involved in the deployment include Fox Television Stations, NBCUniversal Owned Television Stations, Univision, Spectrum Co. (includes Sinclair) and members of the Pearl TV Group, a coalition of broadcasters and manufacturers testing ATSC 3.0 in the Phoenix Model Market. https://www.atsc.org

Leichtman: Pay-TV bloodletting continues

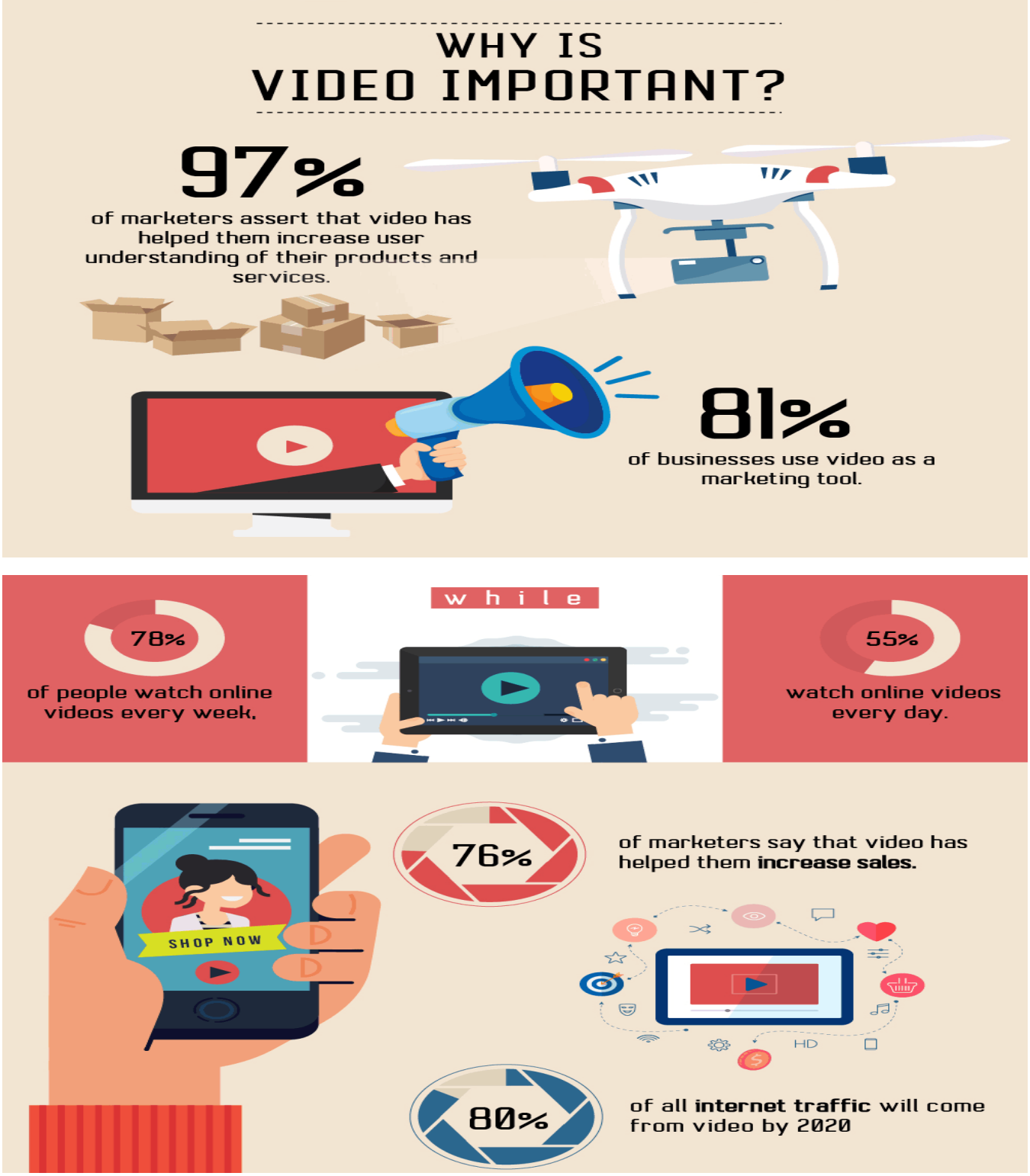
More specifics are coming out about how pay-TV fared in the first quarter of 2019, and they aren't positive. Leichtman Research Group released its own report that found the largest pay-TV providers in the U.S., which make up about 95% of the market, had a net loss of 1.325 million video subscribers in Q1 2019; last year's numbers over the same period resulted in a pro forma net loss of 305,000 subscribers. In total, the top pay-TV providers now have about 87.8 million subscribers. Broken down, that gives the top six cable companies 46.7 million subscribers; satellite TV services 28.3 million; top telephone companies 8.9 million; and the top vMVPD pay-TV services 3.9 million. All services suffered a net loss of subscribers during the measured time period. Satellite TV services took the biggest hit, losing 810,000 subscribers in the first quarter; up from a loss of 375,000 in Q1 last year. The top six cable companies lost about 50,000 more subscribers this year (285,000 in Q1 2018, 335,000 in Q1 2019). Telephone providers' losses more than doubled from 50,000 last year to 105,000 in the recent period. The measured vMVPD services, which include the likes of SlingTV and DirecTV Now, went from a net gain of 405,000 during the first quarter of 2018 to a loss of 75,000 subscribers. No company took a bigger hit than AT&T according to Leichtman's research. Across its three pay-TV services (DirecTV, AT&T U-Verse and DirecTV Now) there was a net loss of 625,000 subscribers; last year saw a net gain of 125,000. Overall, AT&T accounted for 47% of the net losses for all pay-TV providers. Leichtman President and Principal Analyst Bruce Leichtman noted that Q1 2019 marked the third straight quarter of record pay-TV net losses. He also said that the downturn coincides with pay-TV providers' decision to focus on long-term profitability when acquiring and retaining subscribers. https://www.leichtmanresearch.com

Roku and Amazon now control nearly 70% of US streaming media player market

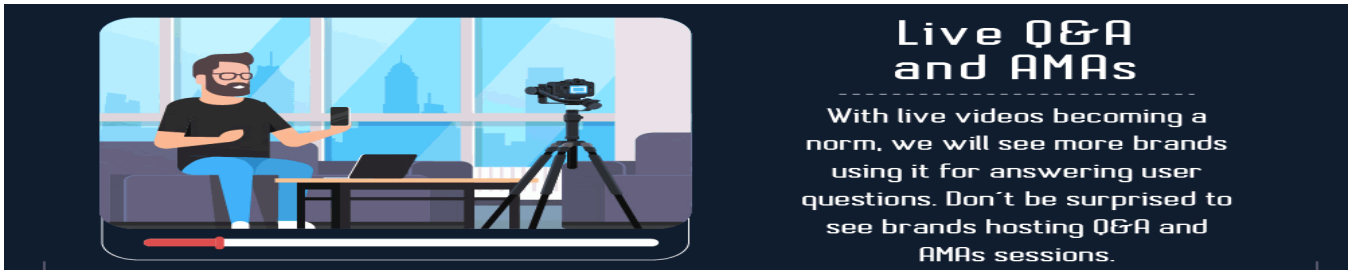
Roku and Amazon Fire TV have increased their dominance over the U.S. streaming media player (SMP) market and now control nearly 70% of it, according to a Parks Associates ranking of the top OTT systems in the first quarter. Market leader Roku controlled 39% of the installed base of SMPs at the end of Q1, according to Parks, representing narrow growth over the 37% in controlled in the first quarter of 2017. No. 2 platform Amazon Fire TV controlled 30%, growing from 24% two years prior. The race between Roku and Fire TV has been a bit subjective recently. Amazon recently announced 34 million regular users for its Fire TV platform worldwide, compared to 29 million announced by Roku at the end of the first quarter. In May, research company The Diffusion Group said both platforms were about evenly distributed. But last month, another research company, Strategy Analytics, made a seemingly out-there declaration that Roku was the king of the OTT world, controlling 70% of the world's connected video devices. It does seem clear, however, that Roku and Fire TV are now the fundamental OTT platforms that video companies must develop apps for – as iOS and Android are in the mobile world. https://www.multichannel.com/news/roku-and-fire-tv-control-70-percent-of-smp-market

7 video trends that will dominate in 2019 and beyond, infographic from Branex

No doubt you're aware that video is the best performing digital content type, and that you should, if possible, be looking to add video into your social media marketing strategy. But what types of video content should you be creating - and which formats and options are gaining momentum and interest? The team from Branex have put together this infographic of rising video trends, which might help to get you thinking about your options, and where you should be paying attention. https://www.branex.ae/




50%
OF INTERNET USERS
look for videos related to a product or service before visiting a store.
80%
landing pages
increase in conversions with the addition of videos on


Live Q&A and AMAs
With live videos becoming a norm, we will see more brands using it for answering user questions. Don't be surprised to see brands hosting Q&A and AMAs sessions.


360 Degree Videos
Businesses will continue to wow their target audience by delivering a unique and immersive experience with 360-degree videos.
360°


YouTube Ads Will Replace TV Ads
With people spending more time on YouTube than in front of their TVs, advertisers might ditch TV ads and embrace YouTube Ads.
YouTube
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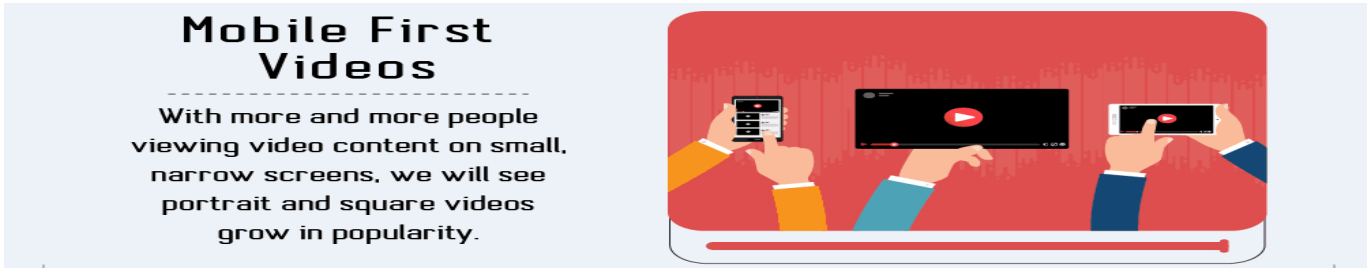
VR Ready Videos
Thanks to the advancement in VR technology and its wider adoption amongst masses, we will see more VR videos come out this year.



Global HDMI Cable Market 2019-2023| Growing Popularity of HDMI 2.1| Technavio

The global HDMI cable market is expected to post a CAGR close to 5% during the period 2019-2023, according to the latest market research report by Technavio. A key factor driving the growth of the market is the high demand for 4K/UHD TVs. One of the major applications of HDMI cables is 4K content display on TVs, where HDMI cable is used for high-definition, multimedia transmission onto TV screens for enhanced viewing experience. HDMI cables are preferred over conventional RCA cables as it can transmit a video signal, a CEC signal, and up to 8 channels of audio signals. This provides better audio-video quality while avoiding audio-video lag. Globally, the shipment of 4K TVs is increasing due to their decreasing price. Also, the rising disposable income of individuals coupled with the increasing number of commercial buildings is supporting the sale of 4K/UHD TVs, where HDMI cables are used to view 4K contents via set-top boxes. Such factors are expected to boost the HDMI cable market expansion during the forecast period. As per Technavio, the growing popularity of HDMI 2.1 will have a positive impact on the market and contribute to its growth significantly over the forecast period.

Technavio has published a new market research report on the global HDMI cable market from 2019-2023

HDMI 2.1 cables allow faster refresh rates, better audio at 48 Gbps data rates, and 8K resolution video at 60 frames per second. These cables also

offer dynamic HDR support, which ensures eARC, quick media switching (QMS), and display stream compression to the HDMI specification. Due to all these features, the demand for HDMI 2.1 cables is increasing across the world. The manufacturers of smart TVs are also launching new products to cater to this demand. It is expected with the launch of products supporting the HDMI 2.1 version, the demand for these cables will increase for the better viewing experience, driving the growth of the HDMI cable market during the forecast period. The APAC region led the market in 2018, followed by North America, Europe, South America, and MEA respectively. The APAC region is expected to maintain its dominance over the global market and register the highest incremental growth due to the increasing demand for HDTVs with enhanced gaming experience in various countries, including India, China, Japan, South Korea, and Thailand. http://www.technavio.com

Pay-TV lost 1.5 million subscribers in Q2 2019, says Leichtman

Pay-TV keeps taking hits in subscribers, with Leichtman Research Group finding in its latest quarterly report that about 1.53 million people dropped their pay-TV subscriptions during the second quarter of 2019. This is the fourth consecutive quarter of decline, per Leichtman, and more than a million of subscribers cutting their service from the same time period in 2018 (420,000). Consisting of the top 14 pay-TV services in the U.S. making up about 93% of the market, which includes satellite, cable, phone and vMVPDs. Satellite companies lost about 855,000 subscribers during Q2, with DirecTV accounting for 778,000 alone in its fifth straight quarter of net losses; Dish's losses of 79,000 resulted in its best quarter since Q2 2014. Cable, meanwhile, had its worst quarter since Q2 2014, experiencing a net loss among the top seven companies of 455,000. Comcast took the biggest hit, but is still the top cable provider by a wide margin. The top telephone providers lost about 100,000 video subscribers—more than double its Q2 2018 numbers – and vMVPD services even suffered a loss of 120,000 subscribers; they experienced a net add of 385,000 in Q2 2018. In the past year, the top pay-TV providers have lost about 5,015,000 subscribers; the year prior saw a loss of 1,060,000 subscribers. https://www.leichtmanresearch.com

