8K? Whoa! How'd We Get Here So Quickly?

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How DID We Get Here So Quickly?

- **CES 2019** was full of **8K TV** models and demonstrations
- First consumer model was Samsung's 85-inch **Q900R**
  - Released in fall of 2018
  - MSRP about $15,000
  - Uses quantum dot technology for HDR, WCG
- More models will come to market in 2019
- Screen sizes starting at 65 inches and ranging to 98 inches
- **Wait!! We're just getting used to 4K & Ultra HD!**

What's Driving The Push to 8K?

- There are a number of factors behind the push
- Some are obvious, others you may not know about
- Part of it is on-going technical innovation
- A lot of it is supply chain management and profitability
- Some of it is "cutting edge" marketing hype
- There has been a lot of "building the plane while flying"
- **But 8K WILL have a market impact within two years!**

To Know Where You're Headed, Look Back Where You Came From

The clues have been there for years

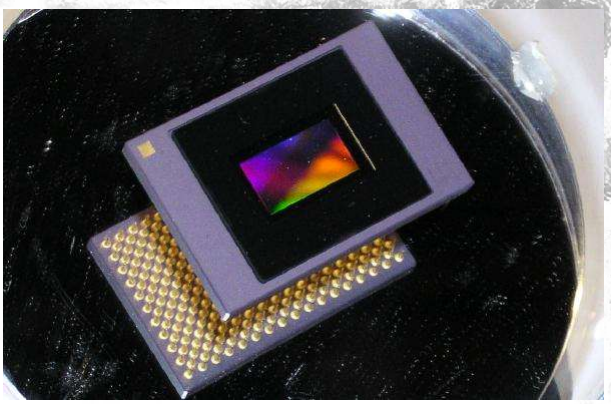
Let's Go Back In Time A Bit…

- The first 4K TVs (84-inch LG LCD monitor) were being shown at IFA in September of 2012
- Sold by **Sony** ($25K), **LG** ($20K), and **JVC** ($18K)
- **MEANWHILE**…**Sharp** had already shown an 85-inch 8K LCD monitor at CES 9 months earlier
- Fabbed on Sharp's new Gen 10 LCD line in Sakai, Japan (opened in 2009)

8K? Who the heck needs that?

Let's Go Back In Time A Bit…

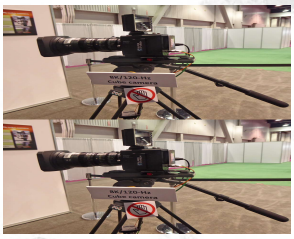
- **NHK** has been experimenting with 8K TV since 1995
- Showed a 4K x 2K camera in 2004
- Exhibited 8K sensor at NAB 2006
- First tests at London Olympics 2012 with a couple of viewing stations
- 8K Super Hi-Vision coverage of all Olympics commenced in 2016
- 22.2 sound system standardized by SMPTE in 2008



NHK Micron 8K Camera Sensor (2006)

Let's Go Back In Time A Bit…

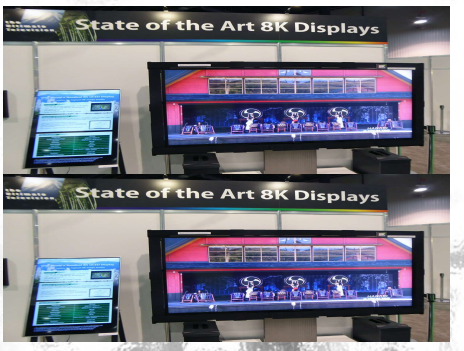
- **NHK** developed a compact (2.2 kg) 8K camera in 2013 to replace their earlier and bulkier models
- Over the next several years, NHK showed 8K/120 production, simultaneous 8K/4K/2K video output, and 8K slo-mo recording and playback tools
- They have engineered their entire 8K production system from scratch ("building the plane while flying")



