

# User and Environment - Aware Media Delivery

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# Evolution of Video Technologies

## Key Milestones:

### THE PAST:

Invention of camera, still image photography, color reproduction, film, moving pictures

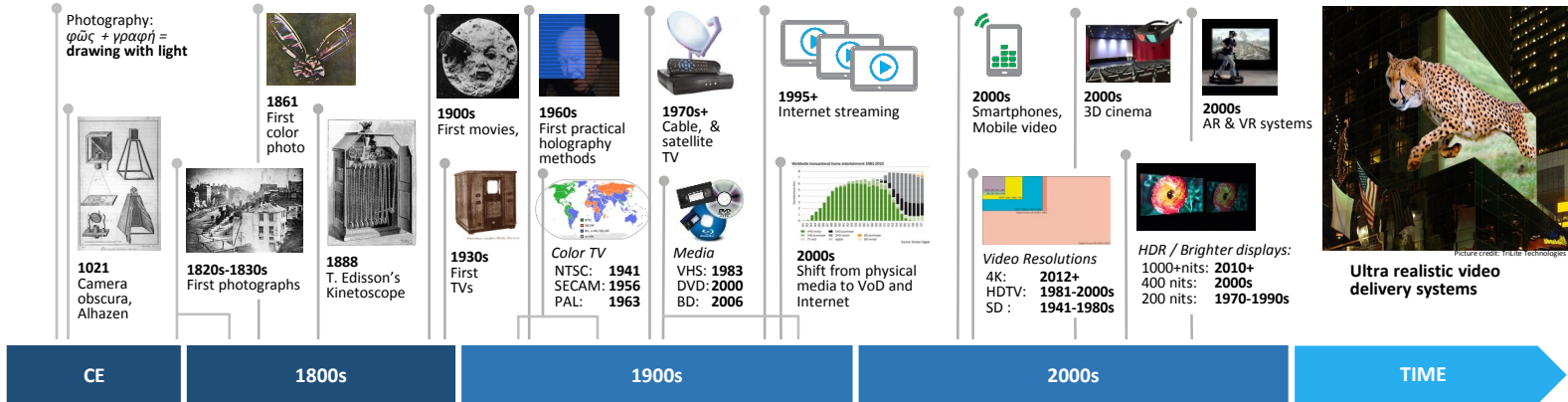
### THE PRESENT:

New delivery methods: TV, recordable media, digital compressed formats, Internet streaming, mobile.

Increasing degree of realism: immersive video, 3D (holography, stereoscopic rendering, etc.)

