



Producing & Distributing Live VR Events at the Highest Quality

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Speakers



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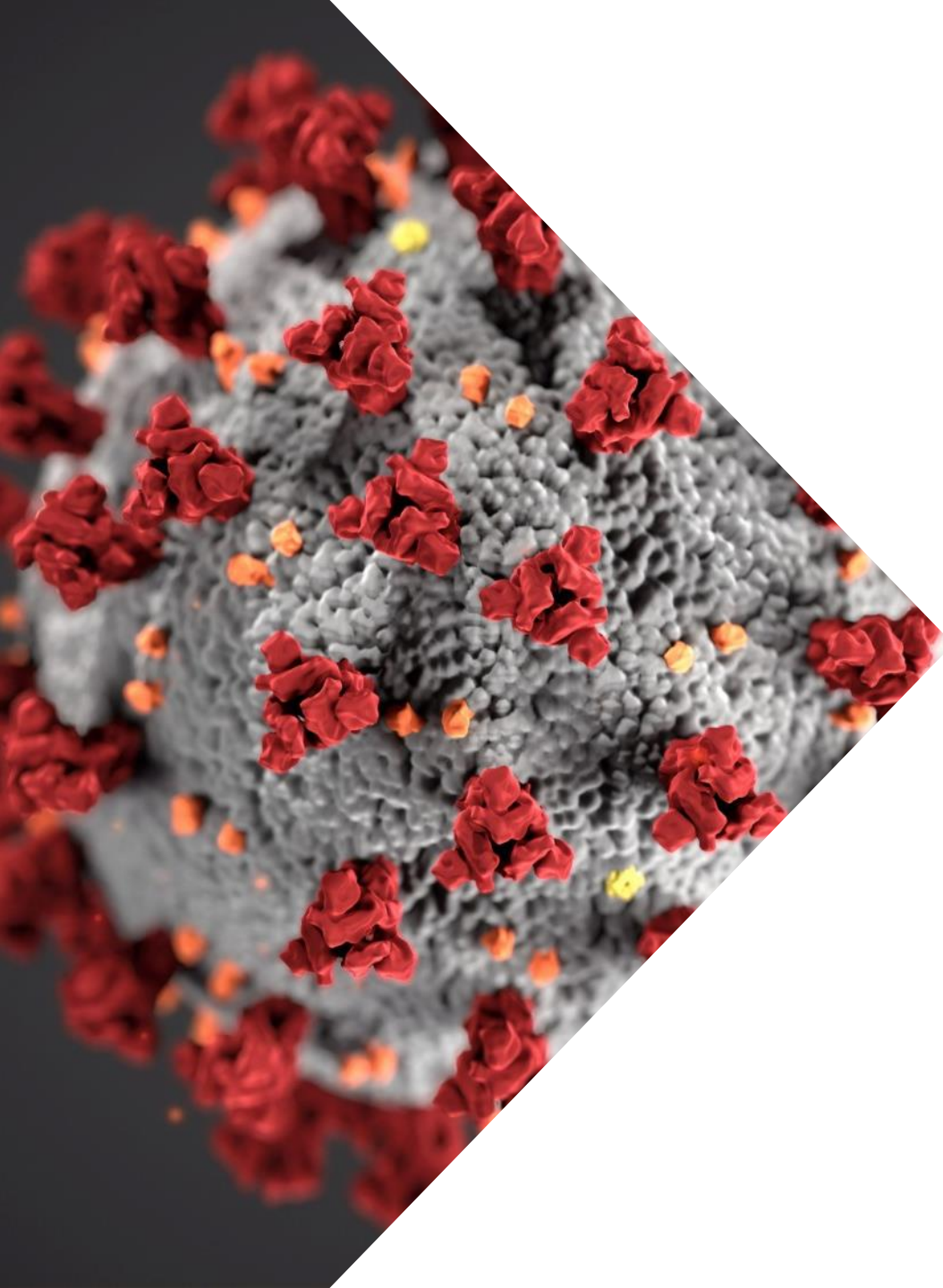
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Rob Koenen

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May you live in interesting times ...

- Streaming instead of visiting
- Virtual presence
- Co-viewing
- Sky launched **sky worlds** end 2020

Mission Statement

To **immerse** our customers in **innovative** & **transformative**, industry defining **experiences**, connecting them to the **connect** they love across the **next-generation** of devices..

①

Original Content

②

Live Events

③

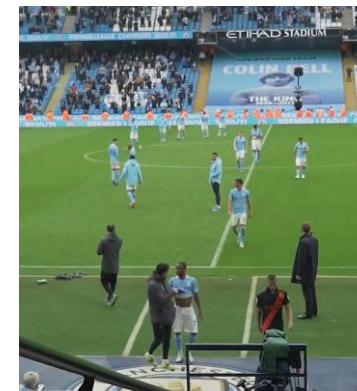
Social Media

④

Gamification

Bringing customers experiences they'll truly value in XR, with audio-visual excellence

Bringing truly innovative XR magic to environmental, immersive and social experiences



Current Content Experiences

Sky Immersive are currently working with Sky Sports to generate live content experiences across a number of sports:



We provide all Sky Sports Linear Channels:



