SMFoLD
Introduction and Overview

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Insight Media

Workshop Support

- Insight Media
- Air Force Research Laboratory (AFRL)
- Third Dimension Technologies
- Oak Ridge National Lab

AFRL Identified Issues

- ## 3D Sensor Data Increasing Dramatically
  - LiDAR, SAR, plenoptic camera, stereo or multi-view to 3D
  - 3D models (actual and created)

- ## 3D Visualization Needed to Improve Productivity
  - Stereoscopic 3D (S3D) not acceptable
  - Field of Light Display (FoLD) is desired

- ## Lack of Streaming Model is Barrier to FoLD Adoption
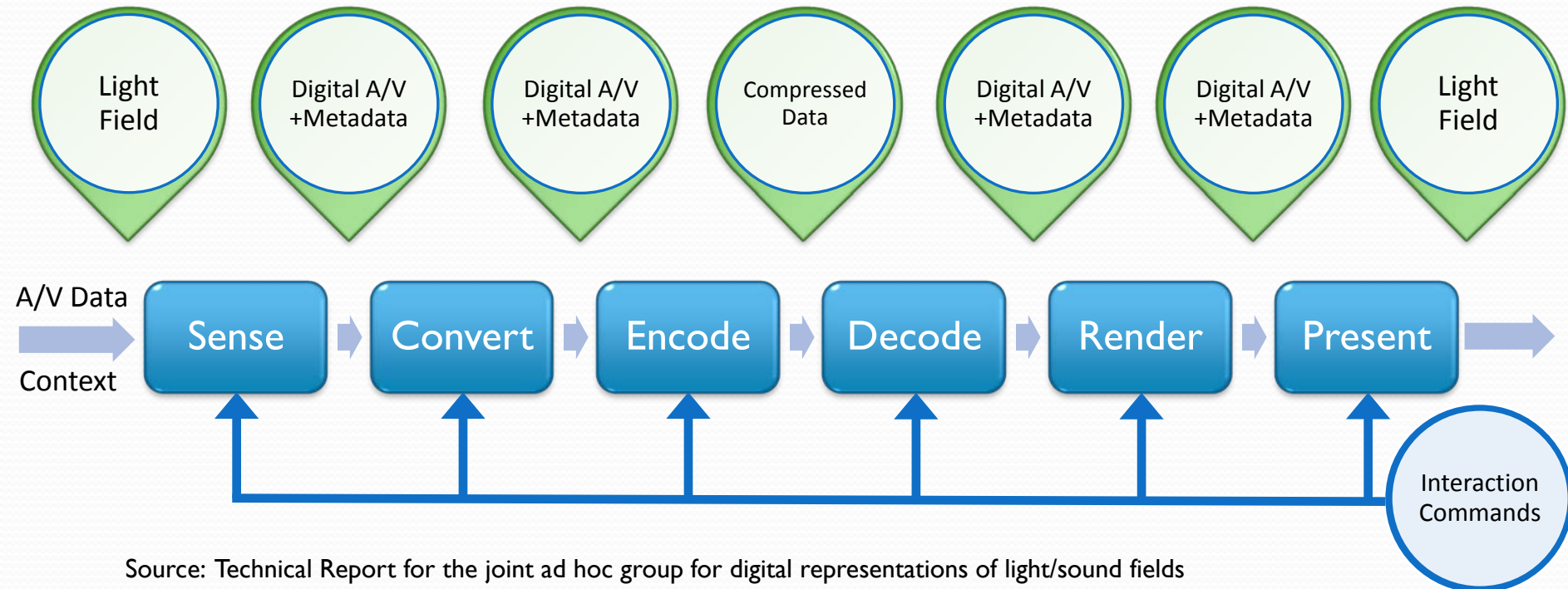 - Proprietary hardware and software