NHK compact 8K camera

Let's Go Back In Time A Bit…

- On the display side, NHK has shown everything from the Sharp 85-inch monitor (7680x4320 pixels) to a 13-inch 8K OLED to be used as a camera monitor

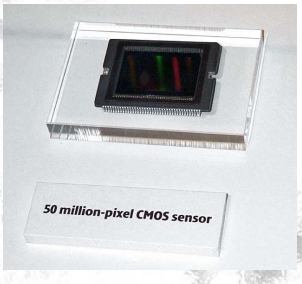


NHK (Sharp) 13-inch 8K OLED with IGZO, shown in 2013

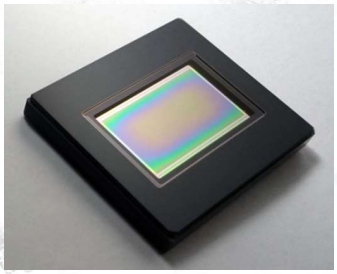
In The Works For A While

- While Ultra HDTV was being introduced to consumers WW…
- And while adoption of 4K TV began ticking up in 2014 (majority of TVs sold by 2020 will be Ultra HD)…
- **NHK** continued to develop 8K acquisition, storage, editing, and transmission hardware and software
  - Rio Olympics in 2016 were covered and broadcast by NHK
  - Demonstrated a practical method for UHF broadcasts using horizontal and vertical polarization on the same channel
  - **Launched a dedicated satellite 8K Hi-Vision TV service 12/1/2018**

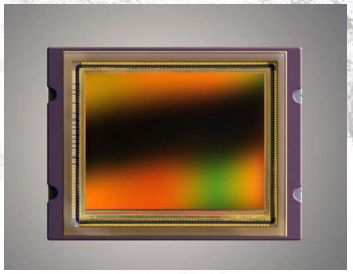
In The Works For A While



Canon 50 MP CMOS sensor, shown at 2010 Expo



NHK 8K 120 Hz CMOS sensor, shown at NAB 2012



Cmosis 8K CMOS sensor, announced in 2016

Multiple 8K camera sensors have been shown for >12 years

Meanwhile, On The Display Side…

- While **LG** and **Samsung** were competing to bring OLED TVs to market in 2013, Chinese LCD manufacturers decided to "jump" to Ultra HD panel fabbing (profit was declining in Full HD LCD panels)
- They were SO successful at it that you can now buy an Ultra HDTV with HDR support for as low as $6 / inch!
- There's little profit in 4K LCD fabbing now. **So, what to do next?**

TCL 55-inch curved UHDTV (2016)

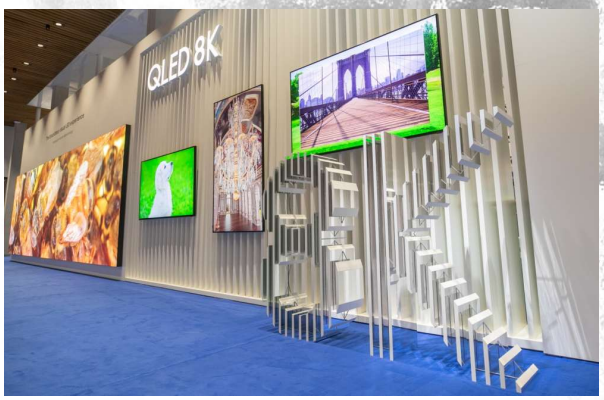
Meanwhile, On The Display Side…

- **Chinese fabs switched focus to 8K**
- Companies looking to make 8K panels include **TCL (CSOT), Foxconn, BOE**
  - Several Gen 10.5 fabs and one Gen 11 fab are now under construction
  - Motherglass size is 2940mm x 3370mm (10.8' x 9.6' if you are playing at home)
- In Korea, **LG** and **Samsung** also starting 8K LCD and OLED production
- LG has 88-inch OLED, 75/98-inch LCD
- Samsung has 65/75/85-inch LCD

Innolux 85-inch 8K LCD TV

Meanwhile, On The Display Side…

- **Samsung** announced 8K digital signage displays at ISE 2019
- Initial offering is the same 85-inch panel used in consumer TVs
- Quantum dot backlight, full array
- Supports HDR & WCG
- No word on display interfaces yet – likely HDMI 2.0 as on the consumer version (max 4320p/30)



And they support HDR!