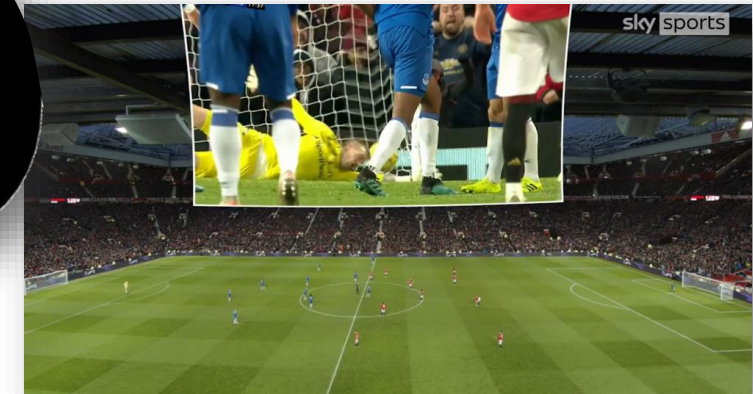
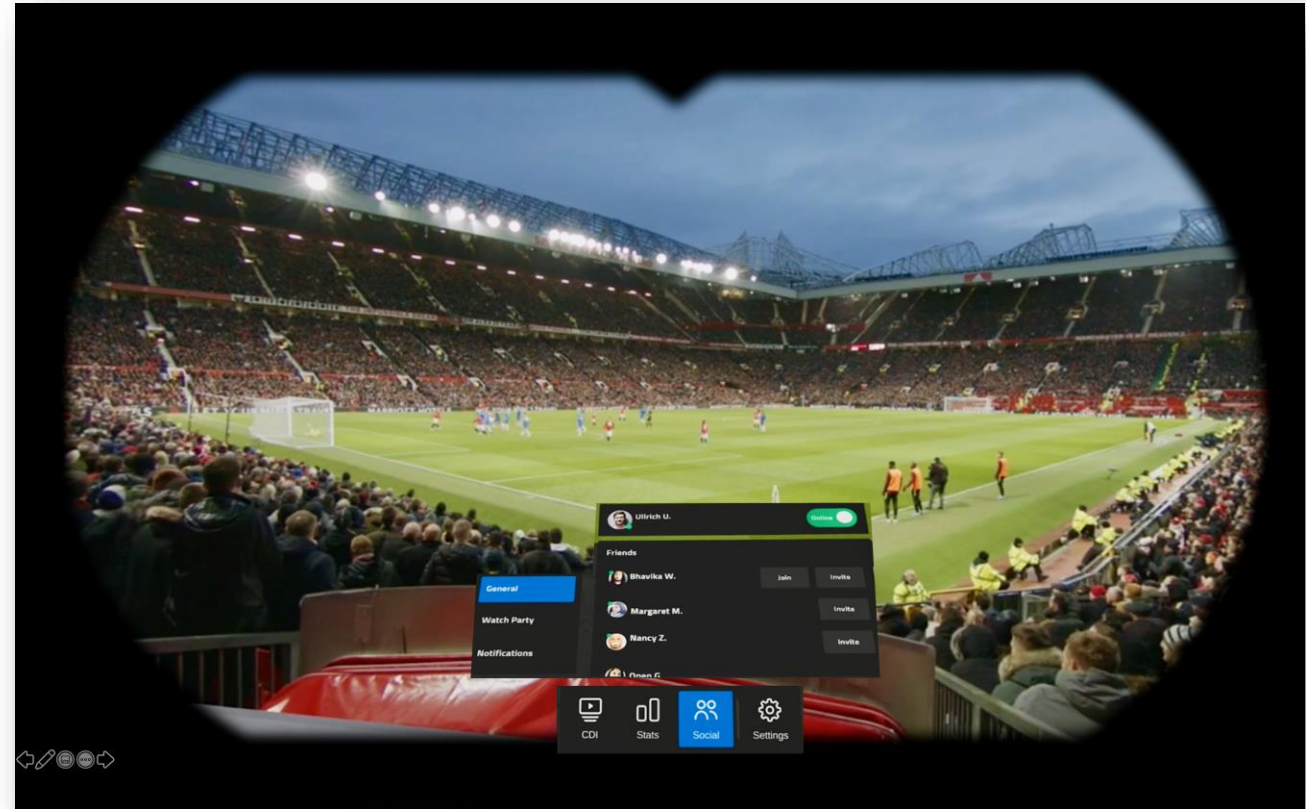
We exclusively stream all Sky Original Movies & Sky Arts into a custom build VR cinema



Sky Worlds Video (Clip 2)

User Experience

- Focused on Headset
- Virtual Skybox
 - Jumbotron: Broadcast feed with commentary
- Enjoy the game with friends
 - Synchronised game feed
 - Avatars and voice chat
- Interface to access:
 - Game and player information; statistics
 - Camera selection
 - Social viewing



