Toward the realization of 6 DoF standards

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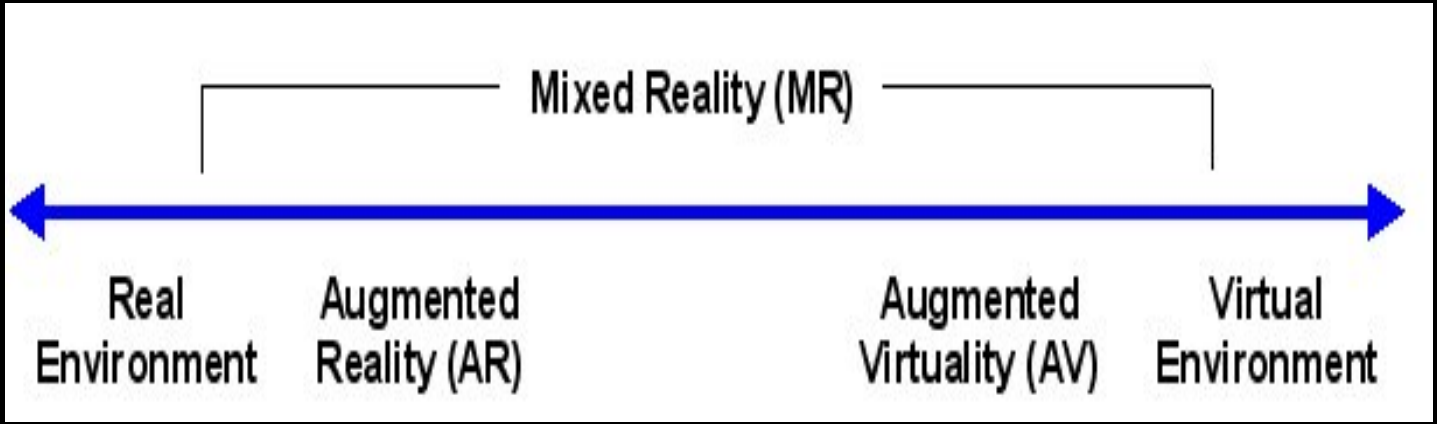
Understanding 6 DoF services (at scale)

Synthetic, natural, or combination of data



- Continuous scale of ”reality” by Paul Milgram*
- A media format that can support the entire scale is essential for flexibility of services and ease of interchange