Marion Stokes recorded 30+ years of TV on Betamax, VHS tapes

From the beginning of the Iran Hostage Crisis on Nov. 4, 1979, to her death in 2012, Marion Stokes was recording everything she could on TV, sometimes resulting in as many as eight tapes simultaneously recording. Described as activist archivist, Stokes' collection eventually totaled 71,000 Betamax and VHS tapes of news broadcasts, commercials and just about everything else that made its way onto TV. Those tapes have now made their way to Richmond, Calif., where they will be digitized and preserved as part of the Internet Archive, while Stokes' story will be told in a new documentary, "Recorder: The Marion Stokes Project." https://www.atlasobscura.com

Broadcasters ask FCC to update transmission regulations for ATSC 3.0

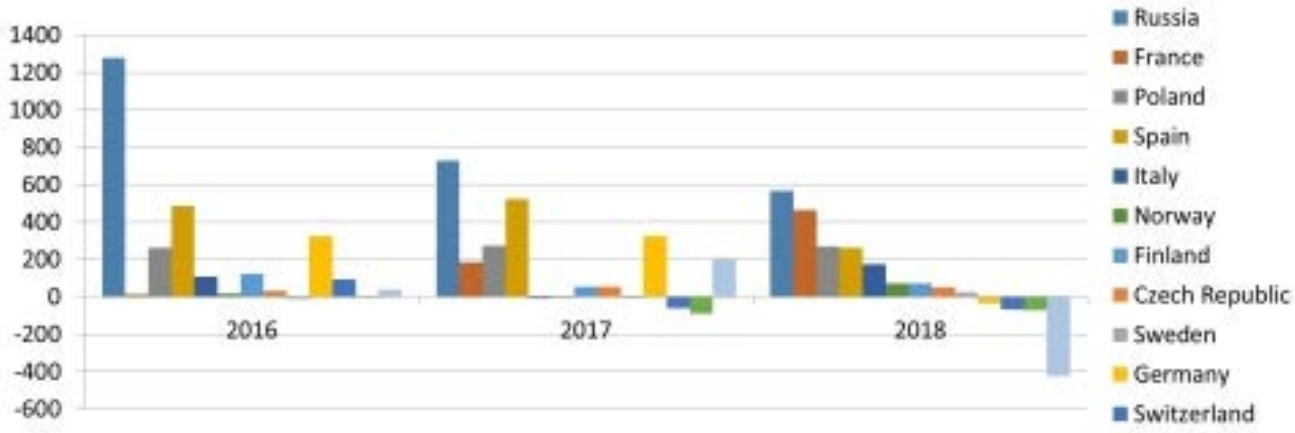
Broadcasters are asking the FCC to relax its rules to allow them to deploy more transmitters at the edge of their service areas as they build out for ATSC 3.0 (aka "Next Gen TV"). In a petition filed with the FCC, the National Association of Broadcasters and America's Public Television Stations (APTV) told the commission that it needs to update decade-old rules governing the use of distributed transmission systems (aka "single frequency networks") that were introduced during the deployment of ATSC 1.0. Such systems allow broadcasters to extend RF coverage by building transmission systems that fill gaps and improve reliability and reception quality. The organizations said that building SFNs for ATSC 1.0 was impractical but are more feasible with ATSC 3.0. When the FCC devised its rules for SFNs in 2008, it chose to limit their use so that broadcasters couldn't use them to expand their reception beyond their primary coverage area. This effort to prevent "dramatically expanded primary coverage rights" to "foster localism" with the technology advances of SFNs in the ATSC 3.0 era can be balanced, the organizations said. https://www.tvtechnology.com/atsc3

UK leads Europe's TV market into cord-cutting era, says Strategy Analytics

Declining pay TV subscriptions in the UK suggest that cord-cutting, which is well established in the US, is now beginning to affect the European market. The report, European Pay TV Index, found that the UK saw a net decline in pay TV households of 424,000 in 2018, the largest decline of any European country. Other countries with falling subscriptions include Denmark, Switzerland and Germany, although the rates of decline are less significant. Pay TV is still growing in some countries such as Russia, France, Poland and Spain, where the pay TV market is generally less mature. According to this research from Strategy Analytics' TV & Media Strategies service, the number of pay TV subscriptions across Europe as whole rose slightly in 2018, reaching 128.5 million. But the growth rate of 1.3% declined from the previous year's 2.2% and this trend suggests subscriptions across the

continent will begin to decline within the next year or two. http://www.StrategyAnalytics.com Other key findings from the report include:

- Telco operators like Orange and Deutsche Telekom are faring better than traditional cable and satellite players like Comcast (which owns Sky) and Liberty Global (which includes Virgin Media). Telco TV subscriptions rose 5.4% in 2018, compared to a decline for their rivals of 1.3%
- In spite of this, Comcast and Liberty Global remain the leading pay TV providers in Europe, with subscriber market shares of 14.9% and 13.8% respectively
- Europe's pay TV market remains highly fragmented, with the top five players accounting for less than half of all subscribers



Annual Pay TV Subscriptions Increase/Decrease: Selected European Markets

Atomos and Panasonic announce 35mm full-frame RAW video over HDMI

Atomos co-developed with Panasonic of RAW over HDMI from the brand new Lumix S1H to the Atomos Ninja V 4K HDR monitor-recorder. The RAW update will be available free on the Ninja V when released by Panasonic. As the world's first full-frame mirrorless camera capable of 6K internal video, the Lumix S1H combines the quality of professional cinema-grade video cameras with the size and photo capability of a mirrorless, making it the perfect companion with the Ninja V. http://www.atomos.com/

Manatt, Vorhaus Digital Strategy study reveals ascendency of online video

Manatt, Phelps & Phillips and Vorhaus Advisors released their inaugural Digital Strategy Study, which analyzes the state of media and content consumption. Through a comprehensive consumer survey focusing on topics including connected TV, subscription video on demand (SVOD), mobile and e-sports, the report identifies a number of key trends that illustrate how consumers are interacting with technology to consume digital content, including:

- **Online video is on the rise, but traditional TV is not dead.** Traditional television continues to fall far behind digital devices for consumers between the ages of 18 to 34, with 72 percent in that group using a smartphone to watch online video once a week or more, compared with only 56 percent who used a television set connected to the internet. However, despite a preference for digital devices among 18 to 34 year olds, television is still the top-rated device for the broader population over the age of 18.
- **SVOD continues to impress and has room to grow.** Of online users, 74 percent subscribe to a service, with nearly six in ten using Netflix. Furthermore, half of all SVOD viewing is consumed on an internet-connected TV, proving that related subscription apps are critical for connected TV's popularity. Consumers also say they are likely to buy up to another 1.6 SVOD services, beyond what they already have.
- **Skinny bundles might be a saving grace for pay TV companies.** While cord-cutting is likely to continue at a steady pace, 35 percent of consumers are interested in subscribing to a "skinny bundle" as a streamlined alternative to cable packages. With 47 percent of respondents saying cost is the

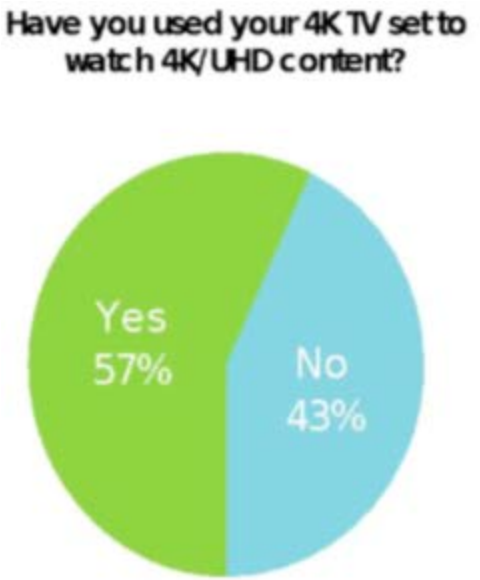
primary reason for cord-cutting, traditional pay TV companies have found traction with this customized offering.

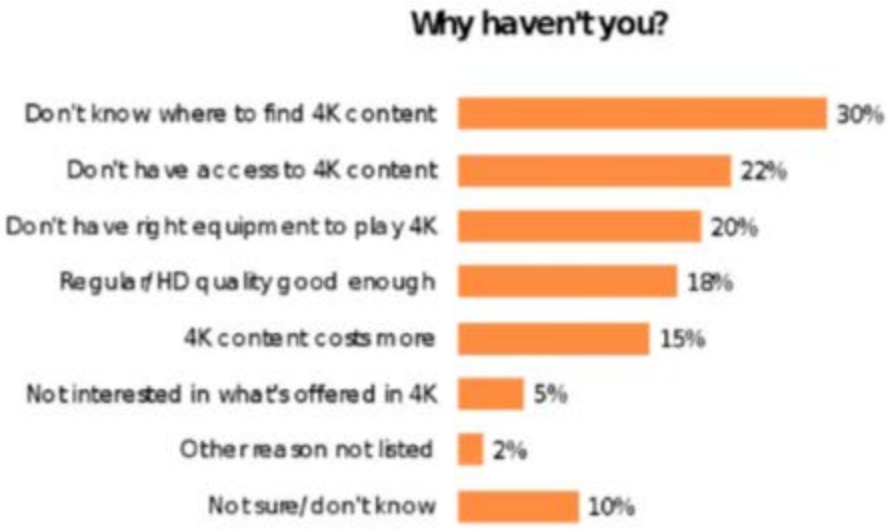
- **Livestreaming remains strong and e-sports' future is bright.** More than half of online users watch livestreaming video every day on a wide variety of topics. Within that category, e-sports is quickly gaining market share as the sixth most popular type of content. Forty-six percent of respondents said they watch more e-sports now than they did six months ago, and 43 percent anticipate spending more time watching e-sports in the upcoming six months.

The study analyzes survey responses from more than 2,000 respondents over the age of 18. The sample was matched to the U.S. Census for age, gender and race, and questions focused on media attitudes and the behaviors of consumers on a broad range of topics. http://www.manatt.com

Hub Survey: 55% have 'Never heard of' Next Gen TV

A slight majority of U.S. consumers say they "have never heard of" Next Gen TV (aka ATSC 3.0) according to a new survey from Hub Entertainment Research. This is comparable to the 58% who have never heard of 8K TV but much larger than the approximately 20% who had never heard of 4K TV. This lack of knowledge of the next generation broadcast standard is just one of numerous conclusions about the current state of the TV set in American homes revealed by Hub's "Evolution of the TV Set." The results are from an online survey of 2,500+ U.S. consumers taken in May and June. The survey included both TV and non-TV homes. Despite the proliferation of viewing video on mobile devices, the TV set still remains the dominant source of news and entertainment in the U.S. household Hub concluded. It found that the average home has 2.7 TV sets and that two-thirds of those homes have at least one smart TV set that is connected to broadband. The TV set in the living room or family room is still the most popular, with respondents saying that 81% of viewing happens on TV sets in those rooms. Half of those "most used" sets are connected to a pay-TV provider while 41% are connected to a streaming TV source. Among vendors, Samsung is the dominant player with 48% of those planning on buying a Samsung-branded smart TV set in the 12 months (LG is a distant second with 12%). Half of the sets in American households are 50 inches or bigger and fewer than three years old, Hub said. Almost half of all U.S. homes now have a streaming media player, according to the survey and 75% of homes stream TV shows or movies to a connected TV screen. When it comes to new technologies, consumers are most interested in 4K and HDR sets with more than 75% of respondents expressing "a lot" or "some" interest in the high resolution imaging technologies. However, while 4K TV sets are now dominant on the retail floor, only 43% have used a 4K TV set to watch actually 4K content.





Television technology is becoming more complex to consumers as they navigate terms such as 8K, HDR and frames per second. https://hubresearchllc.com

Panasonic MegaCon 4K dual panel LCD TV – pixel level brightness control

'MegaCon' is a reference to Mega Contrast. The best way to start understanding what the MegaCon is all about is to look at its key specifications. First, it claims a contrast ratio of 1,000,000:1 – despite being based on LCD rather than OLED technology. Second, it claims a brightness of 1000 nits – over the entire screen. The MegaCon display is also reckoned to be capable of reproducing 99% of the DCI P3 color spectrum that's used in the world of digital cinema – and which is essentially the system currently used when creating most of today's HDR content. Unlike most LCD TVs too, the MegaCon can be watched from a wide angle with minimal loss of contrast or color saturation. Additionally, the MegaCon achieves pixel level dimming. In other words, its backlight system can deliver a separate amount of light to each and every pixel in the MegaCon's 4K image. It's not the usual LED TV situation where a relatively small number of backlight zones have to share their light across large numbers of pixels, reducing contrast and causing issues with light 'blooming'.

MegaCon's screen structure has a monochrome inner panel and a 4K outer panel, with the dimming panel being used to modulate the light coming from the backlighting array into individual pixels of light that are then fed into the final 4K color layer.

The screen is completely Panasonic's own work, for instance. It uses panels manufactured by Panasonic, drawing on the knowledge of high-end 'self-emissive' screen technologies that Panasonic has built up over decades of plasma and OLED screen experience. It also uses a special system designed by Panasonic to perfectly align the monochrome inner and color outer layers, so that lines and pixels in the finished picture don't suffer with ghosting or diffraction noise. https://news.panasonic.com

UHD Alliance introduces new "Filmmaker Mode"

The UHD Alliance (UHDA) along with leaders in consumer electronics, the Hollywood studios and members of the filmmaking community announced today their collaboration on a new viewing mode for watching movies and episodic TV called "Filmmaker Mode. Current TVs use advanced video processing capabilities to offer consumers a broad range of options in viewing various types of content, ranging from sports to video games. Filmmaker Mode will allow viewers to enjoy a more cinematic experience on their UHD TVs when watching movies by disabling all post-processing (e.g. motion smoothing, etc.) so the movie or television show is displayed as it was intended by the filmmaker, preserving the correct aspect ratios, colors, and frame rates. LG Electronics, Panasonic and VIZIO announced support for Filmmaker Mode and expressed their interest in delivering creative intent to the home. Specific product and implementation plans will be announced by each company at the appropriate time.