Sky VR: From Cam to Fan using Tiled Streaming



Production



Contribution



Transcoding



Origin



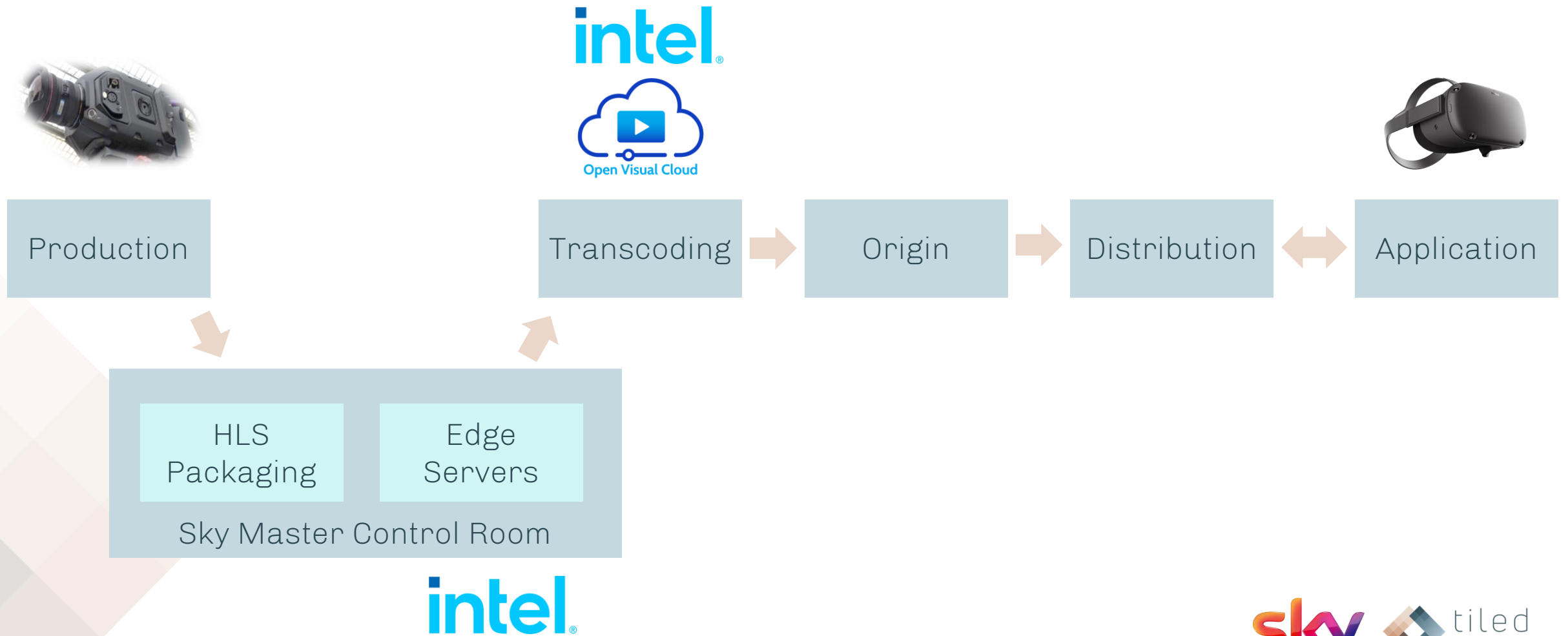
Distribution



Application



How Intel Enables the Experience



Production



Production



Contribution



Transcoding



Origin



Distribution



Application



Camera Choice

- Options

- 360° stitched
- 180° stitched
- Fisheye
- Monoscopic vs. stereoscopic

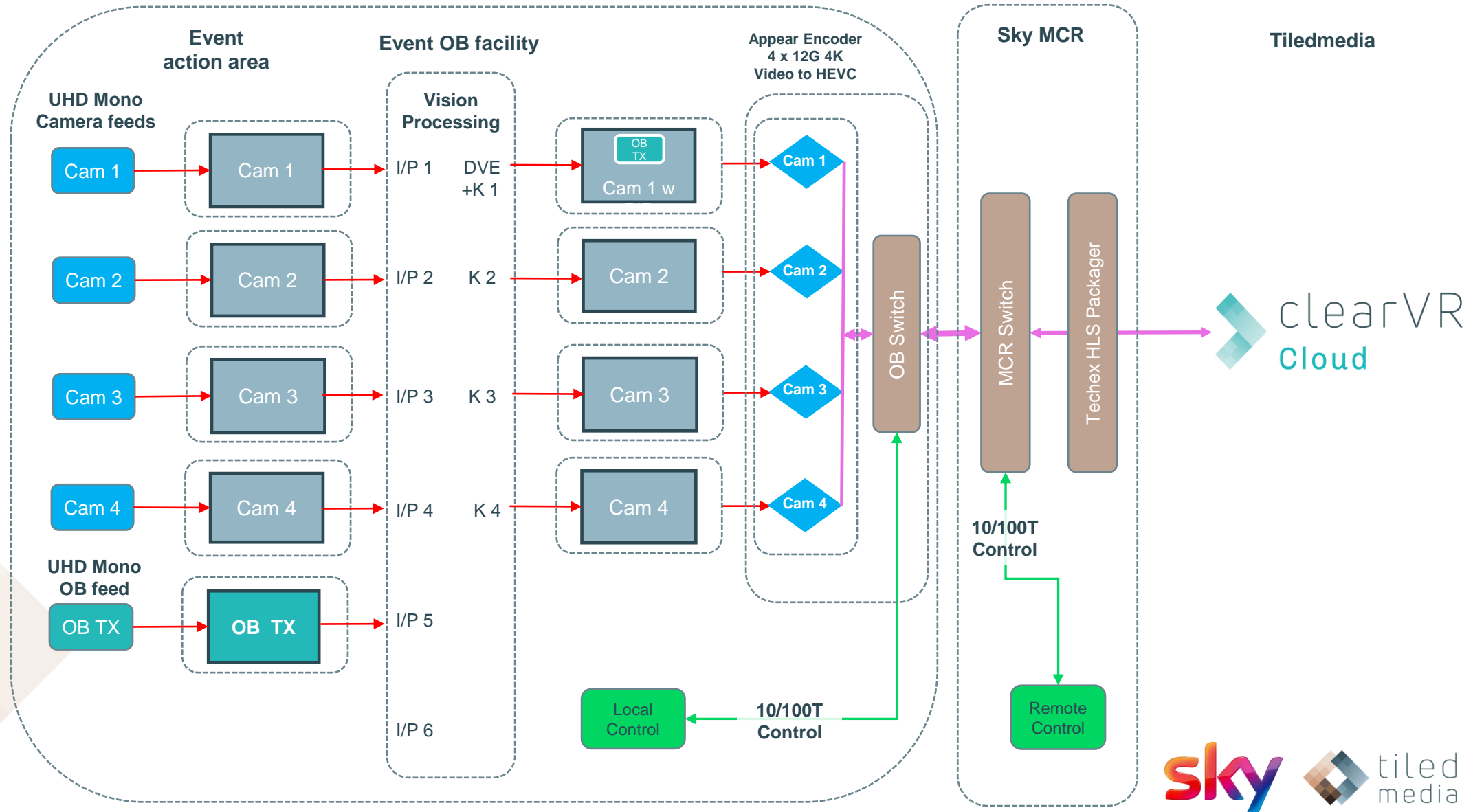
- Choice

- Fisheye, BMD URSA Mini 4.6K with a Canon 8-15mm lens
- Equivalent resolution ~8k ERP (Equirectangular Projection)
- Focal length 8 – 11.5 mm.