### THE FUTURE:

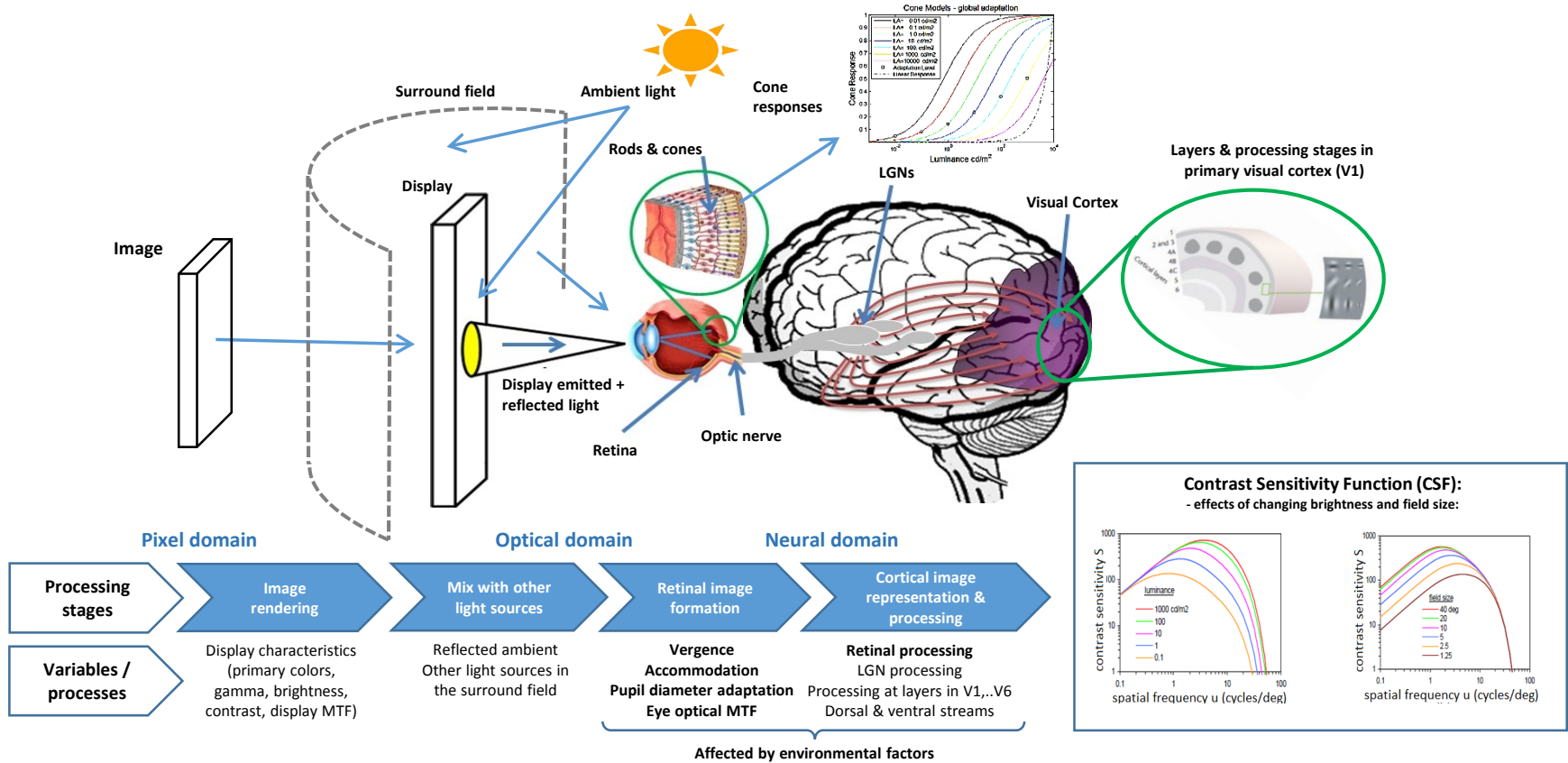
Recording & reproduction systems making rendered video undistinguishable from reality.



## Key Themes/Directions:

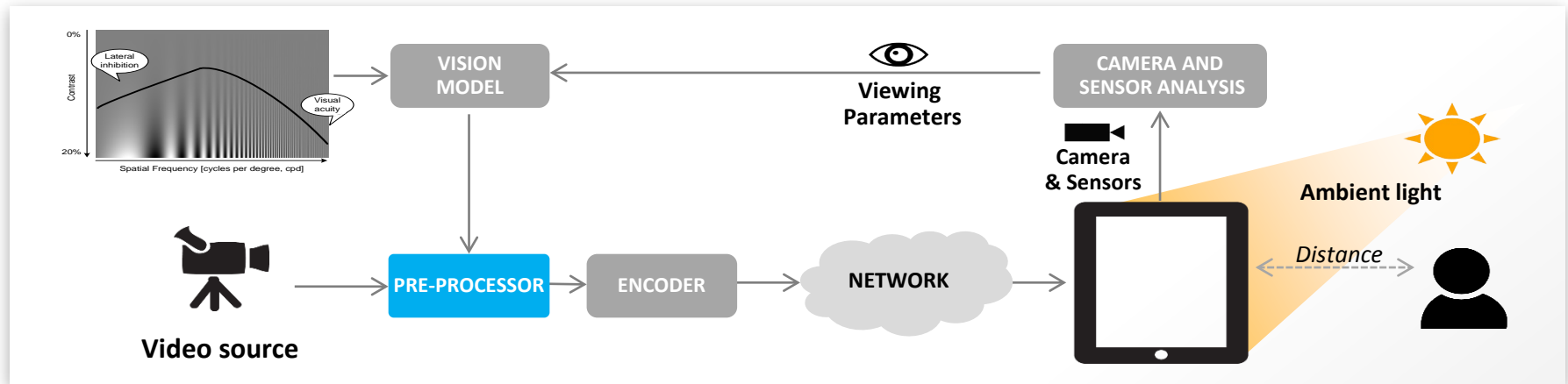
- Increasing degree of realism
  - *Ultimate video/media reproduction = undistinguishable from reality*
- Improving convenience of access
  - *Anywhere, anytime, in any environment*