While studios and CE manufacturers have long worked in concert to deliver new entertainment technologies and experiences to consumers, Filmmaker Mode marks the first collaboration to add leaders in the creative community

to the mix. Notably, unlike some picture modes which may require the user to enter one or more menus to find and select, Filmmaker Mode will be activated either automatically, through metadata embedded in the content, or through a single button which enables the consumer to activate Filmmaker Mode without moving through multiple menu levels. Further, to make finding displays that can display content in Filmmaker Mode, the name and settings will be consistent across multiple TV brands. In addition to consolidating feedback from filmmakers, studios and CE manufacturers, the UHDA engaged the broader creative community by polling their members to identify priorities. As part of the specification development process for Filmmaker Mode, the UHDA worked with and solicited input from the Directors Guild of America and The Film Foundation. http://www.hdalliance.org

CTA announces 8K UHD TV definition, logo

The Consumer Technology Association and its member companies have announced the display definition and logo for 8K Ultra High Definition (UHD) TVs. The logo and definition aim to help retailers and TV buyers identify products that meet the industry's 8K UHD requirements, including attributes such as resolution, digital inputs, bit depth, frame rates and up-conversion capability. According to CTA's latest biannual "Sales & Forecasts" report, 175,000 8K UHD TVs accounting for $734 million in revenue are expected to be sold by year's end. The 8K Ultra HD logo license and certification agreement will become available in the next few weeks. Companies may begin using the logo Jan. 1, 2020. The 8K Ultra HD logo program is an extension of the 4K Ultra HD logo announced in 2014 by CTA. As it did in that instance, CTA convened major video sector companies to draft, discuss and approve the official 8K Ultra HD designation, it said. Among the industry's 8K Ultra HD defining characteristics are:

- A minimum of 33 million active pixels – with at least 7,680 horizontal by 4,320 vertical pixel resolution in a 16:9 viewable window;
- One or more HDMI inputs supporting resolution of 7,680x4,320 pixels; bit depth of 10 bits; frame rates of 24, 30 and 60 frames per second; HDR transfer functions and colorimetry specified by ITU-R BT.2100; and HDCP v2.2 or equivalent content protection;
- The ability to upscale SD, HD and 4K video and display it on an 8K UHD display; and
- The capability to receive 10-bit 8K images and render an image showing responsiveness to changes to any of the 10 bits.

https://www.cta.tech/cta/media/Membership/PDFs/CTA-8K-UHD-Display-Characteristics-July-2019.pdf

Foxconn finally admits its empty Wisconsin 'innovation centers' aren't being developed

"Electronics manufacturer Foxconn's promised Wisconsin **"**innovation centers," which are to employ hundreds of people in the state if they ever get built, are officially on hold after spending months empty and unused, as the company focuses on meeting revised deadlines on the LCD factory it promised would now open by next year. The news, reported by Wisconsin Public Radio, is another inexplicable twist in the nearly two-year train wreck that is Foxconn's US manufacturing plans. The company originally promised five so-called innovation centers throughout the state would that employ as many as 100 to 200 people each in high-skilled jobs, with the Milwaukee center promising as many as 500. Those jobs were to complement the more than 13,000 jobs Foxconn said its initial Wisconsin electronics manufacturing factory would bring to the US, in exchange for billions in tax breaks and incentives that Governor Walker granted back in 2017". https://www.theverge.com/2019/10/23/20929453/foxconn-innovation-centers-on-hold-wisconsin-mount-pleasant-trump-deal

Global market for Quantum Dots 2013-2030 - ResearchAndMarkets

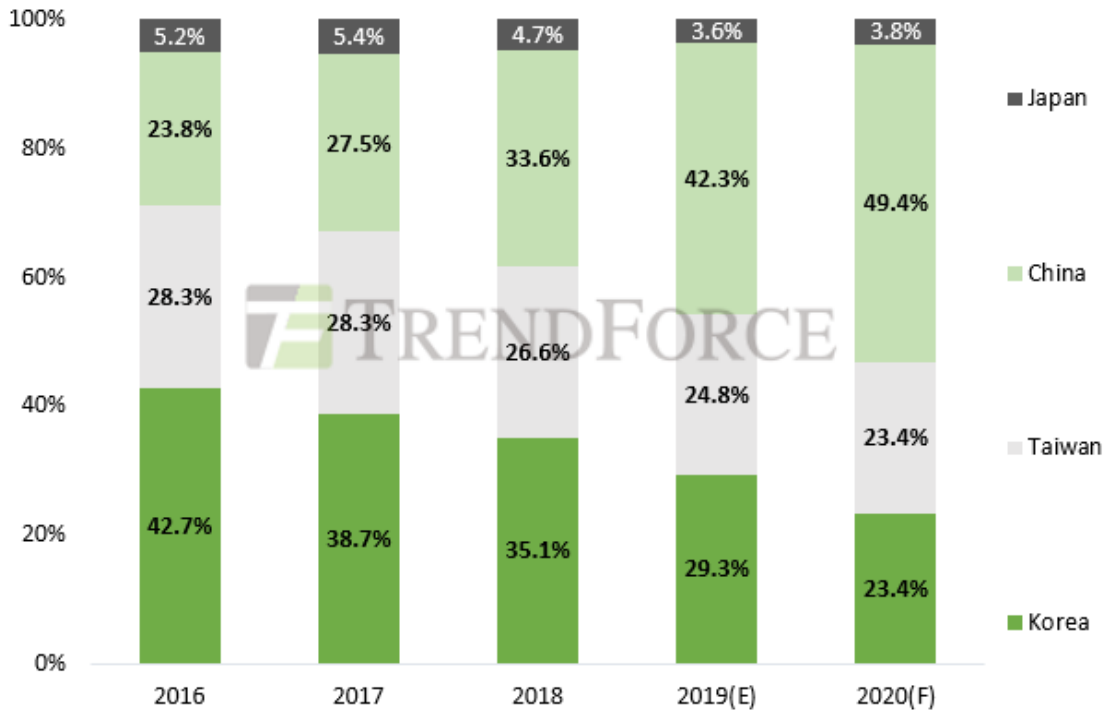
Quantum Dots (QDs) are used in a range of optoelectronic devices, including TVs and displays, light-emitting devices (LEDs), solar cells, photodiodes, thermos-electrics, photoconductors and field-effect transistors, while QD solutions have been used in a number of in vivo and in vitro imaging, sensing and labelling techniques. The quantum dot market continues to grow in 2019. Market segments such as micro and mini LEDs, sensors, lighting, solar windows, anti-counterfeiting and biosciences offer excellent opportunities. The Global Market for Quantum Dots analyses quantum dot suppliers, display manufacturers and OEMs. The global quantum dots (QD) based products market will be potentially valued at more than $35 billion by 2030. The optoelectronics market represents the vast majority of this figure, chiefly High Definition TVs-QLED-TVs. TV displays still dominate the end user

segment for QD-based products with a fast growing market for QD monitors. The use of QDs in solar conversion windows is also being heavily backed this year with a number of companies developing prototypes and funding multi-million dollar investments. The price of large QD-TVs is also falling.

This report on the quantum dots market is now in its 15th edition (First edition 2009) and provides a more in-depth analysis of the HDTV segment and emerging markets for quantum dots, graphene quantum dots and perovskite quantum dots plus a new QD Roadmap. Companies Mentioned: Applied Quantum Materials, Avantama, Bio Square, Dotz Nano, Fraunhofer Institute for Applied Polymer Research IAP/CAN, Green Science Alliance, Hansol Chemical, HP, IQDEMY Quantum Technology, KRI, ML System, Nanoco, NanoPhotonica, Nanosquare, Nanosys, Plessey Semiconductors, Samsung, and StoreDot. https://www.researchandmarkets.com/r/jcdxwa

TV panel makers cut capacity to reduce losses, reports WitsView

By regional large-sized panel input by area, Korean panel makers massively shut down several fabs in 2019. By contrast, China's panel makers increase their capacity. Therefore, China's share of large-sized glass input by area grows to 42.3%. China is now the region whose input by area is the largest in the world. This figure is projected at nearly 50% in 2020. According to WitsView, a division of TrendForce, its latest survey showed that TV panel prices generally have been lower than the cash costs. Thus, panel makers' loss of money has continually expanded. Korean, Taiwanese and Chinese panel makers all started to lower their utilization rates (UT) of TV panel products from September on, in order to improve the severely unbalanced supply and demand and stabilize the prices. Korean panel makers decreased their capacities the most among panel makers. In particular, for Samsung Display (SDC), because TV brands' procurement demand has suddenly dropped in 4Q19, SDC has massively moved down its UT of Korean Gen. 7 and Gen. 8.5 fabs in September and October. SDC's Gen. 7 input is predicted to drop by more than 50% in September and October, and input of its Gen. 8.5 fabs is expected to fall by 30%~40%. LG Display (LGD) plans to shut down some capacities of Gen. 7.5's Fab P7 and Gen. 8.5's Fab P8. The Fab P8 is projected at only have 25% of capacity by the end of 2019, and its Fab P7 is rumored to shut down one-third of capacity in October. A Taiwanese panel maker, AUO began to reduce its input in Gen. 8.5's Fab 8A and Gen. 6's Fab 6B. Particularly, the Fab 8A's input is estimated at only 50% remained in 4Q19 primarily because of the 55" panel prices and bad demand. Its Fab 6B is predicted to reduce by 20% of input in 4Q19 because it moved down the input of 65". China's panel makers also suffered from TV panel segment's loss of money. However, their capacity reduction scales have been lower than that of their rivals. CSOT modified its machinery in Gen. 8.5's Fab T2. Therefore, from September to the end of 2019, the input of Fab T2 is expected to drop by 20%. Gen. 10.5's fab in Hefei of BOE Technology (BOE) and CEC-CHOT's Gen. 8.6 fab both reduce their input by around 20% until the end of 2019. Sharp's Gen. 10.5 fab in Guangzhou temporarily paused its plan to enter mass production phase in 2019 because TV's market demand has been weak. China's large-sized panel input by area surpassed that of Korea, and China's share might reach nearly 50% in 2020. https://www.witsview.com/



Share of regional large-sized panel glass input by area 2016-2020

Interview with Nanosys CEO Jason Hartlove

Jason Hartlove joined Nanosys in 2008 with a proven track record of turning emerging technologies into successful commercial products. He previously developed the Optical Mouse which has sold more than one billion units worldwide and is a standard feature in all PCs. Hartlove also pioneered and developed key technologies used in CMOS image sensors in smartphone cameras, high capacity lithium-ion battery technologies and solid-state inverter technology used in solar and electric car charging systems. His vision for Nanosys has led the company to successfully pioneer and develop Quantum Dot based display technologies. Today, Nanosys maintains a nearly 100% market share for materials used in these ultra-bright displays with lifelike colors sold by companies including Samsung, Vizio, Hisense, TCL, Acer, Asus and Sharp. Prior to joining Nanosys, he was president of the Imaging Solutions Division of MagnaChip Semiconductor in Seoul, South Korea, where he turned an internally focused semiconductor group into a multinational company on track for an IPO. Before MagnaChip, Hartlove was vice president and general manager of the Sensor Solutions Division of Agilent Technologies, and previously held management and development positions at Hewlett-Packard. Hartlove is the author of more than 20 patents, including the winner of the Hewlett Award in 2004 for best patent. He holds a B.S. in electrical engineering from UCLA and has completed graduate work at the Anderson School of Management at UCLA.

Can you give me a little background on Nanosys the company history? Larry Bock founded Nanosys in 2001 as a venture-backed company focused on development of inorganic nanostructures for a variety of end markets including solar, bio-sensing and semiconductors. The technology was exclusively in-licensed from prestigious institutions such as MIT, LBL, UC Berkeley, UCLA, CalTech, Harvard and many others.

In 2008, Nanosys changed its focus and has since been focused on development and sales of Quantum Dots, in which it leads the world market. Today, the company has achieved cash flow break even and continues to grow organically as Quantum Dot adoption takes off in the display market. Founded in 2001, the Nanosys is headquartered in Silicon Valley, California where we operate the world's largest Quantum Dot nanomaterials fab. Our first product, a film for LCDs based on photoluminescent Quantum Dots, that we call Quantum Dot

Enhancement Film (QDEF), hit the market in 2013 in the Kindle Fire HDX 7" tablet. Now, just a few years later, our technology is being deployed in displays of all types and sizes, ranging all the way up to 88-inch TVs. It is an exciting time for quantum dots and Nanosys. There are three key photo luminescent Quantum Dot types made by Nanosys today: traditional cadmium-based Quantum Dots, 100% cadmium free QD and a low cadmium QD formulation- all of which are in the market in mass production today. Each of our products offer unique solutions for the market needs and performance demanded by our customers.

Our company is also actively developing the next generations of quantum dot display technologies. This work is focused primarily in two areas: photo-emissive and electro-emissive. Photo-Emissive technology will move Quantum Dots from the backlight to the front of the display. This technology enables us to replace inefficient, passive color filters with a layer of active Quantum Dot emitters. This results in game changing gains in efficiency, much wider viewing angles and the highest color gamut of any technology. Additionally, the ability to pattern Quantum Dots allows us to bring the color and efficiency benefits of our technology into nearly any type of display from LCD to microLED to OLED. We expect to see this technology commercialized over the next 12-18 months.

Electro-Emissive, which is also called electroluminescent (QDEL), is the future of Quantum Dot technology. EL Quantum Dots are similar to OLED devices in that the Quantum Dots convert electricity into photons. Unlike OLEDs, EL QD displays can be made using the lowest cost printing techniques, offer the robust reliability of inorganic materials and can be tuned to meet any color spec. Nanosys announced record-setting external quantum efficiency (EQE) of greater than 10% for blue cadmium free materials at SID DisplayWeek back in May. We expect to see Electro Emissive Quantum Dots commercialized in the next three to five years.