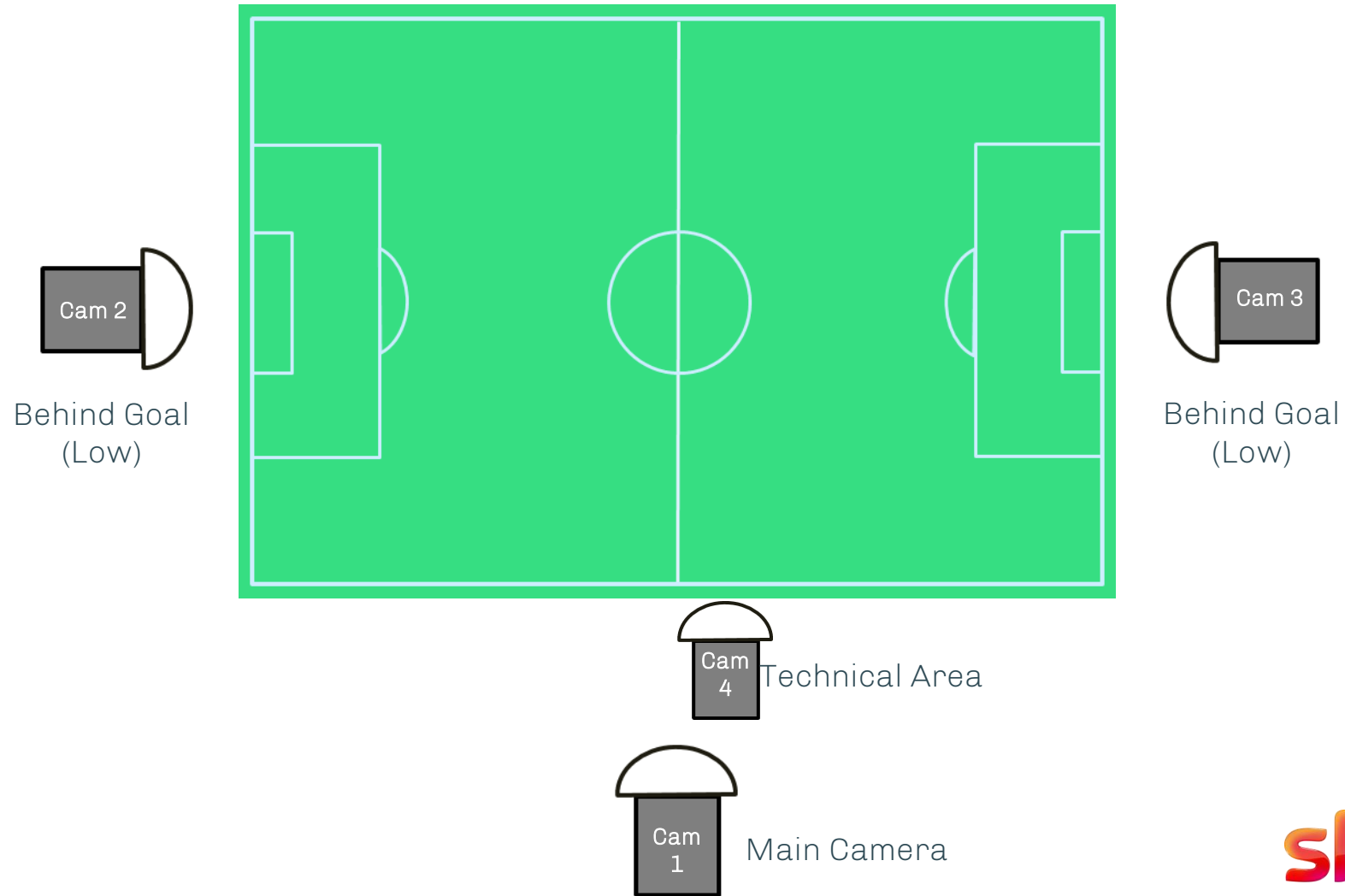


Sky VR Live Immersive Production Infrastructure

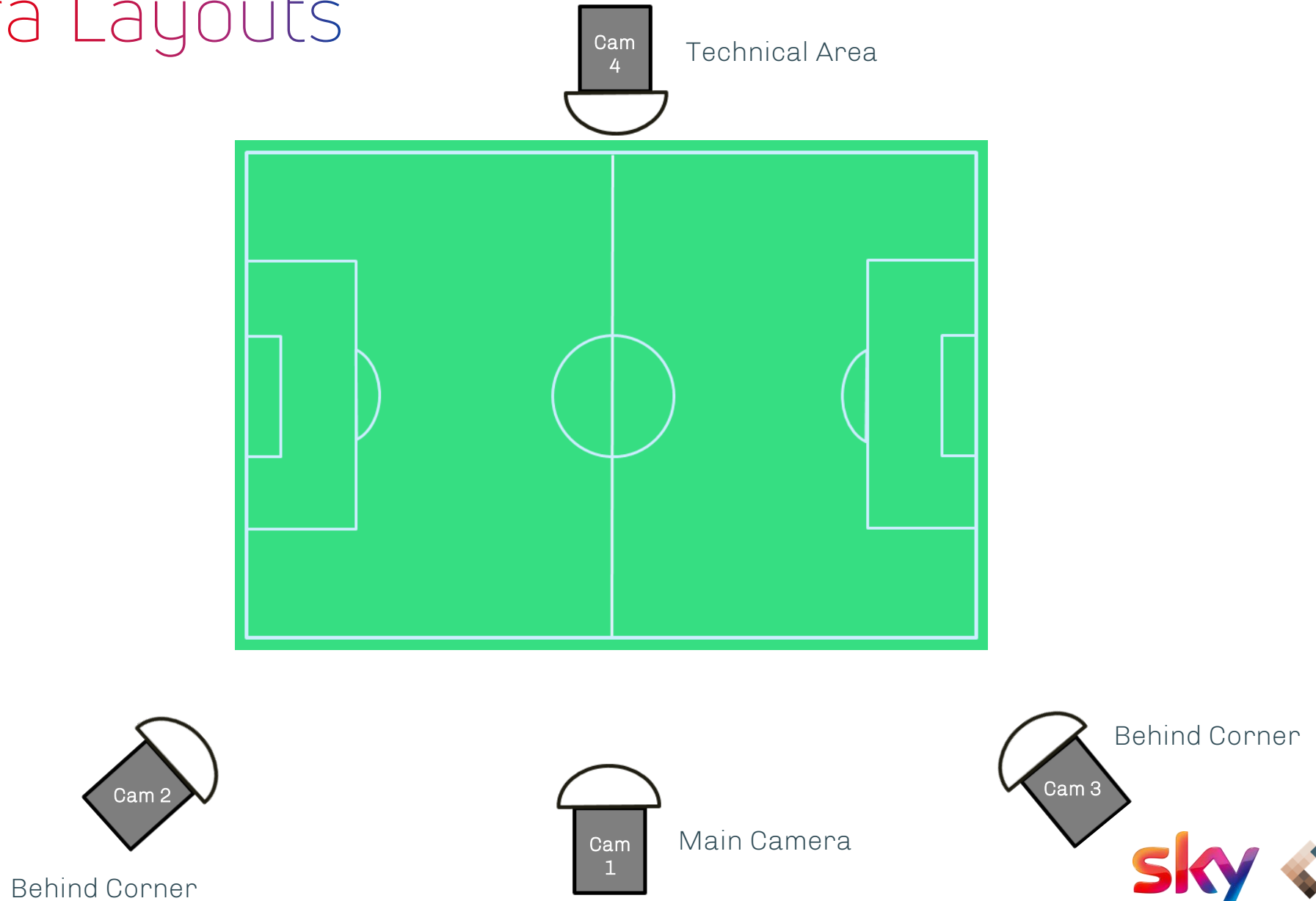


Camera Layouts

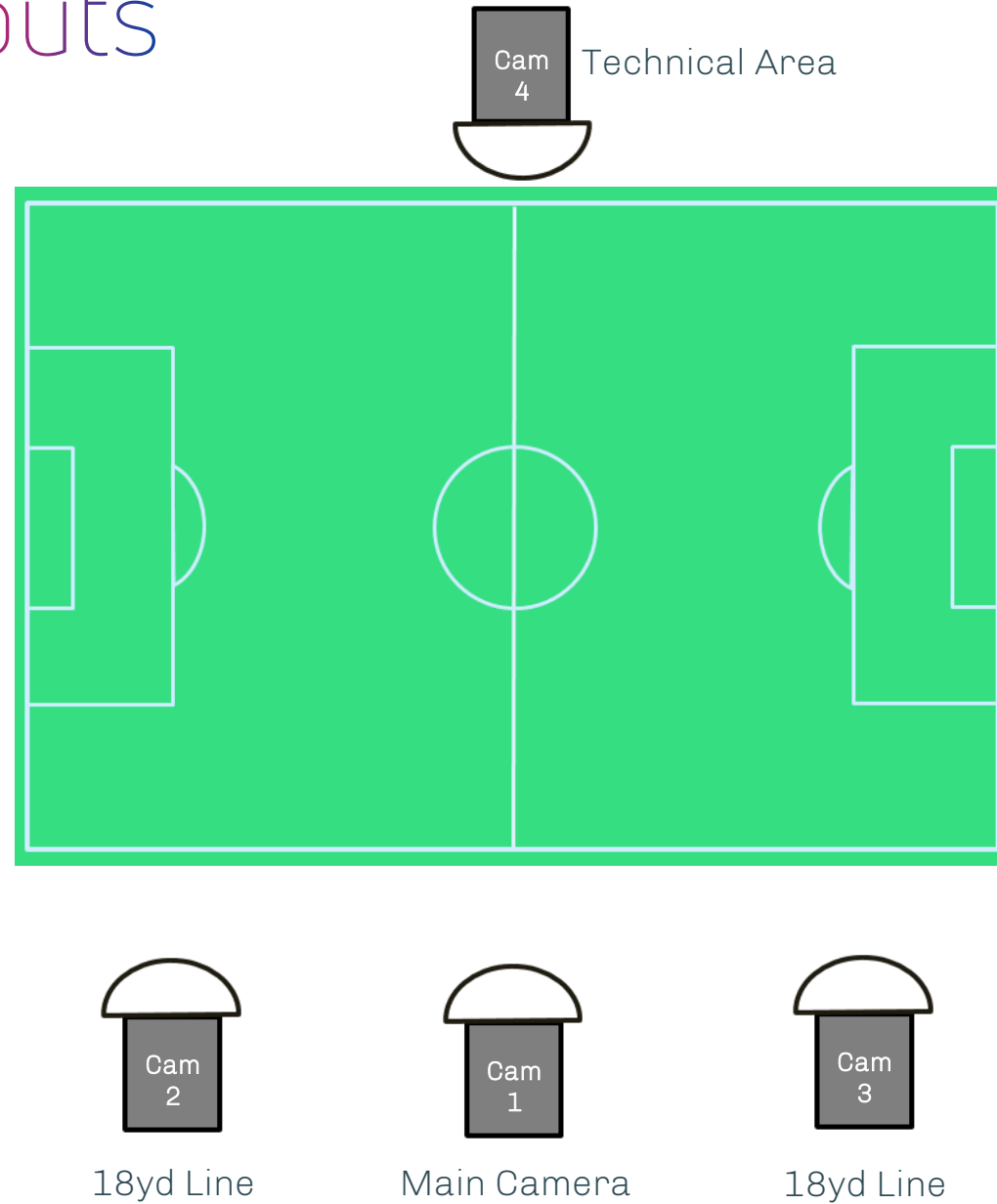
Camera Layouts



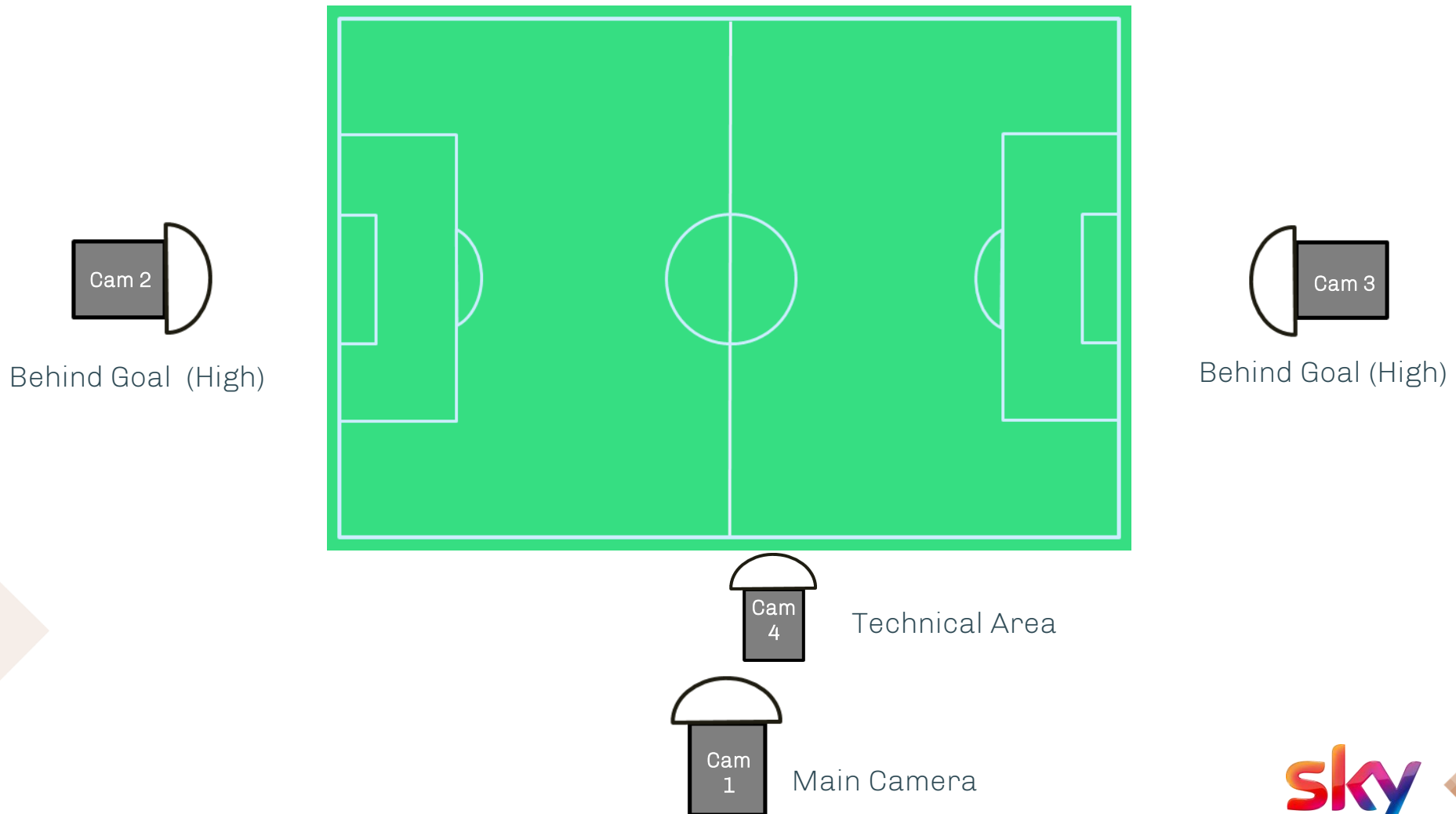
Camera Layouts



Camera Layouts

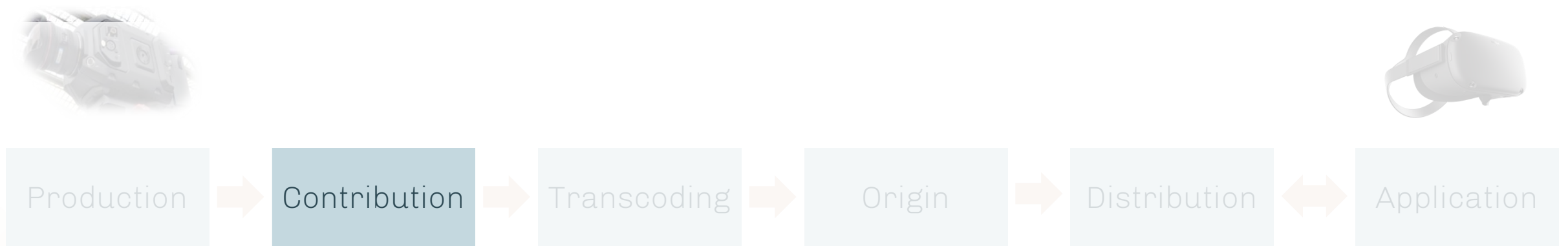


Camera Layouts



Contribution

Contribution



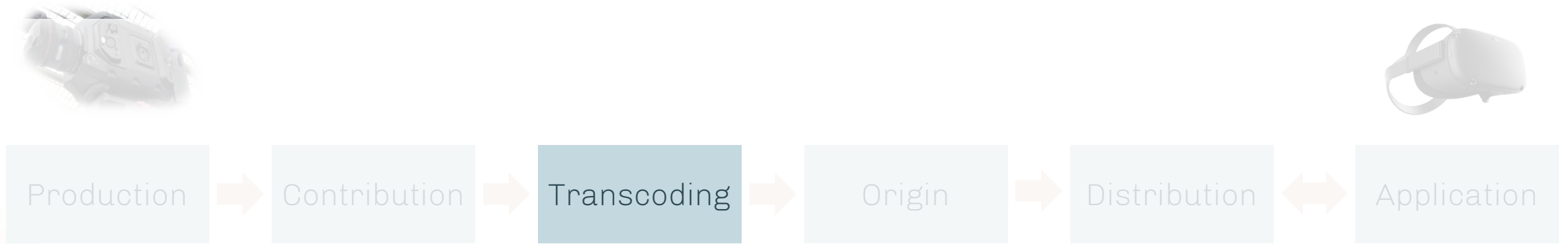
Contribution

- HW 4K HEVC encoders @ 70 Mbit/s
- HLS packager with EXT-X-PROGRAM-DATE-TIME flag in HLS manifest set by NTP-synced source to allow camera switching by user
- HLS pull by ClearVR Cloud for error-free transmission
- VPN and firewall for end-to-end security



Transcoding

Transcoding for Tiled Streaming





Take a VR Video

viewport

You only see about 1/8 of the total picture

viewport