# Why Environment Matters?



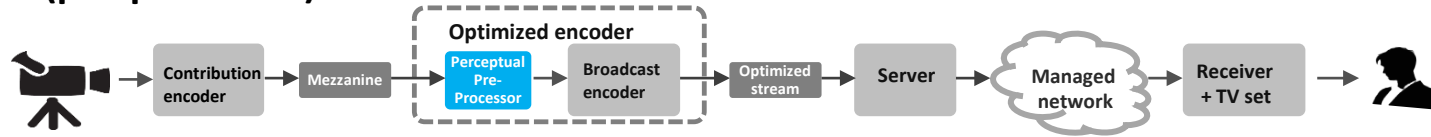
# Targeting Different Viewing Environments

- Traditionally, video encodings are done without taking viewing environment into account
- But, **what if:**
  - we obtain information about viewing environment at user's end, and then
  - apply a **perceptual pre-processing step** to retarget video to such an environment?
- This can be used for:
  - **Making videos look better** (more natural/real) in a given reproduction environment and/or
  - **Improving compression** – remove parts of visual content that are not visible



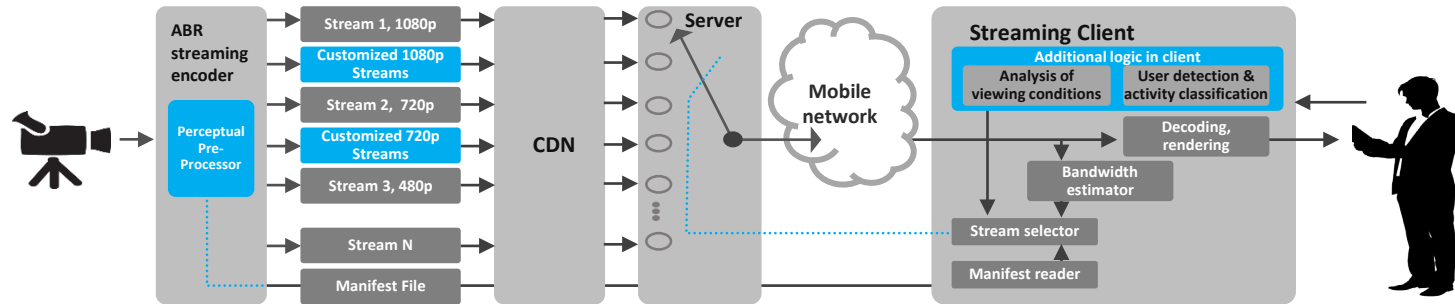
# Deployment Scenarios

## Static (pre-processor)



- Perceptual pre-processor is used to optimize delivery to typical reproduction settings in a living room.
- Geared towards IPTV/cable/broadcast deployments