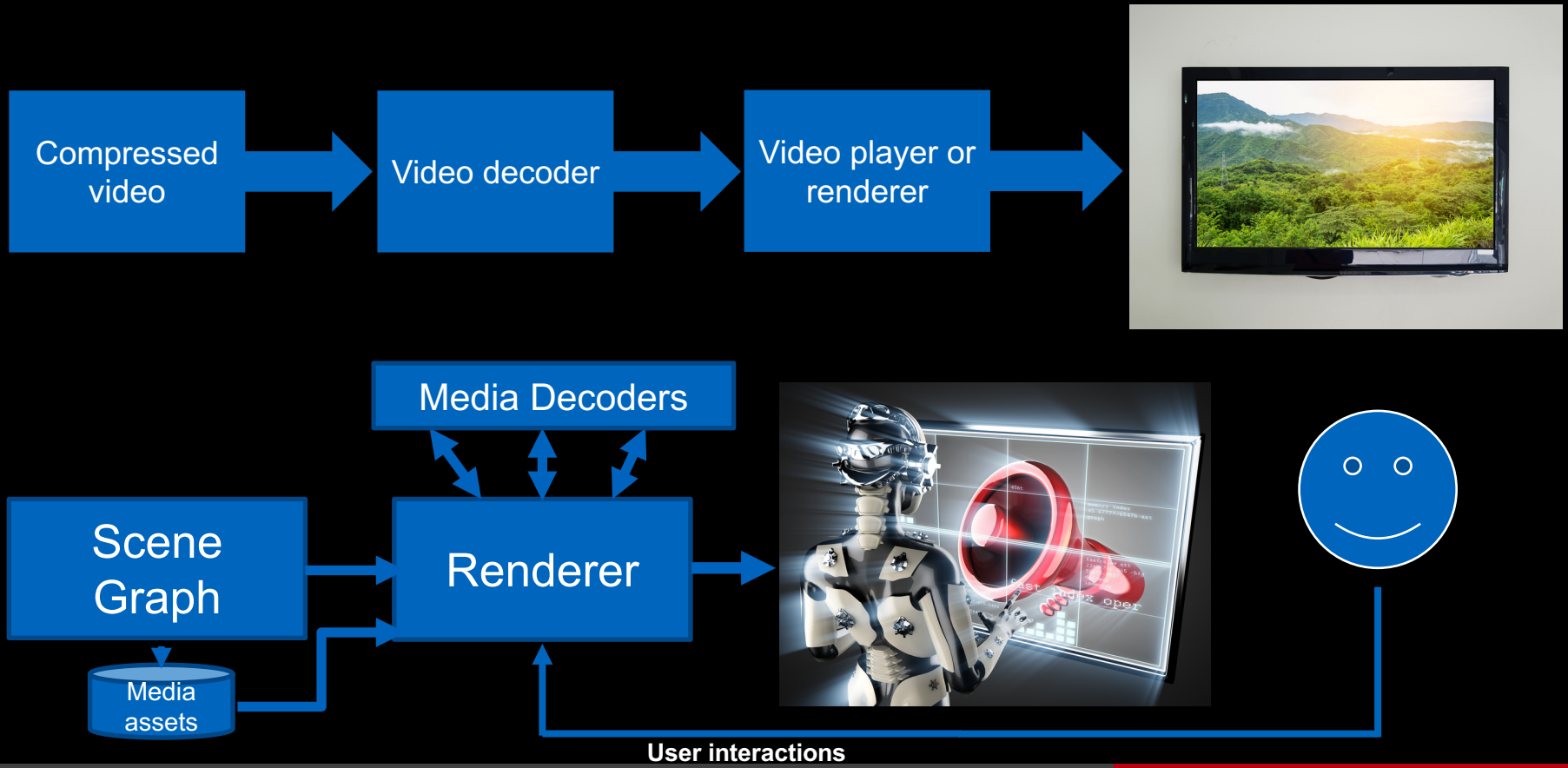
*https://en.wikipedia.org/wiki/Reality–virtuality_continuum

Workflow for 6 DoF

Facebook Workflow for 6 DoF using ORBX

- Leverages OTOY ORBX as media container for interchange
- ~30 tools (not all shown) support ORBX
- ORBX developed by 3D modeling and rendering companies (an ad hoc collaboration led by OTOY)
- Supports a minimum set of interchange formats to specify a scene graph
- Flexibility to add/support other formats

Generic Architecture for Distribution of Video vs. 6 DoF



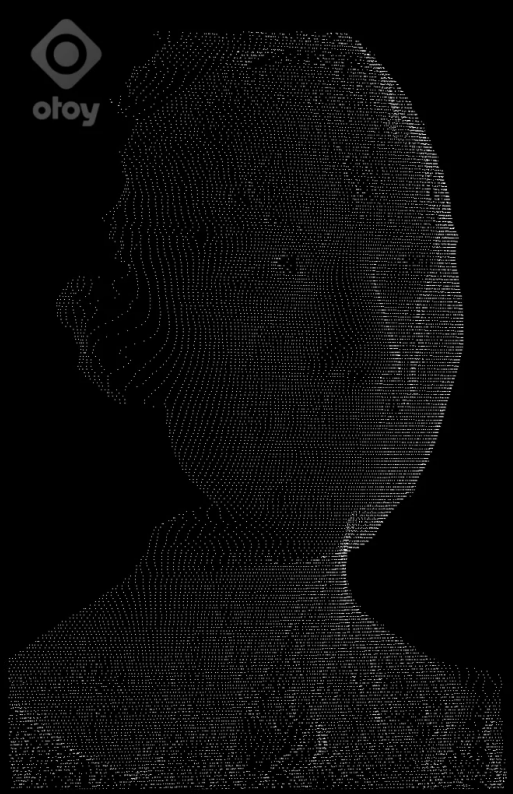
What's missing for interchange/deployment over networks?