Cut the video in tiles

viewport

Determine which tiles are in view



Only stream the tiles in the viewport



Also stream low-resolution background

The image is a 360-degree panoramic view of a lake, seen from inside a wooden pavilion. The view is divided into a grid of 12 columns and 8 rows. A central rectangular area, labeled 'viewport', is highlighted with a white border. This viewport is further divided into four colored quadrants: red on the left, green on the right, and two shades of blue/purple at the top and bottom. The background image shows a calm lake, a sandy beach, and a line of trees under a clear sky. The wooden structure of the pavilion is visible in the foreground and sides.

viewport

When you turn your head ...



Tiling works better with a Cubemap

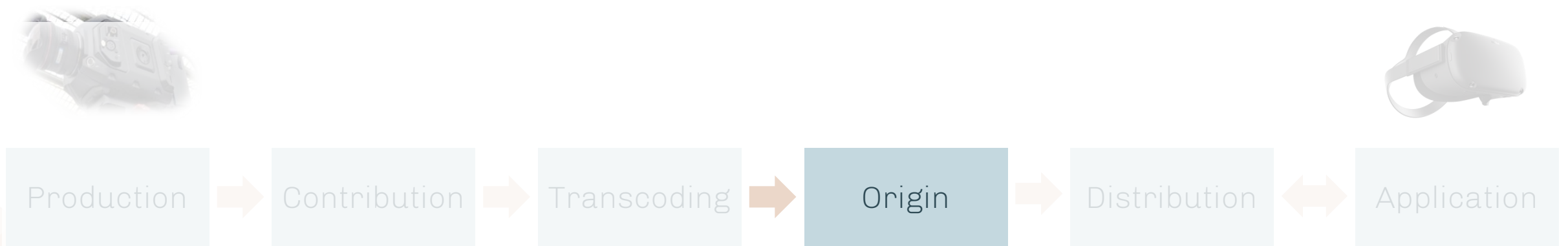