What is your core technology, Quantum Dots, all about and can you briefly describe how it works and what value it brings to displays? Quantum dots are light emitting, semiconducting nanocrystals made using colloidal chemistry. They are unique in that they can be made to emit at any wavelength with very narrow spectrum and very high efficiency. This makes the technology more valuable than LEDs or OLEDs because it does not suffer from limitations in emission wavelength due to material bandgap (for example, the green gap in LEDs) owing to its use of quantum confinement rather than bulk bandgap to set the emission wavelength. Our value proposition is for those applications which require high efficiency, narrow spectral width light, we provide the best solution in terms of cost and performance. Through our patented technology of core-shell-shell QD construction, we make the highest efficiency and best performance QD material in the world today.

What is the company's business model, who are some of your top customers and how is the market developing? It's quite simple: we manufacture and sell the highest quality Quantum Dot materials in the world. Our customers include Hitachi Chemical, Mitsubishi Chemical, SKC, Sumitomo and many others. The end customers who use our materials include Samsung, LG, Vizio, HiSense, Sharp, Toshiba and many others.
Our sales are worldwide although most sales are into Asia based on the geographic nature of the display industry supply chain. We do not have any formal partnerships although we have key relationships with Applied Materials, BOD, Hitachi, LG, Samsung and Tokyo Electron to name a few. In the next two years we want to reach annual sales in excess of $50M and to have annual production of devices (TVs, etc.) exceed 20 million units.

There are many acronyms in use regarding quantum dots. Can you identify the acronyms you use, (such as QDEF, QLED, QDCF, QD-LED, etc.):

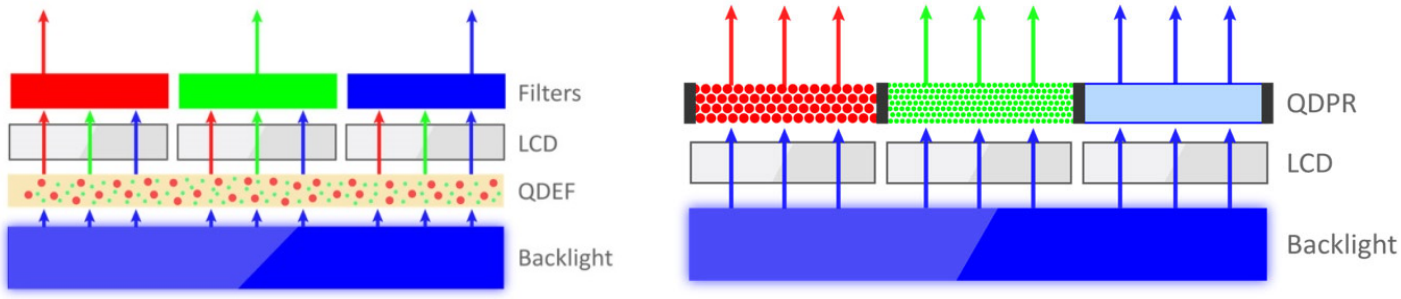
- QDEF: Quantum Dot Enhancement Film
- QDOG: Glass light guide plate with Quantum Dot coating
- QDCC: Quantum Dot Color Conversion
    - The industry also calls this QDCF (Quantum Dot Color Filters). We call this Color Conversion instead because Quantum Dots do not filter the light like passive color filters, instead they actively absorb and re-emit light.
- QDEL: Quantum Dot Electro-Luminescent
- QLED: Samsung's term for displays that employ Quantum Dot technology but also sometimes used for electro-luminescent quantum dots by other parties.

Please explain how QD films can enhance color for an LCD. Quantum dots improve the power efficiency, brightness and color performance of LED LCD displays. This enables LCD to compete with and even surpass OLED displays in many aspects. Quantum dots are a natural fit for displays; they are the world's most efficient emitter material. This means they emit more light for less power which is critical both in TVs, for high peak luminance applications like HDR, and in mobile displays, for improved battery life.

Traditional light emitting materials such as crystal phosphors emit a broad, fixed spectrum. Quantum dots can actually be tuned to convert light to nearly any color in the visible spectrum. This allows display designers to have the ability to tune and match the backlight spectrum more accurately to color filters to produce lifelike colors. Another benefit is displays using QDEF are brighter and use less energy than other high-performance display technologies. With other technologies, increased color performance results in decreased brightness or demands extra energy to maintain brightness.

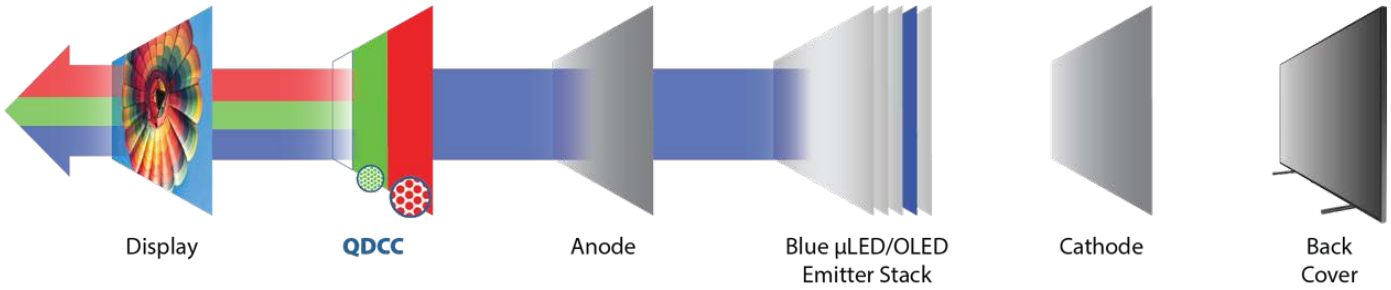
Now, please explain how QDs can enhance color for a color filter. We call this architecture "Photo-Emissive" quantum dot and it could change the way LCDs are made. Today's LCDs shine a white light through red, green and blue color filters, to select the colors seen at the front of the display. This is inherently inefficient because the filters waste 2/3 of the light generated in the backlight. By moving the quantum dots to the front of the display and replacing that wasteful passive filter with an active layer of color converting quantum dots, we can improve power efficiency by two to three times. We expect to see devices based on Photo Emissive quantum dots commercialized over the next 12 to 18 months. This is a big step for the industry and, unlike today's OLEDs, photo-emissive quantum dot displays can be produced in ambient conditions as opposed to in a vacuum.

Just like the image above, when an LCD TV with color filters wants to produce a red color, the color filters block off the green and the blue light produced by the backlight. This wastes 2/3 of the energy created by the backlight. But with QDCC, red and green Quantum Dots are pixelated on top of the blue backlight replacing the wasteful color filters. Unlike color filters, the Quantum Dot Color Conversion layer absorb the blue light and reemit red and green light. By doing so, this can improve the display's efficiency significantly and eliminate the viewing angle problem that traditional LCDs face.



Traditional LCD with KSF Color Filters (left) vs Quantum Dot Color Conversion (right)

Likewise, how can QDs enhance color for an OLED? As QDCC converts blue light into green or red at the surface of displays, it could be used with any blue light source and OLED is actually a great choice. A QD-OLED display would have all of the great contrast benefits of a typical OLED but with better color, brightness and, believe it or not, viewing angle.



OLED TVs today suffer from some big compromises. They rely on lossy color filters and a white subpixel that result in limited color brightness. Viewing angle is also impacted because the color filter layer means the viewer is not looking directly at the emitter. This approach can actually save cost too. Replacing the lossy filters with an efficient, printed Quantum Dot emitter can reduce complexity and lower cost.

And then, how can QDs enhance color for LEDs. Quantum Dots can be patterned directly on top of microLED devices as a color converter. Worth noting that we are not bullish on so-called QD-on-chip where Quantum Dots would be placed in the cup of a high-power LED for lighting or backlighting applications. The high flux and proximity to the chip are not a great fit for Quantum Dots in these applications. QDEL is the future of Quantum Dot technology. It is similar to OLED devices in that the Quantum Dots convert electricity into photons. Unlike OLEDs, QDEL displays can be made using the lowest cost printing techniques, offer the robust reliability of inorganic materials so end users don't have to worry about image retention and can be tuned to meet any color spec.

Are these various color enhancements cumulative? In other words, for example, does an LCD with both a color enhancement film and a QD-based color filter brag an even greater color performance? No, you have to choose one of the benefits.

Apart from improved color, do QDs enhance any other display performance parameters? Quantum Dots are about much more than color. The first is brightness. We think of Quantum Dot for LCD as the most efficient solution for wide color gamut. Quantum Dots are super-efficient light emitters and this allows display designers to eke out more brightness with less power at the widest color gamuts than any other technology. Another benefit that's a little bit less talked about is speed. Quantum Dots are incredibly fast. They can be switched on and off in

just nanoseconds. This compares to conventional phosphors like KSF red which takes milliseconds to completely turn off. Both sound pretty fast but the human eye can see the difference and notice annoying artifacts in the displays that use phosphors. Specifically, displays with conventional phosphors tend to have a reddish trail behind fast moving objects. It's something that will become even more apparent as higher frame rate content is adopted. Finally, I'd point to cost. Today you can buy an award winning 65" Quantum Dot TV for about $600 or about one quarter the cost of a same-size OLED.

Due to the small size of quantum dots, is there an easy path to creating extremely high pixel densities? Yes, this is one of the key benefits for QDCC devices. When you look at super-high-ppi applications like AR/VR you actually start to run into pixel sizes that are smaller than the width of conventional phosphor particles. Quantum Dots are just nanometers wide- they cannot be seen with the help of an optical microscope – that makes it very easy to make pixels smaller than your eye can see. To date we've demonstrated consistent, high-quality, subpixel patterning down to 2 microns using photo lithography and 35 microns using ink jet. We think 2 microns is more than sufficient for even the most demanding AR/VR applications. It also gives us plenty of headroom for large format displays.

Rather than resting on improved performance for LCDs and OLEDs, the logical next step is to make emissive displays utilizing quantum dots. Are there any reasons to believe QLEDs won't displace LCDs and OLEDs entirely? The only thing I'd point to here is the massive installed base for LCD manufacturing. That isn't going away any time soon so we'll have a mostly LCD TV and display industry for many years to come no matter what technologies emerge. QDEL is fundamentally very disruptive to the display market. Unlike OLED and LCD, QDEL devices can *only* be made using solution processing. This is a new way to make devices for the display industry so it will take some time to catch-up on scale.

What are the biggest challenges associated with creating QD emissive displays? QDEL devices are making rapid progress towards commercialization. Nanosys has demonstrated over 10% external quantum efficiency for red, green and blue. This is a major milestone, especially for Heavy Metal Free materials which we believe are essential for this application. There's still a lot of work to do before we see QDEL displays in the market. Much like OLEDs, the biggest challenge for QDEL is lifetime. This is a device integration challenge and an area where we've been able to learn a lot from work already done on OLEDs. However, unlike OLEDs, we don't yet see any fundamental limitations for QDEL lifetimes. Lifetime is currently the biggest challenge when making emissive QD displays but we have started to get a good understanding of the mechanisms impacting lifetime and have also been able leverage the learning from OLED's development over the past two decades- we believe we will move our technology into market a lot faster than it took for OLED.

Is there an emerging material or technology that you know about that might displace QDs any time in the near future? I see a lot of University research buzz around Lead-based Perovskites today. Lead Perovskites are an interesting technology that shares some of the benefits of Quantum Dots like a narrow emission spectrum. The presence of a well-known toxin like lead is likely to give CE brands and display makers pause though. As a result, that technology is likely to run into some adoption challenges so it may not qualify as a disruptor. The disruptive technology that may displace today's Quantum Dots is really emissive Quantum Dots. I realize that's kind of an eye-roll-inducing answer but moving to solution-based manufacturing for displays would be truly disruptive to the industry in the way that other technologies like OLED have not been to date.

Do you see your biggest opportunity as supporting LCD manufacturers, OLED manufacturers, LED manufacturers, color filter manufacturers, brand-name device manufacturers, or some other segment in the supply chain? I think you have to step back and look at the overall market share dynamics in the industry to answer this. Our materials can be applied to any display architecture so the question is really about, where is the industry heading, which technology will scale the most and capture the most area volume? I think the simple answer is that LCD will continue to be dominant across all display types and sizes in the near to medium term. New entrants like OLED and microLED show a lot of promise but lots of investment in capacity is required before they can really challenge LCD. If we look at TV for example, TV has almost 80% share of the total display area produced each year (about 180 million square meters, enough to cover Washington DC with displays!). OLED is still a niche player in TVs. While we do see increased OLED investment for large TV panels, we actually see even

more investment on the LCD side with massive gen 10.5 fabs in China. So, LCD will continue to be not just relevant but the mainstay of the industry for some time to come. We see Quantum Dots thriving in all the industries mentioned above. We see Quantum Dots as the platform technology for all future displays. So, no matter where the industry settles, Quantum Dots will be a key component.

Compared to liquid crystal and OLED materials, do QDs offer any sort of cost advantages to adopters? For LCDs, QDs are a very cost-effective way to enhance the display's performance. We have been improving our Quantum Dots and aggressively driving the price down so we can adopt QDEF into mainstream LCD TVs. So far, Nanosys have been able to drive prices down ~30% YoY. For OLEDs, Quantum Dot can significantly simplify the OLED structure and eliminate their weaknesses. This increases yield and lowers cost making Quantum Dots are a very appealing approach for OLEDs.

Do you intend to operate as a licensing company, a manufacturer of quantum dots, or a higher level manufacturer? Nanosys is focused on being the leading materials manufacturer for Quantum Dot technology. As I mentioned earlier, we operate the world's largest Quantum Dot nanomaterials fab and have shipped over 15 tons of Quantum Dot materials to customers to date. We are currently in the process of expanding the capacity of this facility to meet increased demand from the market.