- Standard interface to renderer
  - media container
  - scene graph
- Agreed-upon primitive formats (minimal set for meshes, point clouds, and textures)
- Photorealistic rendering
- Compression of meshes, point clouds, and floating-point/high bit-depth textures
- Infrastructure to support distribution

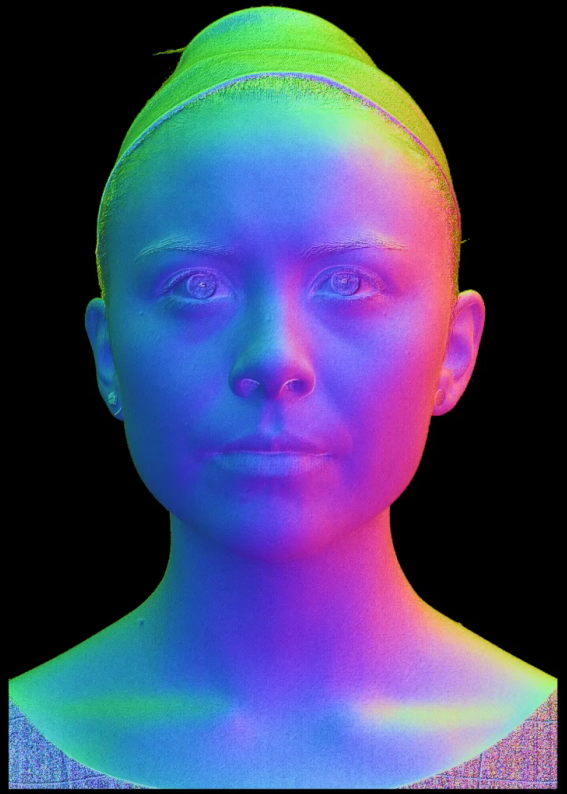
Photorealistic rendering using ORBX

Photorealistic rendering from light fields

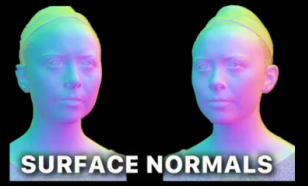
Geometric formats for photorealism

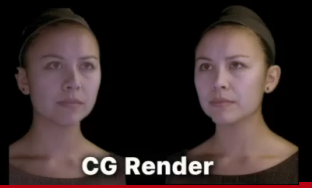


GEOMETRY PASS 1