Transcoding details

- Massively parallel encoding of individual tiles using independent encoders
 - Uses Intel's Open-Source SVT-HEVC, adapted and modified specifically for tiled distribution
 - Packaged as MP4 files
- A few 100s of Intel Xeon cores per camera + a few GPUs for projection
- Background and foreground both have multiple GOP representations for best balance between switching speed, quality, and bitrate
- Total bitrate for all tiles : between 120 and 200 Mbit/s per camera feed depending on exact resolution and recording angle (180, 360)



Contribution to Origin

Contribution to Origin

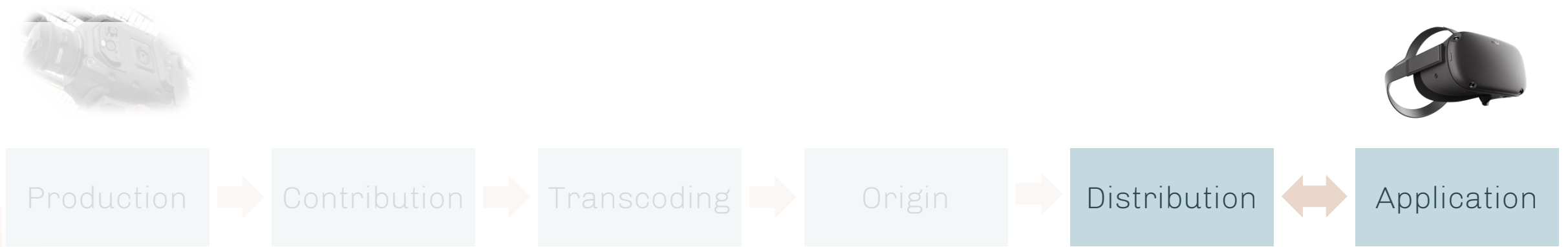


Contribution to Origin

- Transcoded content ingested across 6 Akamai MSL ingest servers that each go up to ~45 Mbit/s
- For a total of 24 ingests covering 4 camera feeds