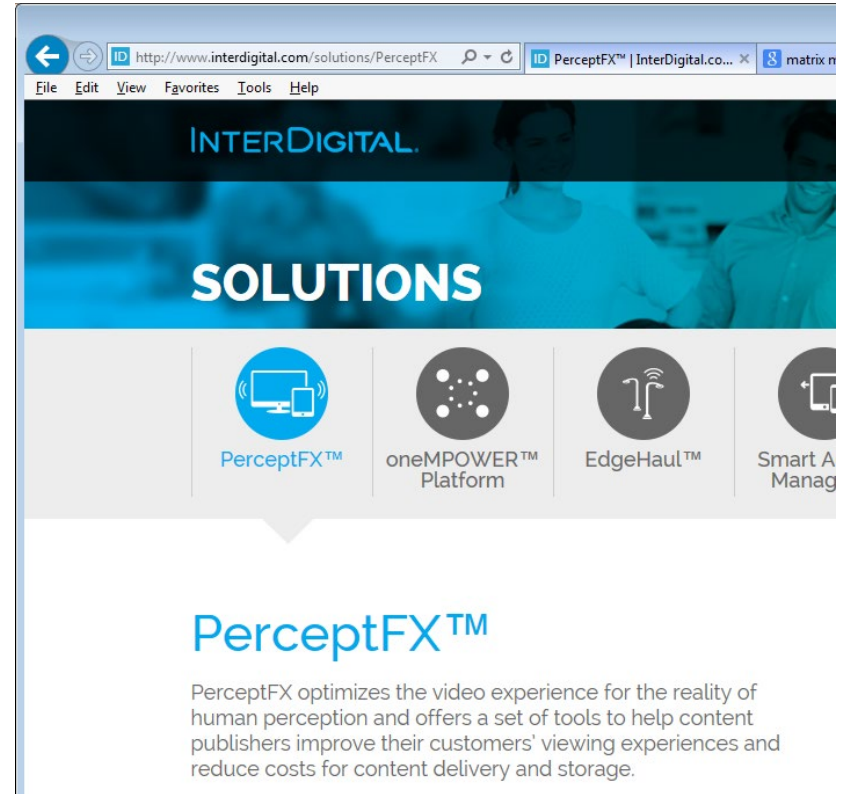
## Dynamic (pre-processor + adaptive streaming)



- Perceptual pre-processor is used to generate additional streams, customized to different possible poses of a viewer (viewing distances where device is held in hands, on lap, or placed on a stand), ambient light conditions, etc.
- Streaming client uses estimated viewing conditions as additional parameters for stream selection
- Geared towards ABR streaming deployments

# PerceptFX™ – Perceptual Pre-Processor from InterDigital

- Product of InterDigital Communications, Inc.
- Commercially available since Aug 2015
- Available as:
  - File-based video processing tool
  - Plugin for video post-production and encoding workflows
  - SDK for integration with video encoding products
- Enables customization of encodings to several types of reproduction settings:
  - At home / TV viewing
  - Viewing on mobile devices
    - Smartphones, 7", 10" tablets, etc.
  - BT.500 expert viewing environment, etc.
- Works with current codecs and formats
  - H.264, HEVC, VP9
  - SD, HD, Ultra-HD
  - HDR (BT.2020, 10-16 bits)
- Can be used for:
  - Reducing bitrates of HD or Ultra-HD encodings or
  - Improving quality at same rates

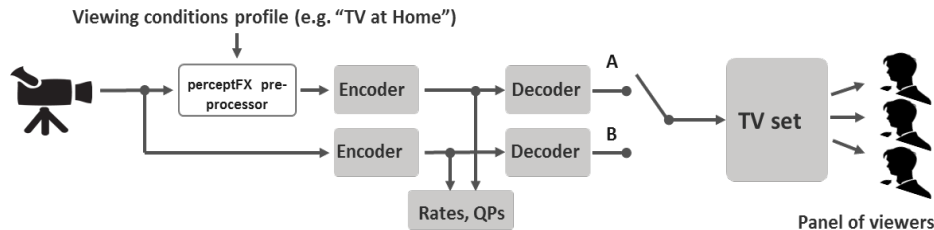


The screenshot shows a web browser displaying the InterDigital website. The URL in the address bar is <http://www.interdigital.com/solutions/PerceptFX>. The page features the InterDigital logo at the top, followed by a large blue banner with the word "SOLUTIONS" in white. Below the banner, there are four circular icons representing different solutions: PerceptFX™ (a blue circle with a white icon of a smartphone and a tablet), oneMPOWER™ Platform (a grey circle with a white icon of a network of dots), EdgeHaul™ (a grey circle with a white icon of a signal tower), and Smart A Manag (a grey circle with a white icon of a smartphone). Below these icons, the text "PerceptFX™" is displayed in a large blue font, followed by a paragraph of text: "PerceptFX optimizes the video experience for the reality of human perception and offers a set of tools to help content publishers improve their customers' viewing experiences and reduce costs for content delivery and storage."

