4K - UHDTV TECHNOLOGY

Ken Botelho
Senior Director of Engineering
NBC Sports Group – Golf Channel
HDTV & Beyond

HDTV "Main Stream" Production Tool Set

- 4K Cinema
- UHDTV 3.8K / 7.6K
- Frame Rate
- Dynamic-Range
- Resolution
- View Point
- 4K O.D.S
- HDR Imaging
- Color Space
- IP-Based CABLING
- Virtual Reality
- 3D Stereo
- Stereo
- Virtual Reality

HDTV & Beyond

NBCUniversal
What is 4K?
<table>
<thead>
<tr>
<th>Resolution</th>
<th>Pixels</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quad FHD</td>
<td>3840x2160</td>
<td>16:9</td>
</tr>
<tr>
<td>Full HD x4</td>
<td>2073600</td>
<td>Full HD x4</td>
</tr>
<tr>
<td>SDTV</td>
<td>720H x 480V</td>
<td>Most FPD (TV/Monitor) in QFHD format</td>
</tr>
<tr>
<td>2K Cinema</td>
<td>2048H x 1080V</td>
<td></td>
</tr>
<tr>
<td>Quad Full HD</td>
<td>3840x2160</td>
<td>(Home/Professional)</td>
</tr>
<tr>
<td>4K2K Cinema</td>
<td>4096H x 2160V</td>
<td></td>
</tr>
</tbody>
</table>

**What is 4K or Ultra HD?**

Both are called “4K”

- **QFHD**: for broadcasting
  - 3840x2160 [16:9]
  - Full HD x4
  - Most FPD (TV/Monitor) are in QFHD format

- **4K2K**: for Cinema
  - 4096x2160 [17:9]
  - Digital Cinema
  - Movie Theaters
  - Projectors

Both are called “4K”

**QFHD**: for broadcasting
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**4K2K**: for Cinema
- 4096x2160 [17:9]
- Digital Cinema
- Movie Theaters
- Projectors (Home/Professional)
Number of Pixels
4 Times Greater Than Full HD

Pixels become smaller, more resolute
What is “4K” resolution

HD vs. 4K Pixel Resolution

HD

4K (Quad FHD)

3840 × 2160

1920 × 1080
If you are too close to HD-1080P, it has visible pixels, jagged outlines, and screen door effect.

You can sit closer to 4K and enjoy a larger, more defined picture.
Wider and More immersive Viewing

Pictures fill up a greater level of consumer’s field of view

Full HD 1080

4K
Phased Intro of 4K UHDTV

Super Hi-Vision
7680 x 4320
4320p 100/120

4k Ultra HD TV
3840 x 2160
2160p 100/120

4K Ultra HD TV
2160p 50/60

Full HDTV
1920 x 1080
1080p

Bit Depth: 10, 12, 14 bit
Color Space: ITU-R BT 2020
Frame Rate: 100/120 FPS
High Dynamic Range: Yes
Audio: 5.1, 7.1 or 11.2 (object based)

Bit Depth: 10, 12, 14 bit (optional)
Color Space: Subset of ITU-R BT 2020 (Metadata)
High Dynamic Range: Yes
Frame Rate: 50/60 FPS
Audio: 5.1, 7.1 or 11.2 (object based)

Bit Depth: 10 bit, 12 bit (optional)
Color Space: ITU-R BT 709
High Dynamic Range: Optional
Frame Rate: 50/60 FPS
Subsampling: 4:2:0; 4:2:2 (preferred; 4:4:4 (optional)
Coding: HEVC Main 10
Audio: 5.1

2020+
2015/2016
2014/2015
Current 4K TV Technologies

Lens to Living Room

Acquisition

Production

Distribution

Exhibition

Display

4K Production Camera

HDCAM Studio Recorder

MASTER Storage Unit

Post Production

Distribution

Exhibition

Media Server

Home 4K Server

4K Ultra HD TV

4K Home Projector

4K Digital Cinema Projector

4K Home 4K Server

4K Ultra HD TV

4K Home Projector

4K Digital Cinema Projector

4K Ultra HD TV

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4K Ultra HD TV

4K Home Projector

4K Digital Cinema Projector
4K in the Home

4K Laptops

4K Boards for Computers

4K Connectivity

4K Devices for the Consumer World
Bandwidth for 4K (it’s all about bitrate)

1080i High Definition

UHD 4K
Bandwidth Connection Requirements

0.5 Megabits per second = Standard broadband connection speed

1.5 Megabits per second = Recommended broadband connection speed

3.0 Megabits per second = Recommended SD quality

5.0 Megabits per second = Recommended for HD quality

25 Megabits per second = Recommended for Ultra HD 4K
• “No one has really come up with a 4K distribution standard for the home yet,”

• The size of a 4K movie depends on a number of variables, including the 4K standard used, the bit-rate and the type of compression employed.