Distribution

Distribution



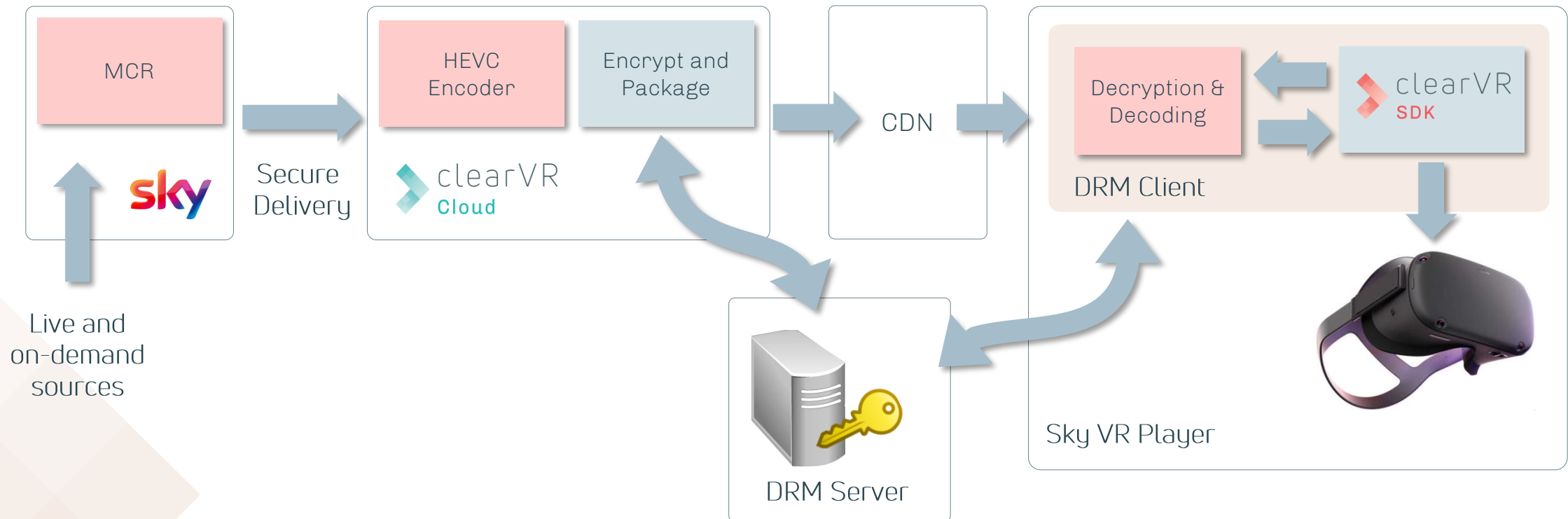
Distribution

- *Scalable*: HTTP/2 retrieval using multipart byterange requests
- *Flexible*: Smart Client knows device, viewport, network and has the logic to determine which tiles to retrieve at what quality
- *Robust*: Client assesses at last possible moment which tiles have arrived, and sends only those to decoder
- Rewriting into a single bitstream, this requires only one (hardware) decoder
- Adopted in MPEG OMAF (Omnidirectional Media Format) v.2 “Advanced Tiling Profile”, a.k.a. “Late Binding”

Distribution

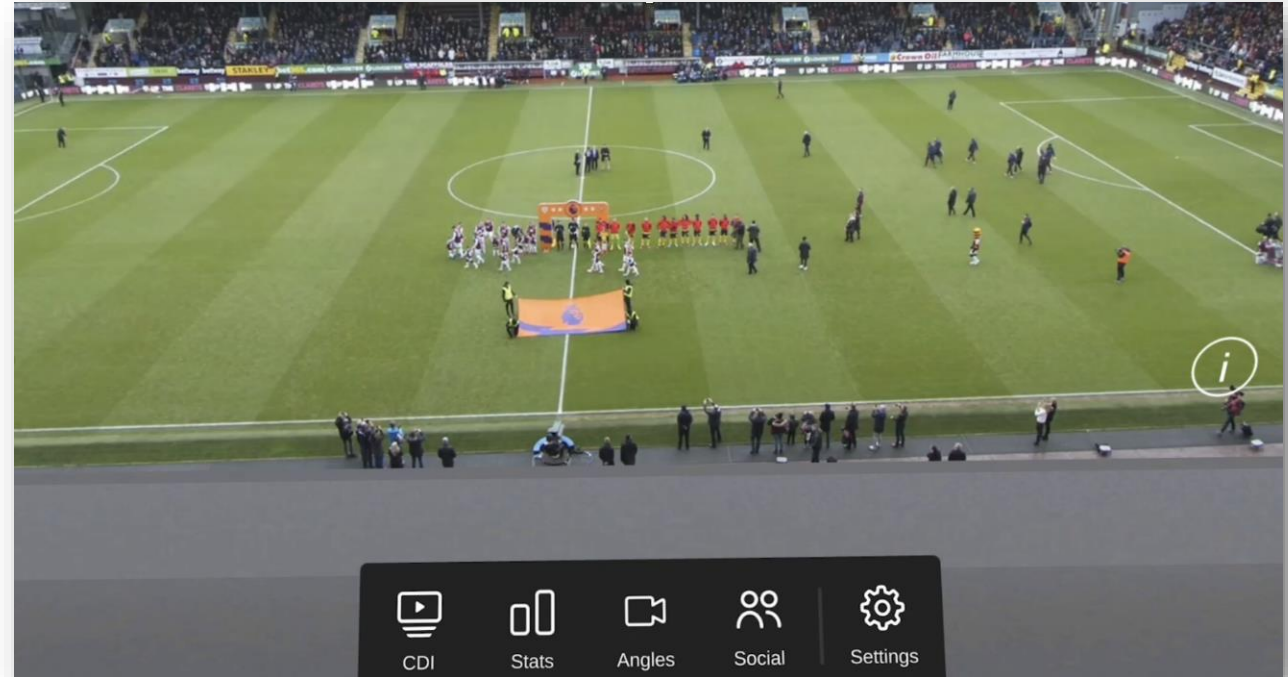
- User bitrate 7-15 Mbit/s,
 - Depends on camera switching and head motion
- Latencies:
 - Tile switching latency (“motion-to-high-resolution”) 50-100 msec.
 - Camera switching latency a few 100 msec.
 - End-to-end latency ~40 sec.