The 8K Ball Is Rolling

- Of the 226 million TVs expected to ship in 2019, more than half will be ultra-high-definition (UHD) models. However, **8K TVs** from major global TV brands **will launch toward the end of 2018**, kicking off the next wave of resolution transition. *"Growth in the TV market typically is the result of more attractive retail prices for large-screen sizes and **the continued commoditization of 4K resolution**, driving TV replacements and upgrades,"* said Paul Gagnon of IHS Markit. *"However, **this has a negative effect on profits**, so TV brands are actively looking for **more growth from advanced TV models to improve earnings.**"*

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Meanwhile, On The Camera Side…

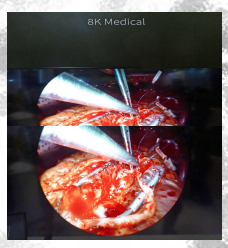
- **Sharp** announced their 8C-B60A 8K camera in the fall of 2017
  - Uses a Super 35mm sensor with 33 MP
  - Frame rates from 23.98 to 60 Hz
  - HLG gamma curve standard
  - Uses Grass Valley HQX Codec (7680×4320 4:2:2 10-bit)
  - Video compression rate 6 Gbps (8K 60p: approx. 1/7 compression)
  - Recording capacity 40 minutes with 2 TB SDHC storage

Meanwhile, On The Camera Side…

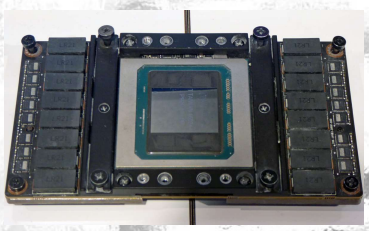
- **Sharp** also surprised everyone with an 8K DSLR prototype at CES
- Micro Four Thirds 8K sensor
- Records 4320p/30 with H.265 coding
- UHS-II SD card slot
- 5” flip-out display for viewing
- HDMI port (likely 2.0)
- **More specs to come at NAB 2019**

It’s Not Just About 8K Cameras

Sharp 8K Videowall (Eight 104-inch 5K panels)