# PerceptFX™ benefits – Ultra-HD use case

## Example evaluation:

- Content: 2160p50, EBU test sequences
- Codec:
  - HEVC Main10 (x265 1.7)
  - constraints: 1sec GOP, 1sec VBV buffer, CBR
  - target bitrates: 15Mbps, 10Mbps, perceptFX-targets
- MOS test:
  - ITU-R BT.500, double stimulus comparison scale test
  - viewing distance = 5 x TV height, ambient = 100 lux
  - 20 viewers, 5 experts + 15 non-experts

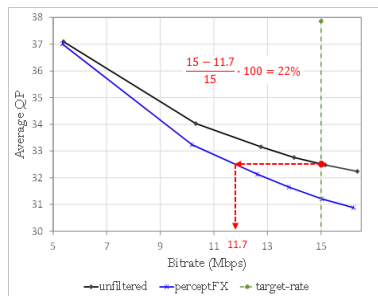


## MOS test results:

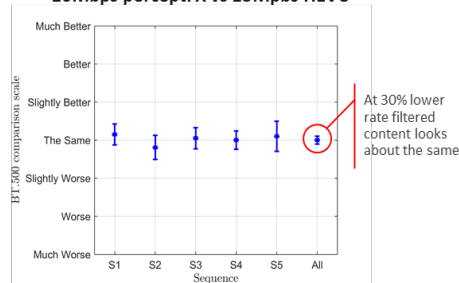
### Rate savings w.r.t. 15Mbps HEVC target

Seq	Type	Average QP @15M	PerceptFX savings
S1	Difficult	39.96	15.21 %
S2	Difficult	41.47	17.59 %
S3	Easy	32.5	35.38 %
S4	Easy	32.39	63.75 %
S5	Difficult	41.5	20.06 %
<b>Average:</b>		37.56	<b>30.40 %</b>

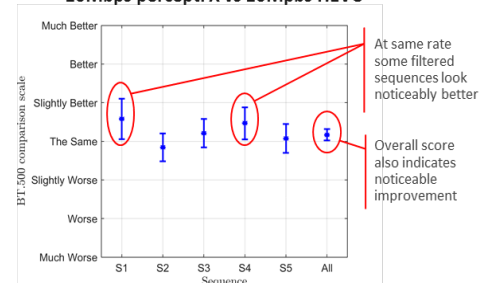
### Rate savings computation



### 10Mbps perceptFX vs 15Mbps HEVC



### 10Mbps perceptFX vs 10Mbps HEVC



# Conclusions & Outlook

- Environment-aware / perceptual processing approach works
  - It works well with today's latest codecs and video formats (H.264, HEVC, HD, UHD)
- Future trends:
  - **Ultra-HD / HDR:** higher resolutions, higher frame-rates, and bit depths – make video streams more redundant, resulting in a higher potential for savings using environment-aware / perceptual techniques.
  - **Mobile streaming:** environment/viewing conditions change dynamically as user moves
    - Dynamic tracking and adaptation to such changes is offering an additional gain potential
    - Realizable by adding user/environment adaptation logic in DASH streaming clients
  - **5G / ultra low-delay networks:** may enable designs of real-time perceptual systems:
    - Gaze-point tracking + perceptual adaptation (foveation) offers **an enormous (2-4x) rate savings potential** compared to conventional systems.
    - Head/eye tracking can also be used for dynamic changes of views/perspectives – enabling **realistic glasses-free 3D rendering on 2D displays.**



# Questions?

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