End-to-End Security



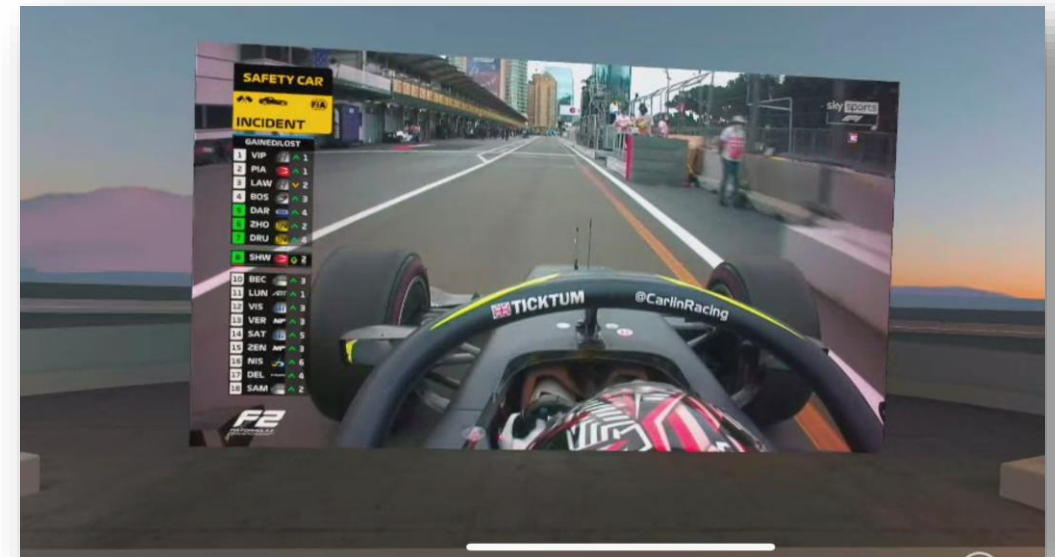
Application by Cosm and Sky

- Unity-based app for Quest 1 & 2
- Access to 12 linear TV channels, live matches, and highlights
- Live Stats, Players, and Line-ups via OPTA feeds
- Join friends in Social Rooms with voice Chat
- Users Viewing in Sync



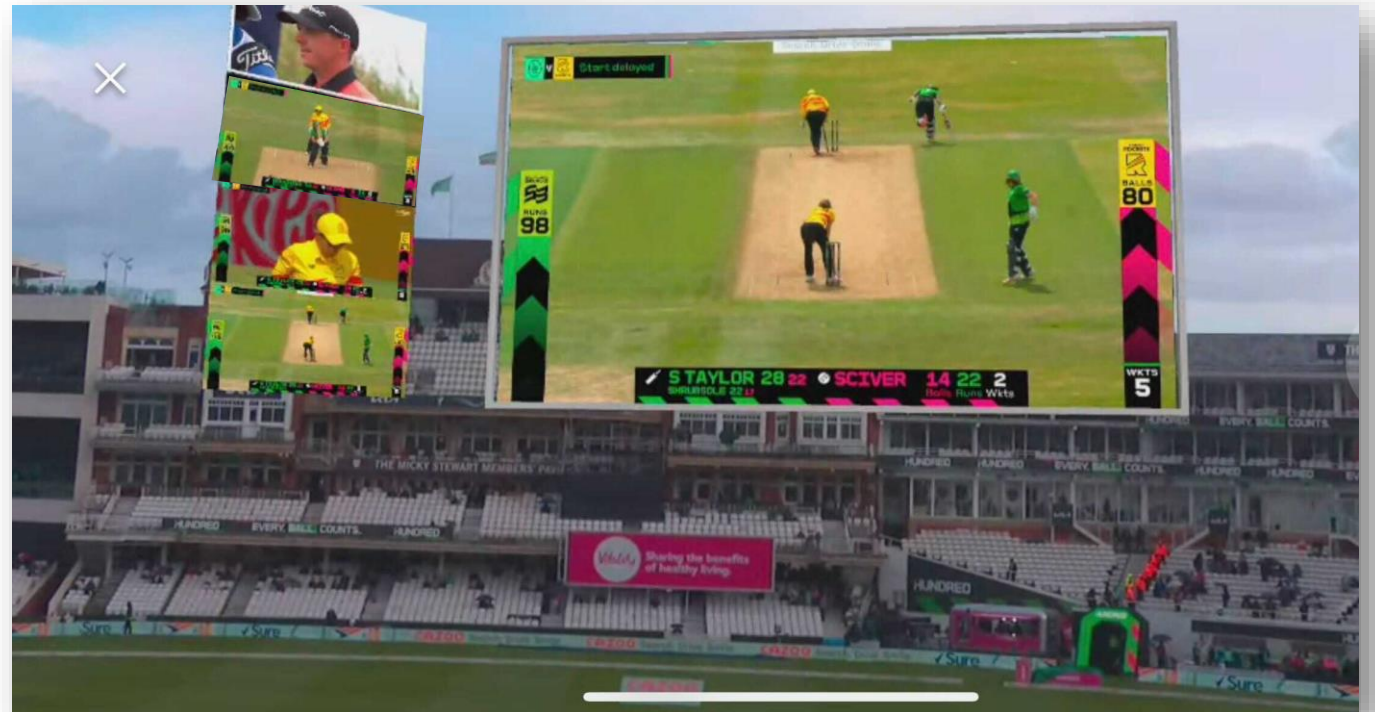
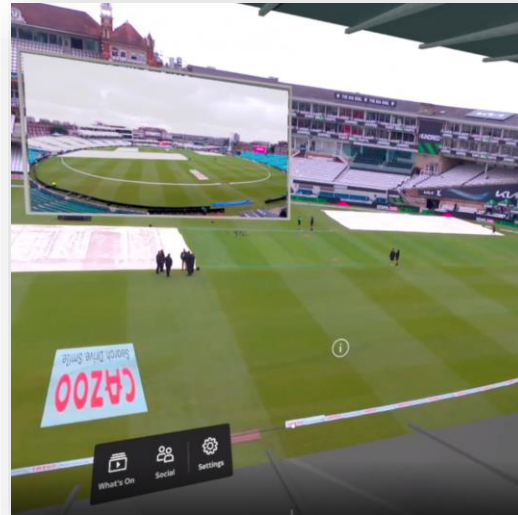
What's More?

- Netball: same experience as football
- Extreme-E: multi-feed in headset
- Sky TV: 12 channels of linear TV in headset Sports and Sky Arts
- Movie night: scheduled movies in a virtual theater



What's Next?

- Mosaic experience with single immersive view and user-selectable Jumbotron
- Cricket and Football
- Full integration with broadcast production
- Looking to scale to many more cameras



"Mosaic" Video (Clip 2)

Speakers



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