AFRL Objectives

- Develop Display Agnostic 3D Streaming Media Model
  - Includes scene description and transmission format
  - Allows for flow and POV control
  - Optimized visualization on any 2D, S3D or FoLD system
  - Open standard that supports DoD needs
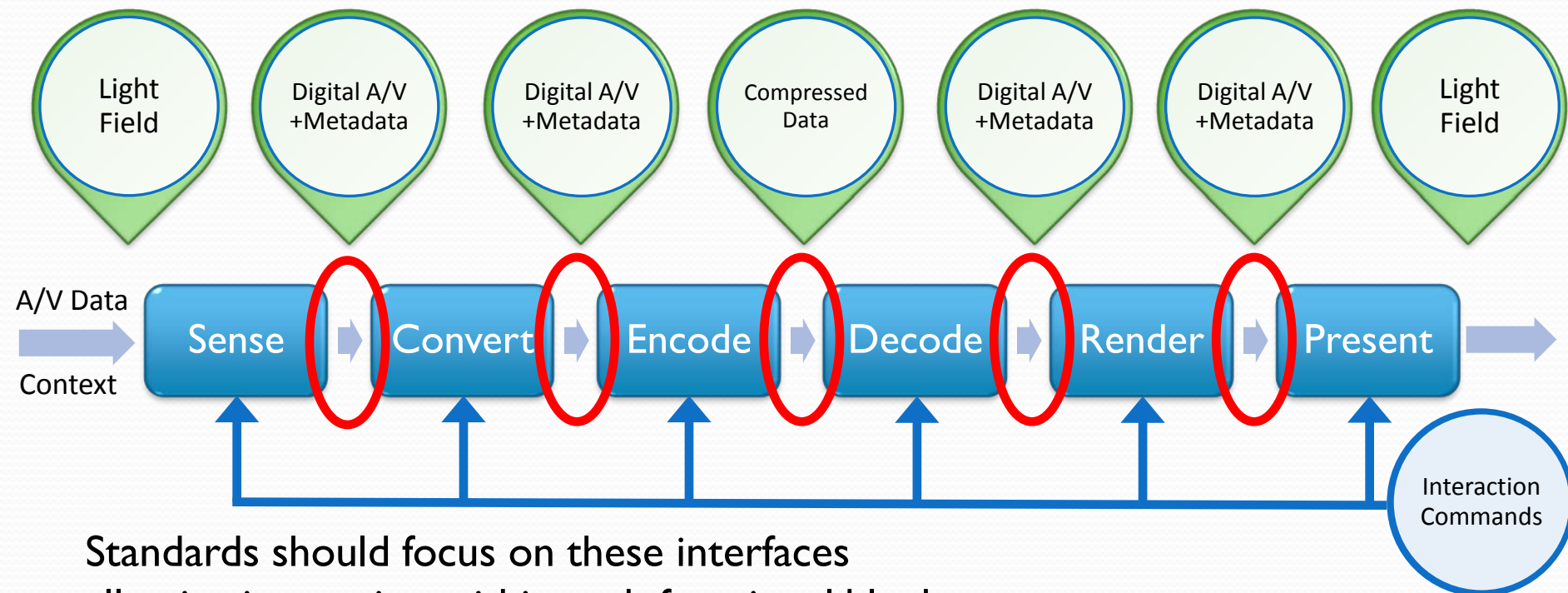
Workshop Objectives

- Overview of Light Field Display Applications
- Overview of LF Capture/Creation, Distribution and Display
- Update on Standardization Efforts
- Feedback and Input for Technical Report
- Assess Need for and Mission of Consortium

Generalized Light Field Workflow

Light Field → Sense → Digital A/V +Metadata → Convert → Digital A/V +Metadata → Encode → Compressed Data → Decode → Digital A/V +Metadata → Render → Digital A/V +Metadata → Present → Light Field

A/V Data → Sense → Convert → Encode → Decode → Render → Present

Context

Interaction Commands

Source: Technical Report for the joint ad hoc group for digital representations of light/sound fields for immersive media applications; June 2016   ISO/IEC JTC1/SC29/WG1(JPEG) & WG11(MPEG)

Generalized Light Field Workflow

Light Field → Digital A/V +Metadata → Digital A/V +Metadata → Compressed Data → Digital A/V +Metadata → Digital A/V +Metadata → Light Field

A/V Data

Context

Sense → Convert → Encode → Decode → Render → Present

Interaction Commands

Standards should focus on these interfaces
allowing innovation within each functional block