Samsung has taken a leading role in developing QDs for displays; are other LCD and OLED manufacturers starting to recognize the advantages of QDs? Absolutely. Most of the top display makers are selling displays based on Nanosys Quantum Dot technology today. We see increasing demand going forward. This year over 100 SKUs have been announced to date. That compares to 75 in 2018 and 48 in 2017. Brands shipping displays using our technology include: Samsung, Vizio, TCL, Hisense, Asus, Acer, Philips and others.

Is there still a lot of room to improve the color space in displays? Of all the display quality metrics, color probably has the furthest to go in terms of matching the acuity of the human visual system. If you look at resolution, contrast, etc. we've made quite a lot of progress as an industry over the last 10 years. Color gamut, while it has improved a lot, still has a long way to go. Most devices on the market can reproduce only 1/3 to ½ of the range of colors our eyes can detect. Even BT.2020, the next logical target for content producers and display makers, covers about 57% of the human visual system. In resolution terms, that's like a 150ppi smartphone. Something nobody would accept today. We look at that and see a big opportunity for Quantum Dots to enable future displays to close that gap in capability with the human eye.

Can QDs be tuned to emit variable colors? In other words, if an individual has a color deficiency or color preference, can QDs be adjusted to better fulfill the user's visual needs? Quantum Dots can be tuned during manufacturing to emit just about any color in the visible spectrum. The color cannot be changed once the dots are made so this is not a user-accessible feature. That said, you could certainly develop a Quantum Dot formulation optimized for specific applications that goes beyond the typical RGB format found in today's displays.

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INFORM the public on the many benefits of LCD technology (vs. CRT and projection, PDP and the coming set of laser RPTV players). The LCD TV Association will debate the claims of competing technologies, as well as sponsor, post and distribute white papers on industry research and relevant topics - as determined by LCD TV Association Advisory Board.

Interview with Russell Kempt
Expanding demand for Quantum Dots in displays and beyond

Russell Kempt oversees strategic partnerships and drives Nanosys' top line. Russell also tells the story of our company and helps customers understand our value proposition in global markets. Russell is an experienced negotiator with impressive diplomacy skills, enabling him to build relationships on behalf of Nanosys worldwide including in China, Japan, Korea, and Taiwan. Russell was most recently with Intermolecular where as VP of Global Sales he grew sales bookings significantly over 4 years, enabling a successful IPO for the company in 2011. Russell developed and managed sales and technical support teams in the US, Europe, Taiwan, China and Korea to execute highly complex sales processes with multiple customer touch points at key partners and customers. Prior to IMI, Russell was Strategic Accounts Sales Director for PDF Solutions where he led a team to successfully close multi-million dollar programs with semiconductor clients including Intel, Samsung, TSMC, Texas Instruments, IBM, Qualcomm and others. Russell has a B.S. in Finance and Management from the University of Nebraska and an MBA from the University of Texas.

I understand you recently completed a significant expansion of manufacturing capacity. What led to the decision to expand your Silicon Valley manufacturing facilities? There are three key influences that are driving rapid growth in Quantum Dot TVs. First, until the second half of 2018, Quantum Dot TVs had been priced comparably to the very expensive OLED sets, limiting volume to the premium niche market. Now in 2019, Quantum Dots sets are being priced competitively to standard LCD sets. Today, consumers have a wide array of choices when shopping for a Quantum Dot TV with TV SKUs priced from $379 to $9,999. Second, an increasing number of brands including Hisense, JVC TCL, Vizio and others have joined Samsung in launching mainstream Quantum Dot products in the US this year. Third, next generation Quantum Dot technologies such as Quantum Dot-OLED hybrid displays are making rapid progress towards commercialization and these will become the next premium market revenue driver for display brands, offering new avenues for growth.

Is Nanosys seeing a great increase in demand for Quantum Dots in the TV and display field? Yes, we see the Quantum Dot display market entering a new phase of explosive growth with more than 50% increase in product shipments for displays with our QDEF technology in 2019. Quantum Dot TVs will continue to out-sell TVs based on WOLED technology (note that WOLED has never matched Quantum Dot TV in volume in any previous year) over the next several years.

What are some of the key highlights in the new manufacturing facility, and how does this place Nanosys ahead of its competitors? The new facility doubles our production capacity to now greater than 50 tons of Quantum Dot materials per year. At the heart of the new facility is a new, 1,300 liter reactor (pictured) that is two stories tall. This new level of scale enables us to produce our proprietary, heavy metal free core-shell-shell Quantum Dots with the highest efficiency and best performance at the lowest cost in the world today. The know-how in manufacturing processes required to scale-up to this level have required a massive investment (over many years) and we don't believe any other company has this depth of expertise.

Are Quantum Dots being used in other fields, and if so, what ones does Nanosys see opportunities in? Quantum dots are light emitting, semiconducting nanocrystals made using colloidal chemistry. They are unique in that they can be made to emit at any wavelength with very narrow spectrum and very high efficiency. This makes the technology more valuable than LEDs or OLEDs because it does not suffer from limitations in emission wavelength due to material bandgap (for example, the green gap in LEDs) owing to its use of quantum confinement rather than bulk bandgap to set the emission wavelength. Quantum Dots have the potential to disrupt

a number industries beyond displays. For those applications which require high efficiency, narrow spectral width light, we provide the best solution in terms of cost and performance. Examples of interesting emerging Quantum Dot applications include:

- **Solar Power: Smart Windows:** Quantum Dots can turn tinted windows into power sources. This enables technologies like building-integrated sunlight harvesting and could revolutionize urban architecture. Solar windows would benefit from Quantum Dot's high efficiency. Buildings utilizing Quantum Dot smart windows may eventually realize net zero energy consumption or even end up supplying the grid with electricity, helping to reduce urban greenhouse gas emissions.
- **Biological Taggants:** Specimen Tracking: Because Quantum Dots are tiny and have the ability to emit bright light in a range of possible colors, they can be used to track pollen grains and other biological phenomenon. Quantum Dots have the potential to solve the challenge of the past 200 years in pollination research and other fields where researchers do not have the data for where the specimen actually comes from prior to study.
- **Smart Farming: Green House Films:** Quantum dots can be coated on various structures such as glass, rigid plastic and flexible film to modify the solar spectrum. This can trigger early fruiting and shorten crop cycle by shaping sunlight to mimic the spectrum of desirable late October sun, leading to increased annual crop yields.
- **Smart Lighting: Circadian Illumination:** Lighting which matches our evolutionary circadian program enables reduced sleep deficit and associated improvement in physical health. Quantum dots can be fine-tuned to emit different wavelengths to meet the requirement of circadian illumination applications and other specialty lighting requirements. Quantum dots are the only low cost and high efficiency way to achieve a continuous, variable spectrum which can match the lighting requirements for circadian illumination applications
- **Photo Medicine: Photo Dynamic Therapy**: Quantum Dots can be made into sheets of light emitting material with high intensity and precise wavelengths which activate certain otherwise inert compounds for treatment. Enables targeting of specific cells, leaving surrounding tissue unharmed. Examples include non-invasive treatment for pre-cancerous lesions as well as rosacea, facial wrinkles, sun damage, and age spots. A high brightness light source is required to make this application work. Quantum Dots are uniquely able to provide light output needed.
- **Sensors**: Quantum Dot sensors are able absorb light 8x faster than Silicon Sensors eliminating silicon sensor challenges like the rolling shutter effect, limited dynamic range and poor low light sensitivity. Quantum Dot sensors enable a new generation of sensors for applications such as time-of-flight sensing increased resolution and infrared capabilities. Quantum dots can be spin coated as the photo-detecting layer onto silicon wafer substrates which contain circuit elements for imaging.

We have been developing Quantum Dot materials that meet the technical specifications of many of these new application areas previously listed and developing strategic relationships with companies who possess domain expertise in these emerging vertical markets.

PROMOTE the industry and technology via speeches, debates, interviews, PR and publically available white papers on topics that promote these goals. The founder's history with the industry ensures many lively and engaging interviews on the industry's strategies and will put a human face on this huge and influential industry. The press is constantly seeking validation from neutral, yet knowledgeable industry experts such as those at the LCD TV Association.

Interview with Ray Soniera about ambient lighting for LCD TVs

Dr. Raymond Soneira is the founder, president and CEO of DisplayMate Technologies Corporation. He has a Ph.D. in Physics from Princeton University, where he spent five years as a long-term member of the Institute for Advanced Study. A detailed biography can be viewed at: http://www.linkedin.com/in/raysoneira**. He has authored more than 35 research articles in scientific journals on physics and computer science, many of which can be viewed at:** http:www.displaymate.com.

Why is ambient light so important when thinking about display performance? Most people watch TVs in ambient light, often high ambient light such as daytime sports. But the on-screen Color Gamut that is actually seen decreases with increasing ambient light, which washes out the image colors.

How is ambient light measured and can you give some real-world examples of lighting conditions that consumers might encounter? The level of ambient light is scientifically called Illuminance, and is measured in units of lux, which is a lumen per square meter. If you are a photographer you may have a light meter that is calibrated in lux. For our measurements we use a laboratory Konica Minolta Illuminance meter. Below is a discussion of the lux levels that you are likely to encounter for indoor TV viewing.

Movie theaters are very dark with close to 0 lux ambient light falling on the screen – they only have a small amount of controlled lighting aimed at the floor for safety. If you have a dedicated home theater with carefully controlled low level ambient lighting then the effects we discuss here may be relatively small, but if you watch TV during the day in a room with windows, or at night with the room lights on, then our ambient light results will be relevant for your TV watching. Plus on weekends there are always lots of daytime TV sports programs that include colorful uniforms, deep green grass and foliage, and colorful scenery that shouldn't appear washed out in daytime ambient light.

As an example, in my living room, which has several northern and western exposure windows, the TV is set diagonally so that it doesn't face any windows. On an overcast day the room ambient light level is around 300 lux. On a sunny day during the middle of the day the room ambient light level can reach 1,000 lux, and in the late afternoon over 2,000 lux as the sunlight streams across the room (but doesn't hit the screen).

Obviously, your results will vary depending on your own TV viewing conditions and room layout. To capture this variance, I typically perform tests and measurements for five ambient light levels: 0 lux, 125 lux, 500 lux, 1,000 lux, and 2,000 lux.

How can a wider color gamut improve TV performance in ambient light? Since ambient light washes out the on-screen colors, the first step is to enlarge the Native Color Gamut of the display as much as possible. Quantum Dots can now further expand the Native Color Gamut very efficiently.

The Blue Primary is produced directly with standard Blue LEDs that are used with Quantum Dots, so then Red is the key Primary Color to extend using Quantum Dots. The deeper and more saturated the Red Primary is the better, and the more it will be able to compensate for the loss of color in high ambient light. With a Wider Native Color Gamut the same method described above for 2K Full HD will then accomplish this for the wider 4K Ultra HD DCI-P3 picture content.

What other innovations are needed to overcome the issue of ambient light so that consumers always see accurate colors on their TV? A wider color gamut alone is not enough. TV makers need to include smart technologies to enable the TV to adjust gamut and brightness dynamically as lighting conditions change. TVs experience a wide range of ambient conditions so there is no simple "set it and forget it" solution for this issue.

Remember the example of my living room, which sees anywhere from 0 to 2,000 lux over the course of a single day. So TVs must be able to make adjustments on the fly in order to ensure colors remain accurate and not over or under-saturated.

Dynamic Color Management is used to adjust the wide Native Color Gamut to the smaller operating Color Gamut needed based on the current measured level of ambient light (and Dynamic Intensity Scales are also needed to correct image contrast levels). This would result in an easy to see major improvement in picture quality and accuracy in real world ambient light viewing conditions, which consumers would quickly recognize, and produce a major marketing advantage for LCD TVs with Quantum Dots.

Implementing an objective and accurate Automatic Brightness Control for LCD TVs is very important and relatively easy, so it should be the first step. Automatic Brightness Controls are still awful and most people turn them off and park the manual Brightness to some fixed high value. My BrightnessGate article from 2010 covered this and described how Automatic Brightness should work. Smartphone makers, like Samsung, have lead the way on this and implemented it on the Galaxy S7. It would be great to see TV makers follow.

Are there any other benefits to this beyond picture quality? A major bonus for using Wider Color Gamuts in ambient light rather than using the brute force method of just increasing the Picture Brightness is that a TV with a Dynamic Gamut can produce the same vibrant on-screen colors in ambient light with just 240 nits compared to 930 nits with a Fixed Gamut. Since display power is proportional to the current Screen Brightness setting, the display power is reduced by 75 percent up through 2,000 lux ambient light by using a Dynamic Gamut produced by Dynamic Color Management. This is very important for TV energy efficiency, and also very important for Smartphones because they depend on limited battery power.

Research & links:

http://www.displaymate.com/Display_Technology_2014.htm#Ambient_Light
http://www.displaymate.com/TV_Performance_in_Ambient_Light_1.htm
http://www.displaymate.com/Mobile_Brightness_ShootOut_2.htm
http://www.displaymate.com/Galaxy_Note10_ShootOut_1G.htm#Interactive_Brightness
http://www.displaymate.com/AutoBrightness_Controls_2.htm

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LCD TV Association

INFORM · PROMOTE · IMPROVE · CONNECT

IMPROVE the products and functions of LCD TV products by inventing and promoting new specifications that benefit the whole industry, such as an industry-wide 'Green TV' program. There are many activities that will benefit our members from early compliance and the associated PR. The emphasis is on perceived value for little or no cost and use this to promote the industry via positive reviews and branding. The founder's experience ensures that these programs will not add cost, but rather help to relieve the relentless pressures on margin for the manufacturer.

CONNECT the industry supply chain with face-to-face meetings and regular communications, via white papers, presentations, quarterly newsletters for members. The Advisory Board members has quarterly meetings - telecon or in-person - to facilitate win/win relationships for the industry partners. With better communication we can speed time to market with better features and functions, particularly for members and their customers, with the ultimate goal of creating more value for the TV vendors and their suppliers, while making TVs more attractive to consumers.

