

immersion.

Overview of Haptics Standardization

Web3D 2022 – Paper #37

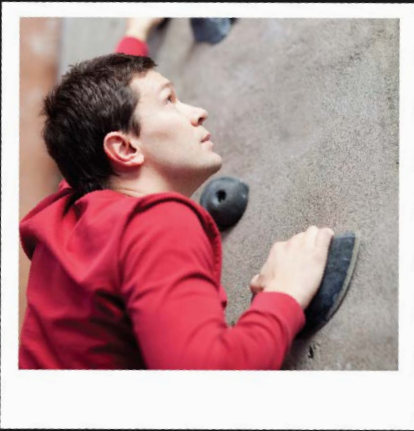
Yeshwant Muthusamy, Ph.D. | Immersion Corporation

Philippe Guillotel, Ph.D. | InterDigital Corporation

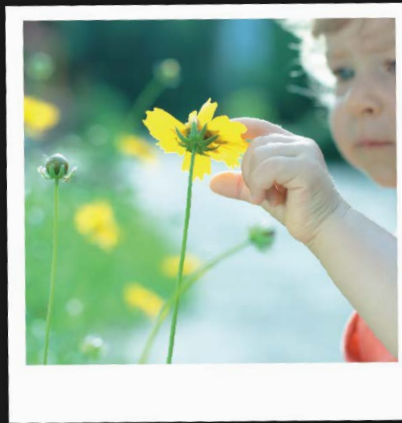
November 3rd, 2022

OUTLINE

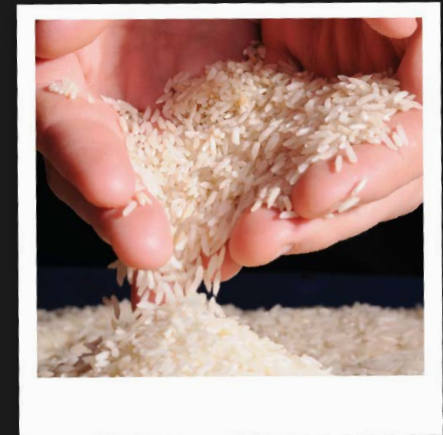
- Introduction to Haptics
- Need for Standardization
- Current Standards Initiatives
 - Haptics Industry Forum
 - MPEG
 - Khronos
 - IEEE
 - ATSC
 - IETF



Touch lets you learn about the world through body movement

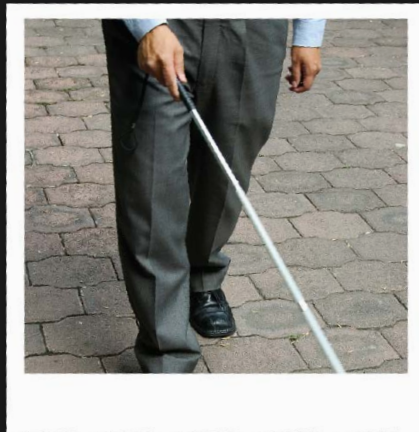


Touch lets you understand through active exploration



Touch creates belief in external reality

TOUCH IS FUNDAMENTAL TO PERCEIVING AND UNDERSTANDING THE WORLD



Touch enables extended proprioception



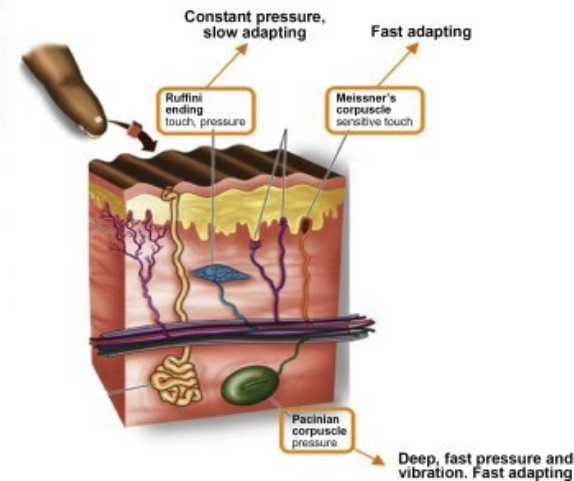
Touch facilitates affective interactions