3D Data Sources / Types

- Light Field Data
  - Plenoptic Cameras
  - Camera Arrays
  - Moving Cameras
- Depth Maps (x,y,RGBD)
  - Time of Flight (ToF) Cameras
  - Structured Light Cameras
- Point Cloud
  - LiDAR

- Object Representation
  - Synthetic Aperture Radar

- Digital Formats
  - 3D mesh with/without textures
  - CAD data
  - Planar primitives
  - Voxels
  - MRI/CT slice data

Some 3D Standards and Activities

- ISO/IEC MPEG
  - 3D-HEVC (multiview + depth)
  - MPEG4 Part 25
- SMPTE
  - 3G SDI (Stereo 3D)
  - ST 2087 – Depth Map Representation
- JPEG PLENO
  - Open standard in progress
  - May not support all display types

- Chromium
  - OpenGL 3D data over TCP/IP
- WebGL
  - OpenGL wrapper for browser 3D
- Open3DGC
  - MPEG 3D graphics implementation
  - Khronos Group – glTF
- VR Interest Group
- W3C – Open web platform for VR delivery

Visual Multimedia Applications, Data Representations and Coding Tools

Category	Functionality	Data representation	Coding tool	Comment
Point cloud	3D rendering, e.g. GIS	(x,y,z) + color	PCC	Under development in MPEG. Uniform color per point in all directions
3D Meshes	3D rendering, e.g. games	(x,y,z) + IFS connectivity + color/texture	MPEG-3DMC MPEG-AFX	Standardized for meshes with non-changing connectivity
Panoramic texture	360° video VR	Large texture	Discussion in MPEG?	Stitched panorama demos exist. Do they use advanced coding tools?
Omni-Directional texture	360° video stereo VR	ODS texture	Not available in JPEG/MPEG	Google jump uses this format. Not clear how much coding is involved?
Microlens Light Field	A posteriori refocus	(s,t,u,v) Optional: depth	Not available in JPEG/MPEG	Are there proprietary coding formats available?
Dense Camera array Light Field	Light field display, Horizontal Parallax Only	(u,v) camera + (s,t, θ,φ) extrinsics + depth	3D-HEVC: Multiview + depth	DIBR rendering 1D-Linear, dense camera arrangements only
Sparse Camera array Light Field	Light Field display and/or Free Navigation	(u,v) camera + (s,t, θ,φ) extrinsics + depth	FTV exploration/CfE with 3D-HEVC extensions	DIBR rendering Targets non-Linear (1D/2D), sparse camera arrangements

Source: JPEG PLENO
AhG Report

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Field of Light Display (FoLD)

- No Vergence-Accommodation Issues
- Horizontal and *(ideally)* Vertical Parallax
- Images Perceptually Indistinguishable from Reality *(ideally)*
- Standalone Displays or Eyewear
- Commercial, Military and Government Applications

Some FoLD Types

- Holographic
  - Diffraction based - *MIT, SeeReal, BYU, Bikent Univ, UofA, 5G the Giga Communication Research Laboratory*
- Multi-View
  - Integral array - *FoVI3D, Ostendo,*
  - Steerable Backlight - *Kwangwoon University, Leia*
  - Holographic stereography
    Third Dimension Technologies
  - Tensor display - *MIT*
  - Multi-projector – *Holografika, USC*

- Volumetric
  - Scanning/spinning
    Actuality, USC, LiteFast
  - Multiple LCD screens
    LightSpace Technologies, Looking Glass Factory, Pure Depth
  - Voxel emitting
    Burton (intersecting lasers), 3DIcon (up-converting with lasers)

1916 list of "scope" or "graph" machines

Phantoscope
Criterioscope
Biograph
Cinematograph
Vitascope
Kinematograph
Wondorscope
Animatoscope
Vitagraph
Cosmoscope
Anarithmoscope
Panoramograph
Katoptukum
Magniscope
Zoeoptotrope
Phantasmagoria
Projectoscope
Variscope
Cinograph
Cinnemonograph
Hypnoscope
Centograph
X-ograph
Electroscope
Cinagraphoscope
Kinetoscope
Craboscope
Viletoscope
Cinematoscope
Mutoscope
Cinoscope
Animaloscope
Theatograph
Monograph
Motorgraph
Kineatograph