People want good stuff to watch…

by Andy Marken

Andy is owner and president of Marken Communications, a marketing and communications Consultant, located in the San Francisco area since August 1977. The 30 year agency has been involved with a broad range of corporate and marketing activities. He is the author of more than 400 articles on management, marketing and communications and a frequent speaker at management and marketing conferences. Experience includes strategic, market planning and execution with communications/Internet firms including AT&T and CERFnet as well as in storage, storage management and video solutions with firms including Philips, InterVideo, Ulead, OWCDigital, NewerTech, Sonic, Corel, Matsushita, Pinnacle, Dazzle, Cyberlink, Mountain Computer, Nikon, Plasmon, NTI, ADS Tech, Verbatim, Mitsubishi and Panasonic.

After attending The Pay TV Show a few months ago in Denver, we came to the conclusion that the M&E industry has a huge issue today…and an even huger opportunity. It can't figure out what it is, how to label itself or what it wants to be when it grows up.

And surprise, our son and his friends – tomorrow's big content consumers - could give a rat's behind. The other evening, we asked him what he was watching on his phone and in typical cryptic fashion he said, *"TV."* Just to keep the conversation going we said, *"Yeah, we can see that but what?" "Cobra Kai."* On his way home from school he had caught up on the news of the day on CBS and then settled in to catch up on *Game of Thrones* before his newest "gotta watch" show. And that is why the cable (news, entertainment, sports) bill we were determined to dramatically reduce remains stubbornly at about $100 per month! It was simpler when we were growing up because everyone huddled around the TV set and watched whatever was on. Today?

There used to be an excitement of everyone gathering around the TV to watch something. Today, the family may be in the same room but what they're viewing/doing depends on the screen they're looking at. Today's TV is TV, no matter how you're watching.

We have choices and everyone in the family exercises her/his right to choose what they want to watch, when they want to watch it, how they want to watch it and where they want to watch it. The only people who care are folks in the M&E industry – analog terrestrial, satellite and cable folks as well as digital terrestrial, satellite, cable people; OTT bundlers/providers; and on the bottom of the pile, the folks who make the stuff…the content creators, developers, producers. Increasingly, everyone is hell-bent on becoming the sole provider of multi-channel services to the household – phone, internet, content.

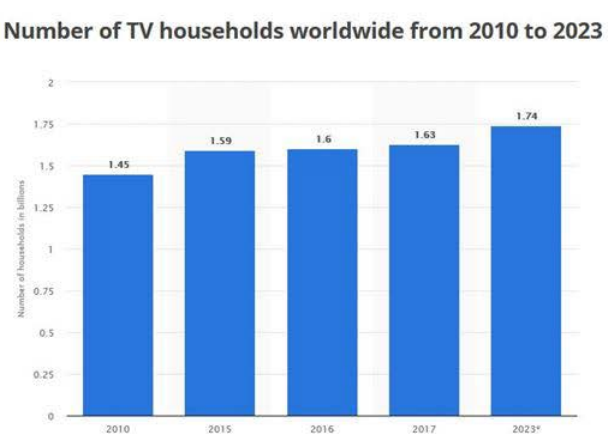
The business used to be civilized. The cable guy had the pipe to the home and the network folks bundled a bunch of stuff – good, bad, mediocre – and sold it to the cable guy who put it all into an even bigger bundle and they didn't care if you watched the stuff or not. To make service better, they went digital and OTT started offering better stuff combined with convenience – on the viewers schedule – and things changed.

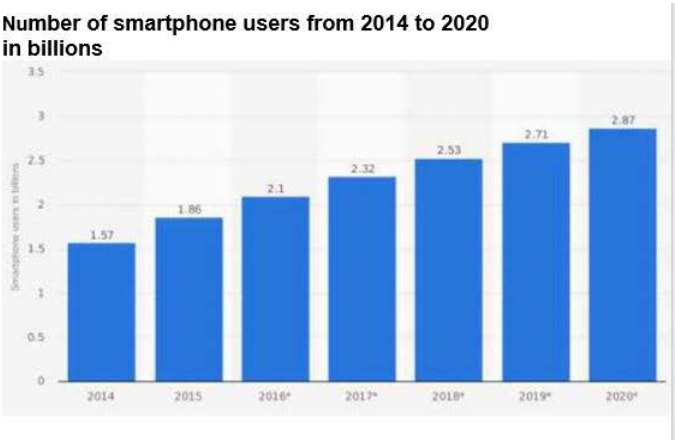
With the advent of OTT streaming content, people had the option of keeping, shaving, cutting their cable service and choosing their "favorite" service channel. It's great content but today, no one wants to watch just one channel. (Source Leichtman Research)

When Netflix, Amazon Prime and YouTube started streaming; our smart TV gave us a choice with stuff on our EPG (electronic program guide and the old cable guide). People in the content food chain – Hulu, HBO, BBC, Vimeo, Disney, Apple, Sling, Philo, CCTV, PlayStation, Pluto, Fubo, TenCent, Hooq, Iqiyi, Voot, Sky, Viacom, AT&T, Verizon, you name 'em – envisioned a painless, virtually zero cost way of having direct access to the consumer. Today, about everyone we know has an embarrassment of riches – hybrid TV.

We can thank (or blame) the introduction of the Internet for giving rise to the dizzying array of content services. *"With all of the devices people now have at their disposal to access the content, the real race begins,"* Allan McLennan, CEO and chief analyst at PADEM Media Group, noted at the Pay TV Show. *"Everyone in the industry is now focusing on getting the largest number of eyeballs tuned in to their streaming service."* Right now, there are two technologies rushing to be the one most used to access that content:

- 5G wired and wireless is just beginning to build-out high-speed, low-latency (lots of data, little delay) service
- Cable people are taking a two-pronged approach to keep their service relevant
    - ATSC 3.0 – doesn't exactly roll off your lips - or Next Gen TV
    - Addition of wireless service to their home internet/TV service



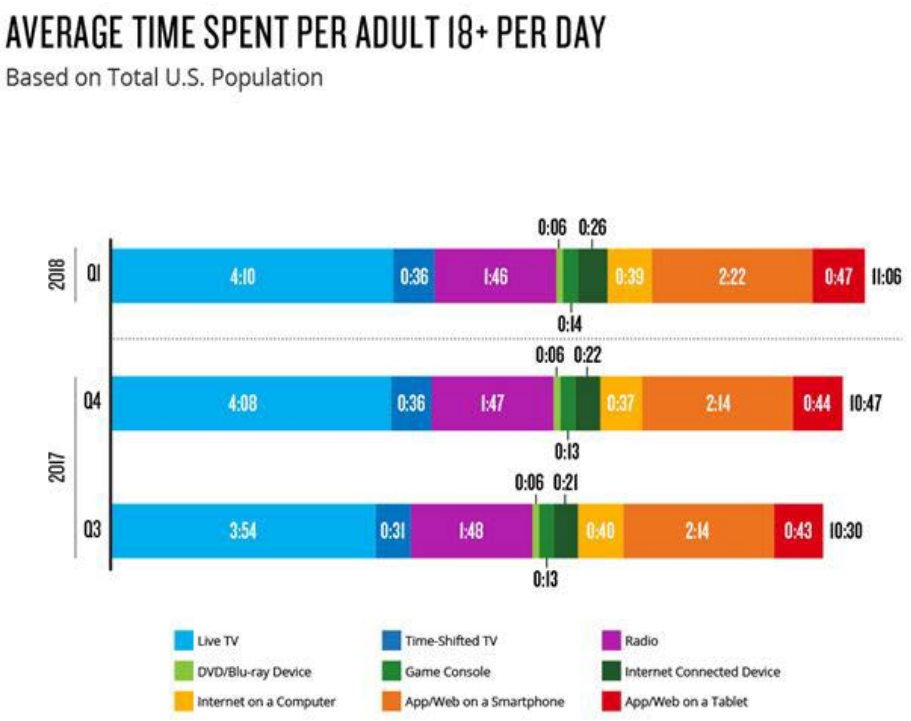


We realize it's difficult to believe that not everyone on the planet doesn't have a TV, smartphone or viewing device, but some people have other priorities than M&E and content.

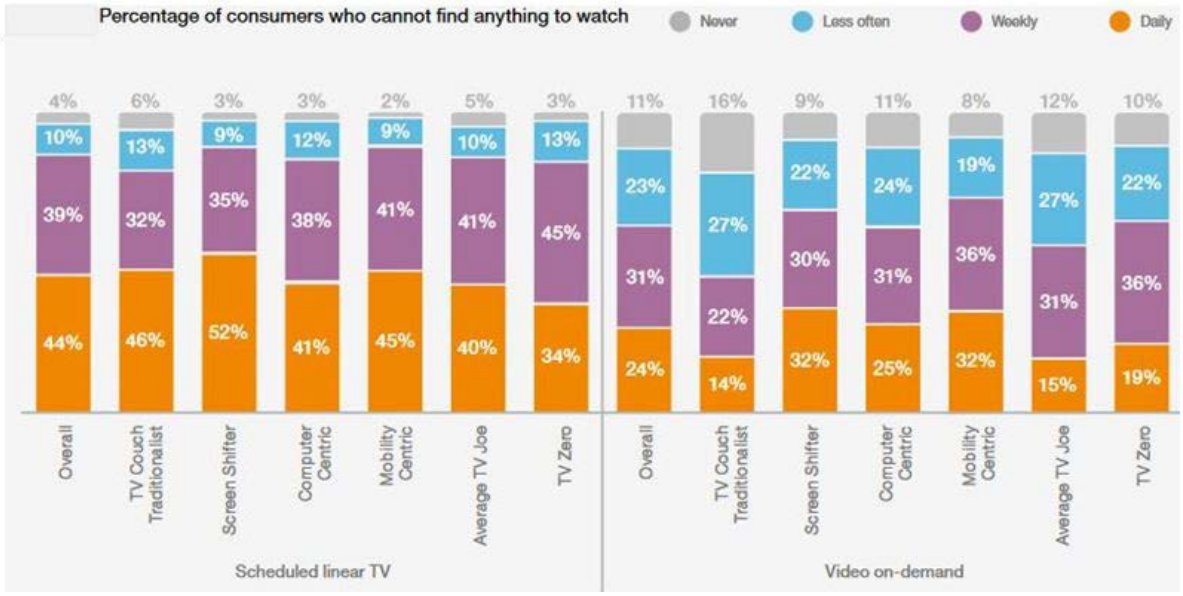
If you just look at the numbers, there are plenty of growth opportunities for anyone/everyone in the TV/content development/distribution industry. After all, there are about 7.7B people in the world, about 1.7G TV households and 2.7B smartphone users worldwide. It's little wonder everyone feels they are going to get their share because people just can't seem to get enough video content.

With the abundance of quality and interesting video content, people in the U.S. and most industrialized countries are spending more time watching more stuff and they're doing it on more screens. (Source: Nielsen)

While it's true that today there is no prime-time TV, the proliferation of options -- day/time viewing and OTT streaming -- are creating a challenge for service providers and viewers.



We have a hodgepodge of services – Netflix, Amazon Prime, Hulu, HBO, YouTube – and may have to add Disney+ and Apple TV+ at the end of the year to satisfy the kids. It's not because we like all of their shows; in fact, we often sign up for one or two and each time rationalize to ourselves, "yeah, we'll watch more of so-n-so's and drop one of the other guys." That's why DEG (Digital Entertainment Group) recently reported there are pay TV subscriptions for 517 operators with 747 platforms – digital/analog gable, satellite, IPTV, DTT across 135 countries with about 1.5M subscribers. In addition, there seems to be a new streaming service with some great new content that is going to capture folks' excitement (and subscription) every week. *"The content and distribution world is changing dramatically,"* McLennan observed. *"Traditional TV, cord-cutters, cord-trimmers, cord-nevers are being bombarded with the next great entertainment solution and they're quickly becoming overwhelmed.*



While content producers, shooters and distributors are offering an increasing volume of news, documentaries, reality, horror, humor and a range of video content to people to view on the screen of her/his choice; people continue to surf channels only to determine there's nothing on TV. It's there, just hard to find.

"They're finding it increasingly difficult to get an overview of all the content they have at their disposal so they can decide what they want to watch," he continued. *"Content producers and distributors will have to begin talking with each other and develop strategies and solutions that will meet the consumers' ever-changing entertainment appetite in the digital age. "In addition,"* McLennan added, *"individually and together they have to focus on developing and enforcing robust cloud security, data protection, DRM (digital rights management) and high-bandwidth content protection as well as rights education at the consumer level. Defending content and revenues from bad actors is not something anyone in the industry can take lightly."* We did our part by telling the kids:

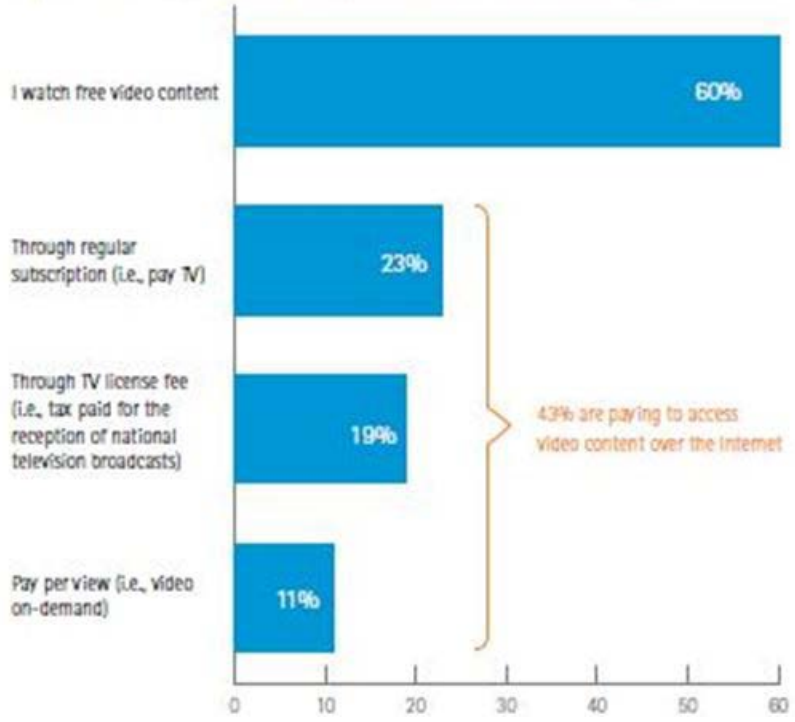
- If they "shared" our passwords they'd lose access to the streaming service for a month
- Most "free" film/show sites gave them something extra – malvertising – and if their activities infected the home network and Wi-Fi service for a helluva' long time, tough

We firmly agree with McLennan that the M&E industry is changing – rapidly; and don't see how SVOD services like Netflix, Disney and others can sustain their hefty investment in new, unique, ad-free content as sustainable. Services like HBO and Hulu have been, and perhaps will continue to be, ad-free subscriptions but they also have deep pocket "parents" that cover the red ink for Emmy and Oscar bragging rights. The statuettes are nice, but they don't put food on the table or money in investors' pockets.