• Compression is unavoidable and is done using various algorithms that, for example, identify scenes with static backgrounds that needn’t be rendered separately for each frame and result in smaller files without a discernible loss in quality.

• The difference between good and poor quality video is often the result of the compression algorithm used.
Bitrate Requirements for Production

- Uncompressed video bitrate of True 4K UHDTV equates to approximately 12 gigabits per second
- Uncompressed 720p and 1080i HDTV requires 1.5 Gbps
- Full” HDTV (1080p) requires 3 Gbps.
- There is already, what is known as a “bandwidth crunch” with some current HDTV service providers and so the need for four to eight times the bandwidth over HDTV to deliver uncompressed 4K UHDTV services is problematic.
- The highest bitrate standardized single-link professional video interface available today is 3Gbps and four of these are needed to be linked together in order to carry a single live uncompressed True 4K UHDTV signal.
Examples of Production Advantages utilizing 4K in Sports Applications
400% from 4K

800%
800% from 4K
800% from HD
Creating a stitched full pitch view by dual 4K cameras.
Camera Position
4K Stitching Shooting
Stitched view

- Maximum 8K x 2K stitched and seamless panoramic images are produced from two fixed 4K Cameras through real-time signal processing.
- As the cameras capture the entire field, the operation, allows replay playback of plays that may be missed by conventional cameras.

HD Cut-out

- Any portion of the stitched image can be clipped to provide a HD cut out image.
- Up to 3 x HD cutout from the stitched view is available simultaneously.
This challenge has been met by the development of the H.265/HEVC (High Efficiency Video Coding) codec.

- H.265 is the emerging successor to H.264.
- Provides twice the compression efficiency of H.264:
  - Full HD 1920x1080p streams: ~6 Mbps
  - 4K streams: ~25 Mbps
  - 8K streams: ~100 Mbps
- However, H.265 cannot provide a Digital Cinema experience:
  - H.265 is “lossy” and cannot provide the same perfect quality as JPEG2000’s “lossless” approach, but the differences may not matter to the majority of users.
  - H.265 is not a DCI-compliant codec.
- The Solution to HEVC loss is possibly XAVC.
4K/8K Challenge: IP Network Capacity

- 4K/8K streaming requires efficiently engineered fibre optic networks that provide at least 25 Mbps per user

- Fibre-To-The networks are deployed but not yet pervasive
  - Existing networks usually have sufficient bandwidth to deliver 4K H.265 (25 Mbps) streams to each user – but implementations vary widely
  - Demand for increased bandwidth driven by explosive growth of Internet video is leading to new investments

- Petabit fibre optic networks on the horizon
  - In August 2013 a group led by NTT transmitted data at 409 terabits/second in both directions over a 450 km section of multicore optical fibre – 818 Tbps in total

- 5G Mobile Networks by 2020
  - 1 Gbps at distances of up to 2 kilometres
4K IP Production

• The infrastructure to support 4K workflows and 4K content delivery is evolving.

• TV manufacturers are creating relationships with content producers and OTT content providers (e.g., Comcast, Charter, Time Warner, Netflix, Amazon etc.), embedding decoders for HEVC, XAVC and VP9, and adopting HDMI 2.0—all in anticipation of a broader range of available 4K content in 2016.

• It is not expected nor is it necessary to upgrade or replace an entire operational environment when making the move to 4K. It is practical to pursue 4K workflows in stages, creating one 4K-ready workflow environment that does not cause disruption to existing operations.

• 4K presents a great opportunity at the creative level. It also presents considerable challenges, but solutions exist to overcome these challenges.
As post-production and broadcast facilities acquire 4K footage, they will need a storage infrastructure that will enable them to work with this newly acquired footage and keep up with the demand for more 4K content.

4K is here to stay, with 8K and 16K on the horizon. It is an inevitable progression as consumers constantly crave a more immersive entertainment experience, surpassing the quality of high definition content, regardless of consumption channel or device.