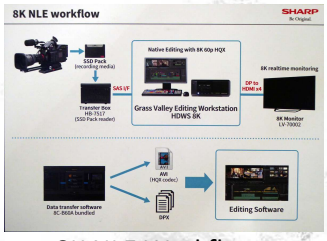


8K Medical Imaging



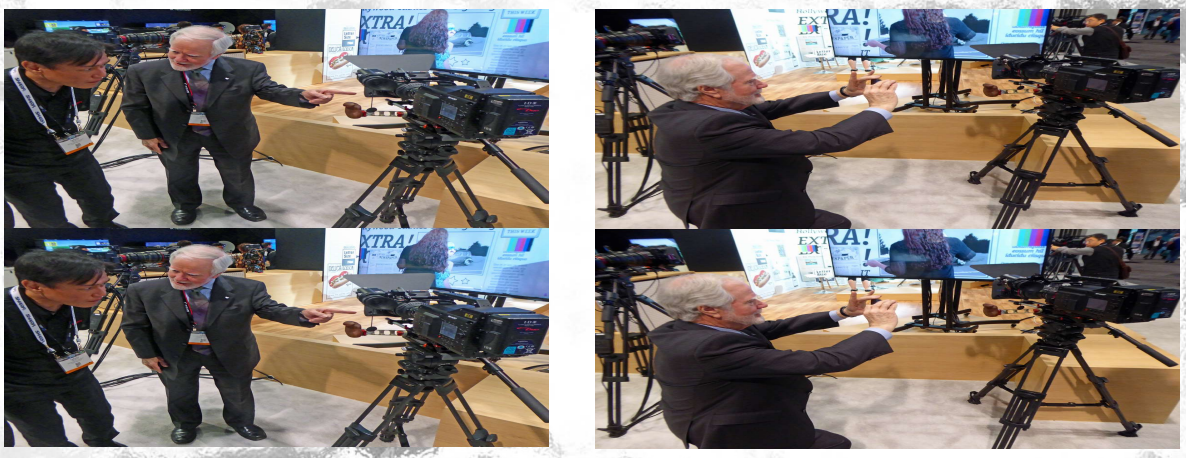
Sharp 8K CMOS Sensor

8K Over IP Demo



8K NLE Workflow

Hey! They're Using My Lenses!



The world of 8K video is full of surprises…

More Players In The 8K Game

Hitachi SK-UHH8060 8K Camera

- **Hitachi SK-UHH8060**
- Single CMOS Super 35mm sensor (7680 X 4320)
- Simultaneously outputs 8K, 4K/UHD, 1080p, 1080i and 720p
- High Dynamic Range and Wide Color Gamut conform to ARIB standards
- 10-inch 4K OLED viewfinder
- 60W power consumption in studio operation mode
- Camera weight 6 kg (13.2 lbs)

More Players In The 8K Game

Sony UHC-8300 8K Camera

- **Sony UHC-8300**
- 3x 1.25" 8K CMOS imagers for 7680x4320 resolution
- 8K/4K/HD simultaneous output to support current 4K/HD workflow
- 8K 119.88p image scanning output over octal 12G-SDI
- S-Log3 and BT.2100 HLG with BT.2020 wide color space and HDR/SDR simultaneous SR Live operation
- Weight 7 kg (15 lbs 7oz)

More Players In The 8K Game

Canon has shown this 8K camera prototype at Photokina

Image: Cinema 5D

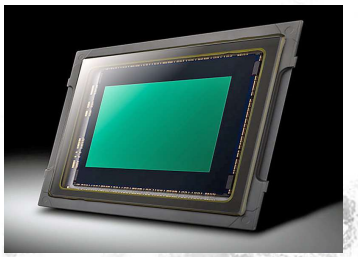
More Players In The 8K Game

RED 8K Cameras

- **RED Monstro 8K**
  - 35.4 Megapixel CMOS Sensor
  - 40.96 mm x 21.60 mm (Diag: 46.31 mm)
  - 60 fps at 8K Full Format (8192 × 4320)
  - 75 fps at 8K 2.4:1 (8192 × 3456)
- **Red Helium 8K**
  - 35.4 Megapixel CMOS Sensor
  - 29.90 mm x 15.77 mm (Diag: 33.80 mm)
  - 60 fps at 8K Full Format (8192 × 4320)
  - 75 fps at 8K 2.4:1 (8192 × 3456)

More Players In The 8K Game

- **Panasonic** introduced its 8K Global Shutter sensor in 2018
  - 8K high-resolution (36M pixels), 60fps frame rate
  - CMOS image sensor with organic photoconductive film (OPF)
  - In-pixel gain switching technology
  - High-speed noise cancellation and high saturation
  - 'Global' shutter enabled for sharper detail in motion images



Classic Misdirection?