It would seem that everyone has Netflix global subscription numbers in their sights and sees fantastic opportunities for their unique, special service. They are sorta' right because there's plenty of room for growth in the subscription content industry. But as YouTube has increasingly shown, ad-supported (free) streaming is equally attractive to viewers--especially if they aren't overwhelmed by run-of-the-mill, boring ads. (Source: Nryimperative)

We're comfortable with the rumors that Netflix is considering including some ads, as long as they're in exchange for a lower monthly subscription and believe that most of the 158M plus subscribers will agree.

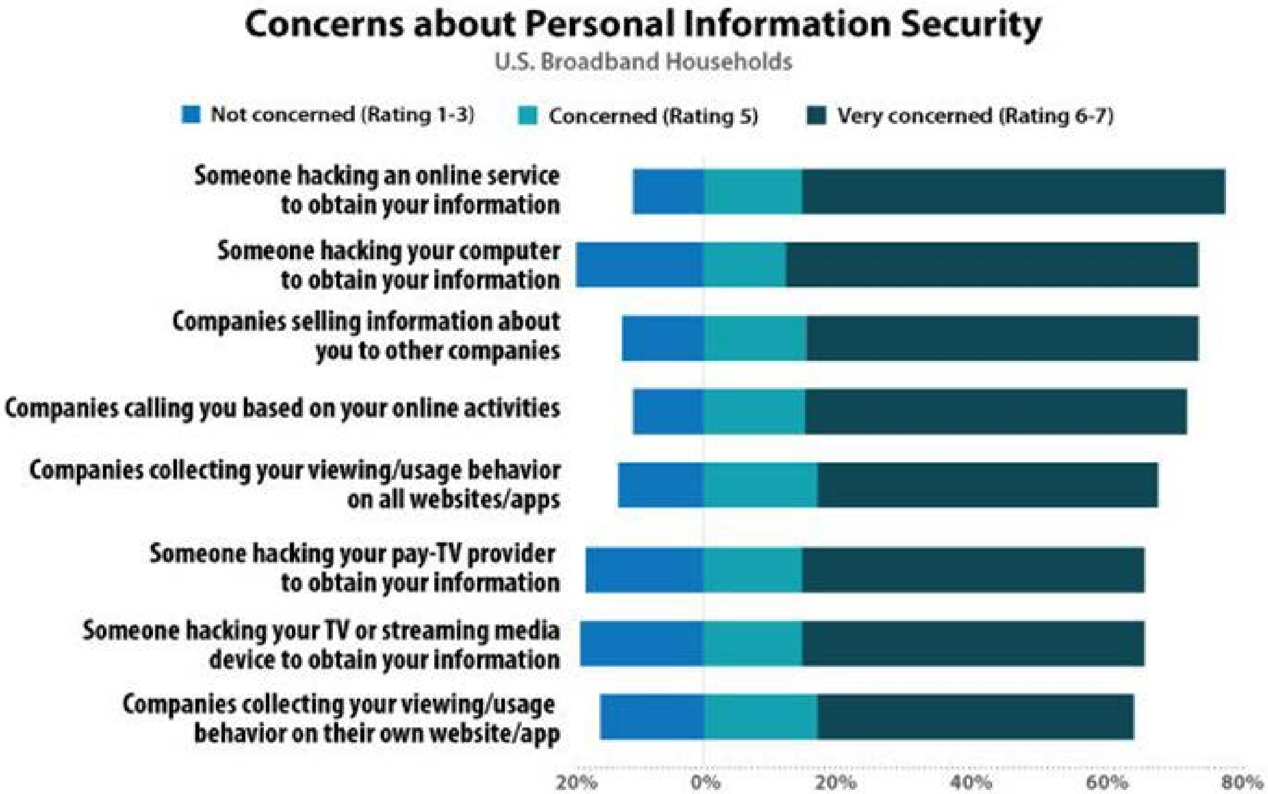
How Viewers Pay to Access Video Content Over the Internet



YouTube's CEO Susan Wojcicki aggressively promoted their advertising opportunities during this year's Digital Content Newfronts in NYC, noting that the service attracts over 1.8B users/viewers every month and it's all about the content not the name attached. Walmart announced that its Vudu service will be ad friendly and you can bet that Amazon Prime will begin offering their "friends" see-it, buy-it opportunities. It's not a pie-in-the-sky projection, it's only logical because the IP-based services already compile extensive user data; and when put to intelligent use, viewers will find it beneficial as long as that data is kept secure and private.

Okay, we admit that the security, privacy bit has been a huge hurdle for content providers/streamers; and we can only hope that bosses pay attention to McLennan's warning earlier because in the long run, their success/failure will depend on it. Especially since Europe's General Data Protection Regulation (GDPR) has given the EU a ready source of income when folks mess up.

In the U.S., the CCPA (California Consumer Privacy Act) will lead to an equally broad view of personal data privacy, collection, sharing. In addition, we're optimistic that the increased use of metadata collection, analytics and AI will ultimately lead to better quality, more meaningful personalized advertising.



Consumers don't mind sharing their personal information with services if it will result in getting better and more personalized content. And if they're using ad-supported channels, it would be a significant improvement if they only had to watch ads that were interesting to them. (Source: Park Associates)

All marketing has to do is understand the new challenges and opportunities that are available for them to really connect with the viewer/customer. It will certainly help when they come to understand it isn't that people don't like ads, it's that they don't like 10 of the same ad in a two-hour time period.

Past Editions of "LCD TV Matters"





You can download prior editions of "LCD TV Matters" from:

http://www.veritasetvisus.com/lcdtva.htm

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TCL TV lineup boosts QDs and MiniLEDs

by Bob O'Brien

Bob O'Brien is Co-Founder and President of DSCC. Bob has decades of experience turning market and business analysis into strategic insights in the display and electronics industries. As Director of Market Intelligence and Strategy for Corning Glass Technologies, Bob developed an intelligence infrastructure to inform pricing strategy, product development, marketing communications, and customer service strategy, and developed external communications for investors and customers to realize strategic Corning's industry leading position. Prior to Corning, Bob worked in engineering, product marketing, finance, and business intelligence for Philips Display Components and LG.Philips Displays. Bob holds a BS in Applied and Engineering Physics from Cornell University and an MBA from the University of Michigan Business School. bob.obrien@displaysupplychain.com

TCL rolled out its 2019 US TV Lineup this week, and the product line shows that the Chinese brand wants to keep its sales momentum and enhance its brand image with premium products. A leaked smartphone roadmap indicates that TCL wants to expand the TCL brand to that category as well.

TCL claims the label of "America's fastest-growing television brand" based on an incredibly strong Q1 with sales growth of 112% Y/Y in North America and was prominent in Amazon Prime Day promotions selling 2018 models. Now TCL introduces Roku TV models in three tiers: the all-new 8-Series, plus a refresh of the 5- and 6-Series.
In 2019, both 8- and 6-Series Roku TV models are adopting Quantum Dot color technology for even wider color gamut and more vibrant performance.

TCL follows Samsung in using the "QLED" sub-brand for these TVs, but DSCC Weekly Review readers will recognize that the technology utilizes a Quantum Dot Enhancement Film (QDEF). Quantum Dots enable the TVs to achieve a measured 100% color volume in the DCI-P3 Hollywood reference color space, and TCL claims that there is a clear advantage to QLED color technology when combined with a powerfully bright TV.

"After a very strong 2018, TCL remains steadfast in driving larger screen sizes and leveraging our vertical integration to bring better products to consumers who want more from their TVs. While TCL has a long history

using QLED technology in markets outside North America … we feel that it's a perfect time to bring this new level of performance to our users in the US market. With the 8- and 6-Series powered by the latest QLED color technology, there are few TVs available that can match their cinematic picture quality," said Chris Larson, Senior Vice President, TCL. "We are confident that these additions will further solidify TCL's position as a leader in North America and the global consumer electronics industry."

TCL's new 8- and 6-Series Roku TV models include Dolby Vision™ HDR technology, Dolby Atmos audio technology, a machine-learning algorithm for video processing AIPQ Engine, and a new calibration feature called iPQ Engine. This smart performance control was first introduced in 2018 TCL TVs and in 2019, TCL is adding functionality that allows an app for select mobile phones to apply a simple, automatic TV color calibration to deliver more color accuracy than ever before.

The new iPQ Engine Mobile app will be available this fall in the Google Play store for Android devices and in the Apple store for iOS devices. All of TCL's 2019 5-, 6- and 8-Series televisions include an Auto Game Mode feature that works with the latest generation of game consoles to automatically enable the TV's Game Mode when a video game is played. Auto Game Mode is designed to deliver some of the lowest input lag performance for fast-trigger response and helps ensure that the TV picture always looks its best with all types of video content.

TCL adopted Roku as its smart TV platform several years ago, and this year's TCL Roku TV models have Easy Voice Control which allows compatibility with popular voice assistants to give users additional options to control the TV. The Roku OS delivers regular software updates with new features over time.

TCL's 8-Series is a true flagship for the brand, stepping up the picture performance with not only QDEF but local dimming via an active matrix mini-LED backlight with more than 25,000 individual mini-LEDs powering the 75" 8-Series TV, and approximately 1000 local dimming zones. TCL calls its backlight technology Quantum Contrast, and it is aimed to compete with high-contrast OLED TVs in delivering a superior overall viewing experience. TCL will have additional models in the 8-Series to be introduced later; they stated that "8K resolution models will be available in screen sizes of 75" and larger soon."

TCL is bringing QDEF not only to its 8-Series, which will likely sell in small volumes, but more importantly to its 6-Series, priced more competitively. The 6-Series models include local dimming with traditional LED backlights, with 100 zones on the 55" model and scaling up on larger sizes. The TCL 5-Series will target the mainstream consumer, with the standard TCL features but no QDEF, at prices starting under $300.

TCL 2019 TV Model Line-up:

	QDEF	# Zones	43"	50"	55"	65"	75"	Prices
8-Series	Y	1000				X	X	$1999/$2999
6-Series	Y	100				X	X	$600/$1000
5-Series	N	n/a	X	X	X	X		Starting <$300

While TCL aspires to rise to the top-tier of TV brands, its more immediate target would appear to be Vizio. The 8-Series compares favorably in some respects with Vizio's flagship PX series TVs. Both the Vizio and TCL flagships are 4K resolution and support Dolby Vision HDR, but the TCL 8-Series' miniLED with 1000 zones outdoes the PX series with 384 zones, and TCL's prices sit below Vizio's comparable models at $2200/$3500. Vizio may have an edge in peak brightness; they claim 3000 nits while TCL does not specify.

In addition to its 2019 TV model launch, TCL leaked this week some information about an upcoming product line of smartphones. The roadmap leaked on Twitter includes a T! model with a 6.53" LCD screen to be introduced this quarter in Europe at prices starting at €299, a step-up T1 Pro with an OLED screen to be introduced early next year, 5G models to be introduced later in 2020, and a foldable model priced over €1000.

TCL has sold phones under the Blackberry and Alcatel brands, but introducing a line under the TCL brand represents a renewed focus on building a complete line of consumer electronics products to compete with the big three of Samsung, LGE, and Sony.

Losing the TV Remote Control (Intentionally)

by Pete Putman

Peter Putman is the president of ROAM Consulting L.L.C., which provides training, marketing communications, and product testing/development services to manufacturers, dealers, and end-users of displays, display interfaces, and related products. He also publishes HDTVexpert.com, a Web blog focused on 21st-century digital TV, display, interfacing, and wireless technologies, and is a regular contributor to industry trade publications including Sound & Communications, TV Technology, and Church Production. Pete received his Bachelor of Arts degree in Communications from Seton Hall University and holds a Master of Science degree in Television and Film from Syracuse University. He is a Senior Academy Instructor for the International Communications Industries Association (ICIA), and was named ICIA's Educator of the Year for 2008. He is a frequent speaker at industry trade shows and technology conferences, including InfoComm, NAB, the Hollywood Post Alliance Technology Retreat, and the SMPTE Fall Technology Conference. This article is reprinted with permission from Meko's Display Daily. http://www.displaydaily.com

The term "television" today means something very different than it did sixty years ago. Back then, the television experience was best described as radio with pictures. You turned on the power, raised the volume, rotated the channel selector, and sat down to watch. Quite a far cry from streaming programs to your phone or recording two or more shows to a DVR!

While we're more engaged with the idiot box than ever from a content perspective, some things are harder to change. Ever since those first televisions came to the home in the 1940s, engineers have been obsessed with ways to control things like power, volume, and channel changes without having to get up out of a chair.

The first attempt at this was Zenith's Lazy Bones wired remote in 1950. It worked great for controlling power, volume, and channel changes, but there was a small issue with tripping over the connecting cord. (Conveniently

overlooked in advertisements of the day that showed men in tuxedos and women in cocktail dresses enjoying an evening in front of the TV while drinking martinis)!