Rayoscope
Motiscope
Kinotigraph
Phenakistoscope
Venetrope
Vitrescope
Zinematograph
Vitopticon
Stinnetiscope
Vivrescope
Daramiscope
Lobsterscope
Corminograph
Kineoptoscope
Scenamotograph
Kineograph
Thromotrope
Kinebleboscope
Pictorialograph
Kinegraphoscope
Vileograph
Kinevitograph
Photokinematoscope
Kinesetograph
Mophotoscope
Phototrope
Movementoscope
Touniatoscope
Vilophotoscope
Waterscope
Visionscope
Phonendoscope
Lumiograph
Heliographoscope
Pantobiograph
Zoetrope
Chronophotographoscope

Vileocigraphoscope
Pantominograph
Ammotiscope
Acheograph
Kinographoscope
Lifeoscope
Sygmographoscope
Kineoptoscope
Cieroscope
Velograph
Stereoptigraph
Eragraph
Moto-Photoscope
Zoopraxoscope
Tachyscope
Thaumototrope
Thropograph
Mimicoscope
Musculariscope
Involograph
Shadographoscope
Counterfivoscope
Realiphotoscope
Rythmograph
Photoscope
Originagraph
Persistoscope
Selfseminograph
Getthemoneygraph
Parlorgraph
Phasmatrope
Klondikoscope
Stroboscope
Chronomatograph
Scenoscope
Tropograph

Need for standards?

There were this many moving picture devices already by 1898.

One on the list was made up by Jenkins; the rest of the imaginative names really existed, but only one is still is use today. Can you identify those two?

Some FoLD Applications

- Cinema and Video
- Telepresence
- Design of Autos, Aircraft, Buildings, etc.
- VR/AR/MR for Gaming, Entertainment and Work
- Situational Awareness (military, commercial air control)
- Big Data Visualization (satellite, oil & gas, pharma, scientific)
- MRI, CT and Ultrasound Data

Possible Consortium Mission Statement

- Facilitate development of open streaming standards of true 3D data to all 3D and 2D displays by providing liaison between interested parties to share information, provide education and work to bridge gaps in the standardization process.

What Might a Consortium Do?

- Accomplish Tasks: Writing Report Sections, Standards Committees
- Broaden Range of Light Field Applications (DoD, government, medical)
- Newsletter, Blogs, White Papers, Webinars and Seminars to aid in:
  - Standards development
  - Commercialization
  - Industry and end-user education

- Help Develop Light Field Metrology
- Hold Annual Conference with Exhibits
- Identify Key Research Areas (maybe assist in funding)

Consortium Funding

- AFRL Support for Limited Time
  - SBIR/STTR (Small Business Innovation Research) funding
  - Very beneficial to ensure tasks are completed quickly without relying on volunteers to complete
  - TDT/ORNL one of two teams likely to bid for Phase II
- Longer Term: Dues to Support On-going Activities

Agenda

9:00	9:20	Introduction	Chris Chinnock, Insight Media
9:20	9:45	Acquisition	Jon Karafin, Lytro
9:45	10:10		Siegfried Foessel, Fraunhofer IIS
10:10	10:30		coffee
10:30	10:55	Displays	Lloyd LaComb, Arizona State University/TIPD
10:55	11:20		Tommy Thomas, Third Dimension Technology
11:20	11:45		Thomas Burnett, FoVI3D
11:45	1:15		Lunch

1:15	1:40	Standards	Walt Husak, Dolby (JPEG PLENO standardization)
1:40	2:05		Howard Lukk, SMPTE (standardization)
2:05	2:30		Arianne Hinds, CableLabs (MPEG standardization)
2:30	2:45		coffee
2:45	3:10	More	Jules Urbach, OTOY
3:10	3:35		David Price, VR Industry Forum
3:35	4:30	Panel Discussion	Panel discussion

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Logistics

- Please wear badges to facilitate networking
- Please turn cell phones off (or to vibrate)
- Speakers have 5 minutes after his/her presentation for Q&A
- Audience participation is encouraged – please use microphone
- We are on a time schedule - please keep that in mind especially during the coffee/tea breaks
- Presentations will be available for download after the event