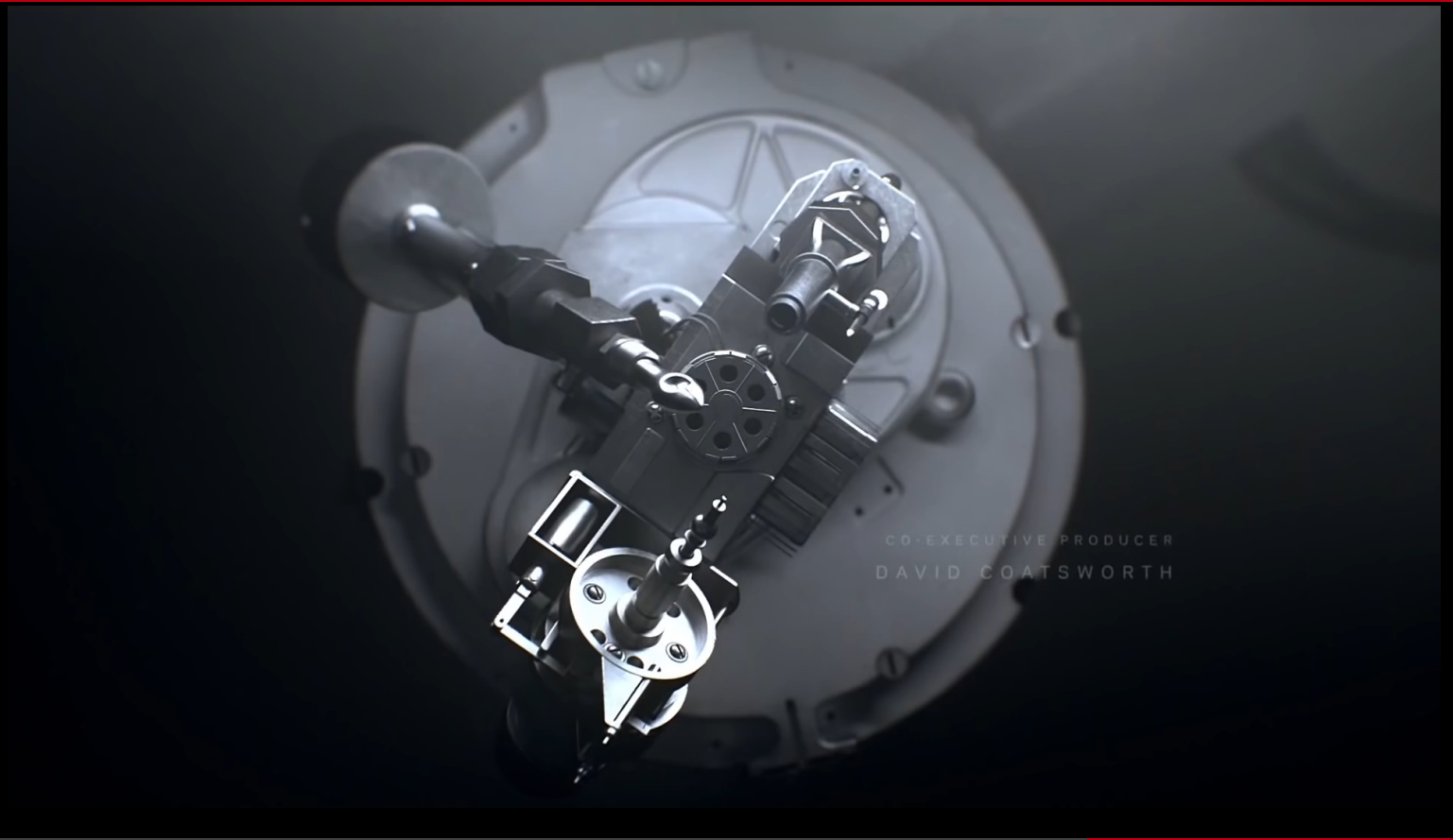


GEOMETRY PASS 2





Synthetic content

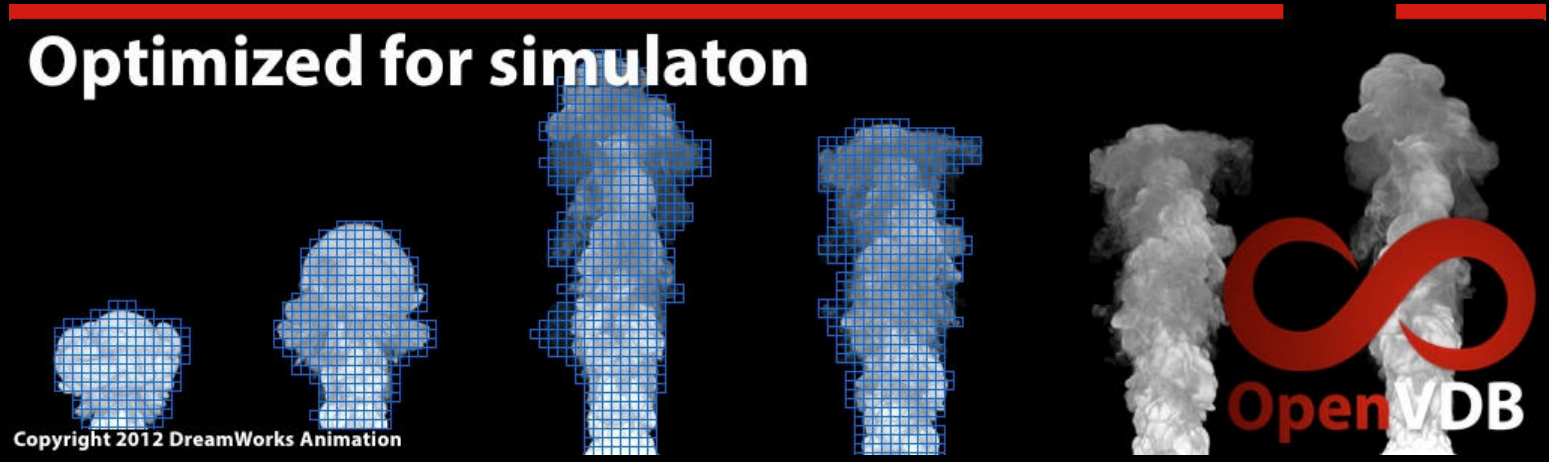


Fundamental data formats in ORBX

Texture support by EXR

- Open EXR
  - Initially developed by ILM
- Supports 16-bit floating point
- Supports 32-bit integers
- Arbitrary number of channels
- Time-tested, vetted by industry, widely supported

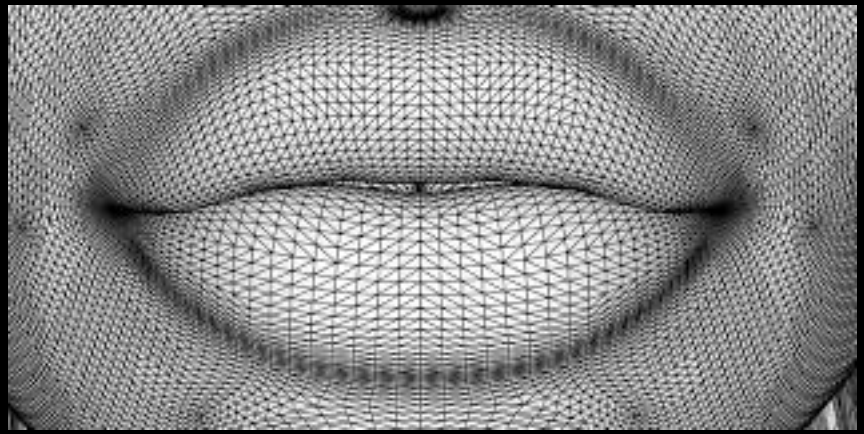
Point cloud supprt by OpenVDB



- OpenVDB: Initially developed by Dreamworks
- Supports point cloud representations
- Fog, fire, smoke, clouds
- Vetted, widely adopted by VFX industry, 3D modeling

Mesh support by Alembic

- Alembic: Initially developed by ImageWorks
- Provides complex computation of procedural geometric constructions
- Hair, grass, fine textures
- Vetted, widely adopted by VFX and 3D modeling industries



Other features of ORBX by OTOY

- Support of virtual file system
- Inflator/deflator for packaging
- Flexible scene graph via human-readable XML
- Fundamental attributes for velocity of objects, motion, light source, etc …
- Capable of supporting other formats, including compressed data formats