The first design for a true wireless remote control came five years later and was invented by Eugene Polley, an engineer at Zenith Corporation. He came up with something that looked like an oversized flashlight that signaled four different photocells embedded in the television's frame to control the same functions as the earlier wired remote. And it worked, so long as no sunlight was falling on any of the photocells.

But the third time was the charm. In 1956, Polley and fellow Zenith engineer Robert Adler came up with the now-legendary Space Commander, a three-button remote that used ultrasonic tones (created by striking tiny chimes in the remote) to operate power, change channels, and control volume. It worked so well that it remained a viable product for more than a decade, albeit an upscale "premium" add-on to televisions.

While many TV models still required the viewer to operate controls manually, the game changed completely with the introduction of infrared remote controls in the late 1970s. By 1990, infrared remotes were ubiquitous, operating televisions, home theater receivers, projectors, CD players, and laser disc players.

All kinds of crazy remote-control products came to market at that time, like IR-tracking wireless mice (very unreliable), wand-style mouse controls (suffered from ballistics issues), and RF-based wireless tracking balls and remotes (clobbered by interference). In my days of writing for various trade publications, I had the pleasure (and aggravation) of testing many of these "sounded like a good idea at the time" products, none of which exist today.

Around the turn of the century, R&D efforts accelerated. For many years at CES, we would be ushered into a private suite to see how someone could simply wave their hands to extract a virtual book from a shelf, open the cover, turn the pages, and close the book. Or control volume, channel up/down, program guide, and other functions simply by pointing a finger and moving a hand up and down or sideways.

There were RF-based wands to control TV functions that also let you scribble on the screen and change channels simply by drawing a channel number. You could wave the palm of your hand over a screen representation of movie titles, pause on one of them with your selection highlighted by a white glow, and then open and watch the movie simply by closing your fist and pulling your hand back – as if you were pulling a DVD off a shelf.

Other companies showed how you could scroll up and down pages of text, scan through maps, and select icons to launch programs on a laptop simply by using your eyes. You could read and turn sheet music the same way and make selections by using your finger or thumb to press a virtual "enter' button on the side of the screen.

All of these were amazing demonstrations, and all were aimed at getting rid of the traditional handheld remote. But there were drawbacks to every idea. For one thing, it gets pretty tiring waving your hands and arms around to make something happen. (And it looks pretty silly, too).

Also, holding your arm still while making different gestures with your hand and fingers is just too much work. Waving a wand isn't much better, as the ballistics for one person won't be the same for another, resulting in overshoots of the screen and some pretty sloppy writing that resembles graffiti more than anything else. Just

about every one of these companies was either bought out by tech behemoths like Intel and Apple, or shut down operations when their capital ran out.

Gesture-based control examples

Voice May be the Only Way: It appears that the only practical candidate to replace the traditional remote is voice recognition, paired with artificial intelligence. This would seem to be the most difficult trick to pull off, as such a system has to recognize (1) different voice pitches, (2) different languages, (3) and different accents, not to mention deciphering voices that mumble.

And yet, engineers have done it. Over the years at CES, Conexant showed me numerous demos of successful speech recognition while loud TVs, boom boxes, and even vacuum cleaners were running at the same time. In each case, their system correctly recognized voices and executed commands as spoken. These voice recognition systems are so good that they can function in noisy rooms amid music and speech coming from televisions and AV receivers.

A Voice Recognition Enhancement by Conexant

Sixty years after the Space Commander, we may finally be ready to replace handheld remote controls with our voices. Both my TiVo Bolt and Comcast X1 remotes now offer voice control for everything from finding programs to changing channels. Amazon is adding Echo Buds, ear buds that link to Alexa, along with Echo Frames, eyeglass frames equipped with tiny speakers and microphones.

Today, millions of voice recognition systems now nestle comfortably in homes, streaming music and searching the Web. (Rarely being used to order anything online, by the way.) We aspire to the zenith of couch potatoes as we converse with our television, looking for something interesting to watch tonight…like that History Channel documentary on TV remote controls…

Display Industry Calendar of Events

Please notify mark@veritasetvisus.com to have your future events included in the listing.

November 2019			
November 1-2	VR/AR Global Summit	Vancouver, British Columbia	
November 5-6	International Future Computing Summit	Mountain View, California	
November 5-7	Microtech Innovation Summit	San Jose, California	
November 6-8	4K-HDR Summit 2019	Malaga, Spain	
November 9-13	Conference on Computer-Supported Cooperative Work and Social Computing	Austin, Texas	
November 10-13	Interactive Surfaces & Spaces	Daejeon, Korea	
November 12-15	Semicon Europa -- Be Flexible	Munich, Germany	
November 12-15	Symposium on Virtual Reality Software and Technology	Sydney, Australia	
November 13-14	Automotive HMI and Display Forum	Berlin, Germany	
November 17-20	SIGGRAPH Asia	Brisbane, Australia	
November 20-21	Printed Electronics US	Santa Clara, California	
November 21-23	China International Touch Screen Exhibition & Seminar	Shenzhen, China	
November 27	DSCC Korea Conference	Seoul, Korea	
November 27-29	IDW	Sapporo, Japan	
December 2019			
December 2-6	Interservice/Industry Training, Simulation and Education Conference	Orlando, Florida	
December 3-5	Smart Haptics	Seattle, Washington	
December 4-6	FineTech Japan & Display 2019	Tokyo, Japan	
December 9-12	CineAsia	Hong Kong, China	
December 11-13	SEMICON Japan	Tokyo, Japan	
January 2020			
January 6	Digital Hollywood CES	Las Vegas, Nevada	
January 7-9	Viscom	Dusseldorf, Germany	

January 7-10	2020 International CES	Las Vegas, Nevada	
January 14	Printed & Flexible Electronics China	Shanghai, China	
January 14-15	China International Quantum Dots Summit	Shanghai, China	
January 14-15	China International OLEDs Summit	Shanghai, China	
January 14-15	Emerging Technologies Conference	Shanghai, China	
January 15-17	NEPCON World Japan	Tokyo, Japan	
January 16-21	International Conference on Imaging Theory and Applications	Nashville, Tennessee	
January 26-30	Electronic Imaging 2020	Burlingame, California	
January 26-30	Stereoscopic Displays and Applications	Burlingame, California	
January 29-31	JFlex 2020	Tokyo, Japan	
February 2020			
February 1-6	APEX Expo	San Diego, California	
February1-6	Photonics West 2020	San Francisco, California	
February2-4	AR/VR/MR	San Francisco, California	
February 4-6	ICE Totally Gaming	London, England	
February 4-6	Intersolar North America	San Diego, California	
February 5-7	Semicon Korea	Seoul, Korea	
February 9-12	Tangible, Embedded, and embodied Interaction	Sydney, Australia	
February 11-13	Strategies in Light	San Diego, California	
February 11-14	Integrated Systems Europe	Amsterdam, Netherlands	
February 15-20	Medical Imaging	Houston, Texas	
February 17-20	Hollywood Post Alliance 2020 Tech Retreat	Rancho Mirage, California	
February 21-23	Sound & Vision 2020	Bristol, England	
February 24-27	FLEX	San Jose, California	
February 25-26	Emerging Technologies That Matter	Singapore	
February 26-27	Electronic Displays Conference 2020	Nuremberg, Germany	
February 26-28	3D & Virtual Reality Expo	Tokyo, Japan	
February 26-28	PV Expo 2020	Tokyo, Japan	

March 2020			
March 9-11	DVB World	Valencia, Spain	
March 10-11	Wearable Technology Show	London, England	
March 10-12	Image Sensors Europe	London, England	
March 11-13	Smart Materials	Barcelona, Spain	
March 11-13	Phosphors & Quantum Dots Industry Forum	Portland, Oregon	
March 16-17	Virtual Reality Developers Conference	San Francisco, California	
March 16-20	Game Developers Conference	San Francisco, California	
March 17-20	Intelligent User Interfaces	Cagliari, Italy	
March 18-20	FPD China	Shanghai, China	
March 22-26	Advances in Computer-Human Interactions	Barcelona, Spain	
March 22-26	IEEE VR	Atlanta, Georgia	
March 24-27	2020 Measurement Science Conference	Anaheim, California	
March 24-27	European Sign Expo	Madrid, Spain	
March 25-26	LOPE-C -- Large Area, Organic and Printed Electronics Convention	Munich, Germany	
March 26-28	Infocomm China	Beijing, China	
March 28-31	IEEE World Haptic Conference	Washington, DC	
March 29 - April 1	International Conference on Display Technology	Wuhan, China	
March 30 - April 2	Cinemacon	Las Vegas, Nevada	
March 30 - April 2	MIPTV	Cannes, France	
March 31 - April 3	Digital Signage Expo	Las Vegas, Nevada	
April 2020			
April 2-4	International Sign Expo	Orlando, Florida	
April 14-16	Infocomm Brasil	Sao Paulo, Brazil	
April 18-22	NAB 2020	Las Vegas, Nevada	
April 21-22	Image Sensors Automotive	Stuttgart, Germany	
May 10-12	2020 China VR&AR Fair and Summit	Guangzhou, China	

May 13-14	Printed Electronics Europe	Berlin, Germany	IDTechEx
April 14-18	SPIE Defense, Security, and Sensing	Anaheim, California	SPIE.
April 22-26	LAVAL Virtual	Laval, France	LAVAL VIRTUAL
April 25-30	CHI 2020	Honolulu, Hawaii	CHI 2020
April 28-30	Sign UK/Digital Signage Showcase	Birmingham, England	sign digital UK
May 2020			
May 5-7	Symposium on Interactive 3D Graphics and Games	San Francisco, California	i3D
May 5-8	International Conference on Animation, Effects, Games, and Digital Media	Stuttgart, Germany	fmx
May 12-14	AutoSens USA	Detroit, Michigan	AutoSens
May 13-14	Broadcast Video Expo	London, England	bve
May 13-14	Medical Wearables	San Jose, California	Medical Wearables
May 18-21	Archiving 2020	Washington, D.C.	
May 18-21	Embedded Vision Summit	Santa Clara, California	embedded VISION
May 18-22	AIMCAL R2R Europe Conference	Valencia, Spain	AIMCAL
May 21-22	Graphics Interface 2020	Toronto, Ontario	
May 25-29	Eurographics	Norrköping, Sweden	Eurographics
May 27-29	Infocomm Southeast Asia	Bangkok, Thailand	
May 27-29	Augmented Human Conference	Winnipeg, Manitoba	Augmented Human
June 2020			
June 2-6	Computex 2020	Taipei, Taiwan	
June 3-5	World Congress of Advanced Materials	Singapore	
June 5-8	Virtual & Augmented Reality World Conference	Toronto, Ontario	VRTO
June 7-12	SID International Symposium	San Francisco, California	SID
June 8-10	SID Display Week Business Track	San Francisco, California	DISPLAY Supply Chain Consultants
June 8-12	Collaborative Conference on Materials Research 2020	Seoul, Korea	3D Research
June 9-11	E3 Media and Business Summit	Los Angeles, California	
June 9-11	Sensors Expo & Conference	San Jose, California	sensors expo & conference

June 10-11	AR & VR World	London, England	
June 10-12	CES Asia	Shanghai, China	
June 13-19	InfoComm '20	Las Vegas, Nevada	
June 17-19	Interactive Media Experiences	Barcelona, Spain	
June 18-25	International Planetarium Society 2020	Edmonton, Alberta	
June 21-24	Interaction Design and Children	London, England	
June 22-25	CineEurope	Barcelona, Spain	
June 22-26	Digital Holography and Three Dimensional Imaging	Vancouver, British Columbia	
June 22-26	3D Image Acquisition and Display	Vancouver, British Columbia	
June 23-26	Symposium on Engineering Interactive Computing Systems	Sophia Antipolis, France	
June 24-26	LED & OLED Expo 2020	Seoul, Korea	
June 24-26	SIIM 2020	Austin, Texas	
June 26-28	C-Touch & Display Shanghai	Shanghai, China	
June 28-July 1	International Conference on Flexible and Printable Sensors and Systems	Manchester, England	
June 29 - July 1	Nanotech Conference & Expo	National Harbor, Maryland	
July 2020			
July 6-9	International Symposium on Flexible Organic Electronics	Thessaloniki, Greece	
July 19-23	SIGGRAPH 2020	Washington, DC	
July 19-24	HCI International	Copenhagen, Denmark	
July 20-21	International Conference on Organic Electronics	Paris, France	
August 2020			
August 11-13	Australasian Gaming Expo	Sydney, Australia	
August 19-21	Infocomm Mexico	Mexico City, Mexico	
August 19-21	Integrate	Sydney, Australia	
August 23-27	SPIE Optics+Photonics	San Diego, California	
August 26-28	Touch Taiwan	Taipei, Taiwan	

LCD TV Association

Inform • Promote • Improve • Connect

For more information on the LCD TV Association, membership, or to join, please visit us on the web at www.LCDTVAssociation.org or email membership@LCDTVAssociation.org

About the LCD TV Association

The LCD TV Association is a global, non-for-profit marketing trade association, formed to help the entire LCD supply chain and retail channel through to the end consumer via various communication tools, including speeches, interviews, sponsored research, as well as industry newsletters, meetings and standards settings – resulting in better information and distribution of this information, as well as better understanding of the rapidly changing world of flat TVs and HDTVs for all related parties. Participating at the many industry trade and consumer shows around the world to help promote members' interests, as well as create better LCD TV products for everyone, our goal is to serve both the industry needs and promote the consumers best interests. We encourage and engage in discussions to promote the industry overall, as well as helping foster healthy competition and create better products with higher value propositions for consumers and retailers alike. The LCD TV Association can help fight the growing "specsmanship" in trade publications and refocus conversations on true image quality and understanding for consumers, and help the whole LCD TV ecosystem to improve and thrive. For more information on the LCD TV Association, it's membership, or to join at one of the various levels available, please visit us on the web at http://www.LCDTVAssociation.org.

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