- We were all entranced by the 'bright, shiny' object – 4K
- Meanwhile, **8K R&D** was going on for **almost 20 years**
- No coincidence that we've reached this inflection point!
- You will see multiple 8K TV models by **Q4 2019**, including some from Chinese brands **(TCL & Hisense)**
- **Samsung** is bringing out a 65-inch 8K LCD with QDs and target price is < $5,000 MSRP (about $77 per diagonal inch)
- **Then, there are the usual caveats…**

Got Speed? You'll Need It

Display Signal	Refresh (Hz)	Color Mode	Bit Depth	Data Rate
7680x4320p	24	4:2:2	10-bit	19.1 Gb/s
7680x4320p	30	4:2:0	8-bit	17.8 Gb/s
7680x4320p	30	4:2:0	10-bit	21.4 Gb/s
7680x4320p	30	4:2:2	10-bit	28.5 Gb/s
7680x4320p	30	4:4:4	10-bit	42.8 Gb/s
7680x4320p	60	4:2:0	8-bit	35.6 Gb/s
7680x4320p	60	4:2:0	10-bit	42.8 Gb/s
7680x4320p	60	4:2:2	10-bit	57 Gb/s
7680x4320p	60	4:4:4	10-bit	85.5 Gb/s
7680x4320p	120	4:2:2	10-bit	114 Gb/s
7680x4320p	120	4:4:4	10-bit	171 Gb/s

Got Speed? You'll Need It

- **NONE** of the uncompressed 8K data rates will pass through a 10G switch
- **NHK** has shown 5:1 compression using TiCO to pass 8K/60 4:2:0 10-bit color through a 10 Gig switch
- **HDMI 2.1** is fast enough, but won't be here until late Q4 2019
- **DisplayPort 2.0** announced at CES, but specs not written yet
- **CAVEAT EMPTOR!**

Fastest HDMI input is v2.0 (18 Gb/s)

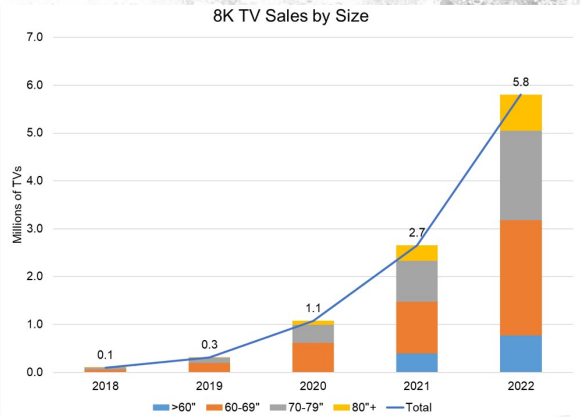
And There's Now An 8K Trade Group...

- **8K Association** announced at CES
- Goals:
  - Promoting 8K TVs and content to consumers & professionals
  - Educate consumers & professionals about the 8K ecosystem
  - Help secure native 8K content for members
  - Encourage service providers (especially OTT) to develop 8K programs
  - Facilitate communication within 8K ecosystem to help commercialization
  - Develop initial technical requirements for 8K input signals
  - Develop initial 8K TV categories and minimum specs for image quality

TCL Hisense AUO Panasonic SAMSUNG

The Seven-Year Itch

- **Are we <u>really</u> ready to move to 8K??**
  - We transitioned from SDTV to 720p TVs ≈ 7 years (1998-2005)
  - We transitioned from 720p to 1080p TVs ≈ 7 years (2005-2012)
  - It's been 6.5 years since the first Ultra HDTVs appeared – 4K TVs are cheap now
  - LCD panel makers are ramping up 8K glass production (next wave?)
  - Forecasts say **5.4 million 8K TVs will ship WW in 2022** with 60% of sales in China



Source: DSCC/Insight Media

Summary

- 8K TV is coming, whether you think it makes sense or not
- A lot of the development work has already been done with cameras and sensors (lenses for 8K cameras will come)
- Codecs can handle the load (JPEG XS, H.265, VVC)
- Display panel fabs gearing up for 8K production by 2020
- Display interfaces not fast enough – double up? Use DSC?
- 8K TVs have very good upscaling engines (Full HD, 4K)
- **Didn't buy a 4K TV yet? Might as well wait a bit longer!**

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