Creating standards for wide-scale distribution

MPEG

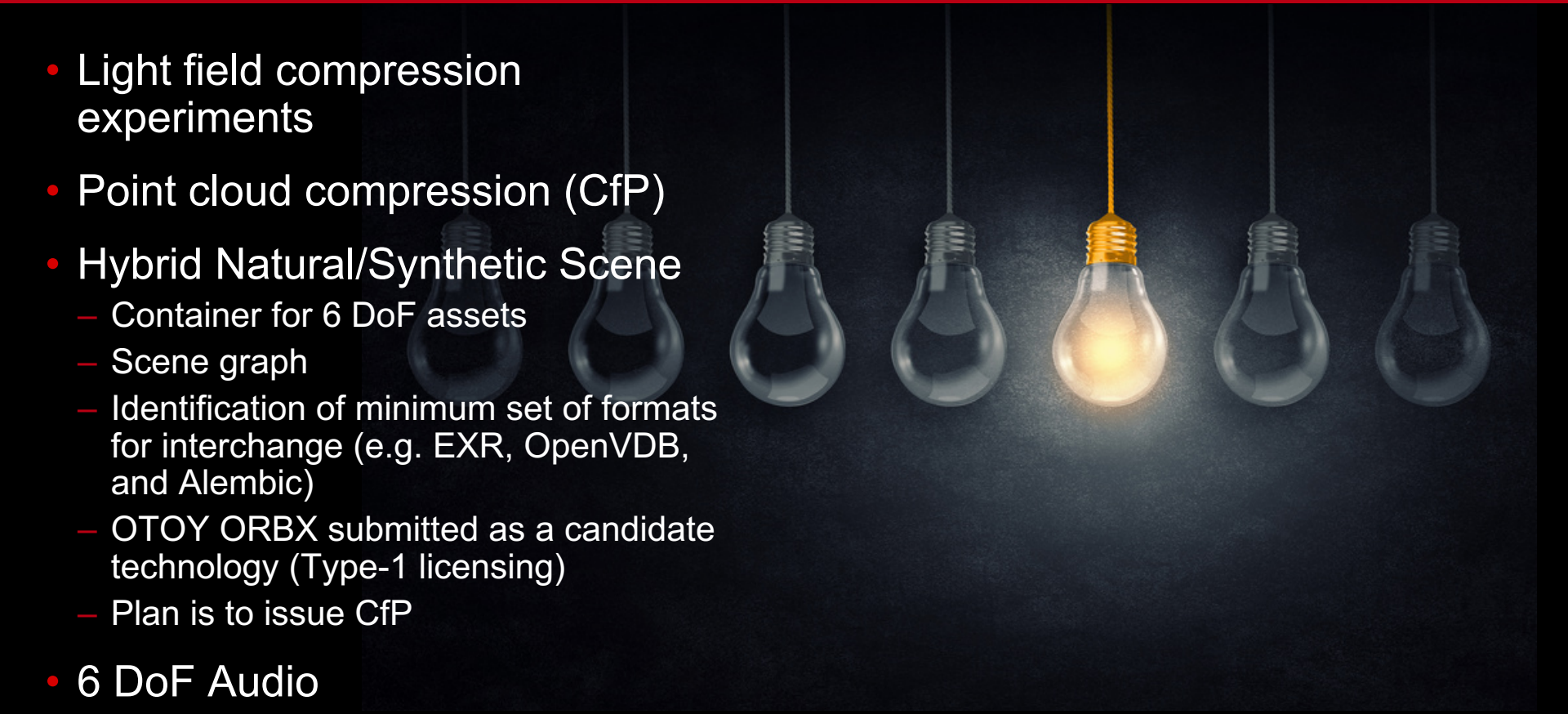
- Organized under ISO/IEC
- Some joint work with ITU-T, e.g. HEVC
- Participants are accredited by their national organization, i.e. country
- Development of specifications follows a due process structure; voting conducted by country
- Usually meets 3-4 times per year; roughly 400 experts attend each meeting

Toward MPEG’s vision of virtual reality

Work already underway or completed: 3DoF

- DASH extensions for streaming VR and signaling ROI
- Omnidirectional MediA Format (OMAF) for projection mapping metadata and other signaling for renderer
- HEVC enhanced for flexible tiling
- Future Video Coding: Follow-on to HEVC
  - 360° stereo + 3 DoF video
  - 8K and higher resolutions
- Audio completed for 3 DoF

Work started for 6 DoF



- Light field compression experiments
- Point cloud compression (CfP)
- Hybrid Natural/Synthetic Scene
  - Container for 6 DoF assets
  - Scene graph
  - Identification of minimum set of formats for interchange (e.g. EXR, OpenVDB, and Alembic)
  - OTOY ORBX submitted as a candidate technology (Type-1 licensing)
  - Plan is to issue CfP
- 6 DoF Audio

Conclusion

MPEG and immersive technologies for VR

- Good progress
- Short term focus on 360° video and audio for 3 DoF
- Long term 6 DoF audio and visual (natural/synthetic)
- Future Video Coding (8K+higher resolutions)
- More info @ http://mpeg.chiariglione.org