Basics of Haptics

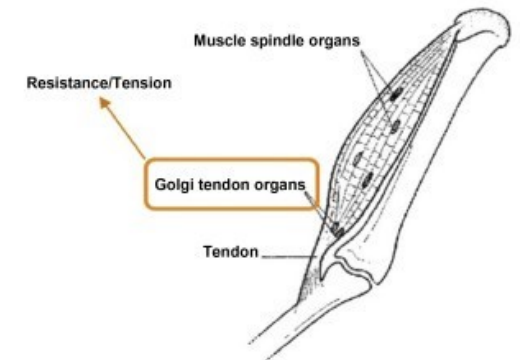
- Four classes of mechanoreceptors in the human body: Merkel, Ruffini, Pacinian, and Meissner
 - Receptors sense vibration, surface texture, deformation, and pressure
 - Work together to provide nerve pulses to the brain that are merged to create a haptic perception of the world
- The goal of a haptic actuator is to stimulate one or more of these mechanoreceptors to create a haptic experience

ACTUATION TYPE	TYPE OF STIMULATION	RELEVANT MECHANORECEPTOR
Electromagnetic	Vibration	Pacinian
Piezoelectric	Vibration + Texture	Pacinian
Kinesthetic	Deformation + Force	Merkel + Meissner
Surface	Friction	Meissner + Pacinian
Other	Stretch + Deformation	Ruffini + Meissner + Merkel

Tactile feedback



Kinesthetic force feedback



- Mechanisms to encode, decode, and evaluate/measure performances of these haptic sub-modalities are quite different from those for audio and video.
- Unlike audio (two ears), human tactile sensors are distributed over **2 sqm** of skin surface area – coding needs to account for this
- Perceptual coding optimization will need to uniquely exploit the properties of these receptors
- The range of frequencies of interest for haptics is **0 – 800 Hz**
 - 5 Hz and below is particularly significant for kinesthetic haptics (force feedback)

INDUSTRY UPTAKE OF HAPTICS

Mobile



1.4B Units in 2021

Android and iOS both support advanced haptic playback APIs but use incompatible effect encoding

Gaming



100M+ Units in typical console life

PS5 implements advanced vibration and kinesthetic feedback but utilizes a proprietary effect encoding.

XR



Expected to grow to 50M+ Units with Meta Quest and PSVR

No standardized effect encoding currently in use.

Lack of consistent coding between and across these platforms limits content creator investment

Auto: Delightful and Usable Touchscreens



Haptics in Consumer VR

Virtual Reality controllers shift from a single controller to dual motion controllers

Neither Oculus Touch nor HTC Vive controllers incorporate rumble

Instead use single Linear Resonant Actuators (LRA) per controller with a limited multi-frequency band



Full Body Touch Experiences

01
HAPTIC FEEDBACK SYSTEM



02
MOTION CAPTURE AND AVATAR SYSTEM
Full body motion tracking with high precision. Includes software and plugins for Unity/Unreal/Motion Builder.



Need for Haptic Standardization

Without Standards

- Market fragmentation – Walled Gardens
 - Proprietary APIs
 - Incompatible HW-to-SW interfaces
 - Different motor characteristics
- Content creators and application developers are de-incentivized to include haptics in their applications
 - Changes to lower levels of the haptic stack typically necessitate changes to the upper layers
- Adverse impact on end-user adoption

With Standards

- Standards harmonize haptics offerings from vendors
 - Without compromising vendor differentiation
- Content creators and application developers incentivized to incorporate richer haptic experiences
 - Leverage standard interfaces throughout the haptic stack
- Walled gardens give way to a flourishing haptic ecosystem that benefits all stakeholders.

Haptics Industry Forum



- HIF is a community for best practices and standards in touch media: <https://hapticsif.org>
- HIF Working Groups provide a platform for discussing cross-platform challenges, establishing best practices, and aligning on industry standards

29 *industry members to date*

participate in an **open, voluntary industry group** with professionals from different platforms and verticals

5

published RPs and Specifications

7

Active Working Groups

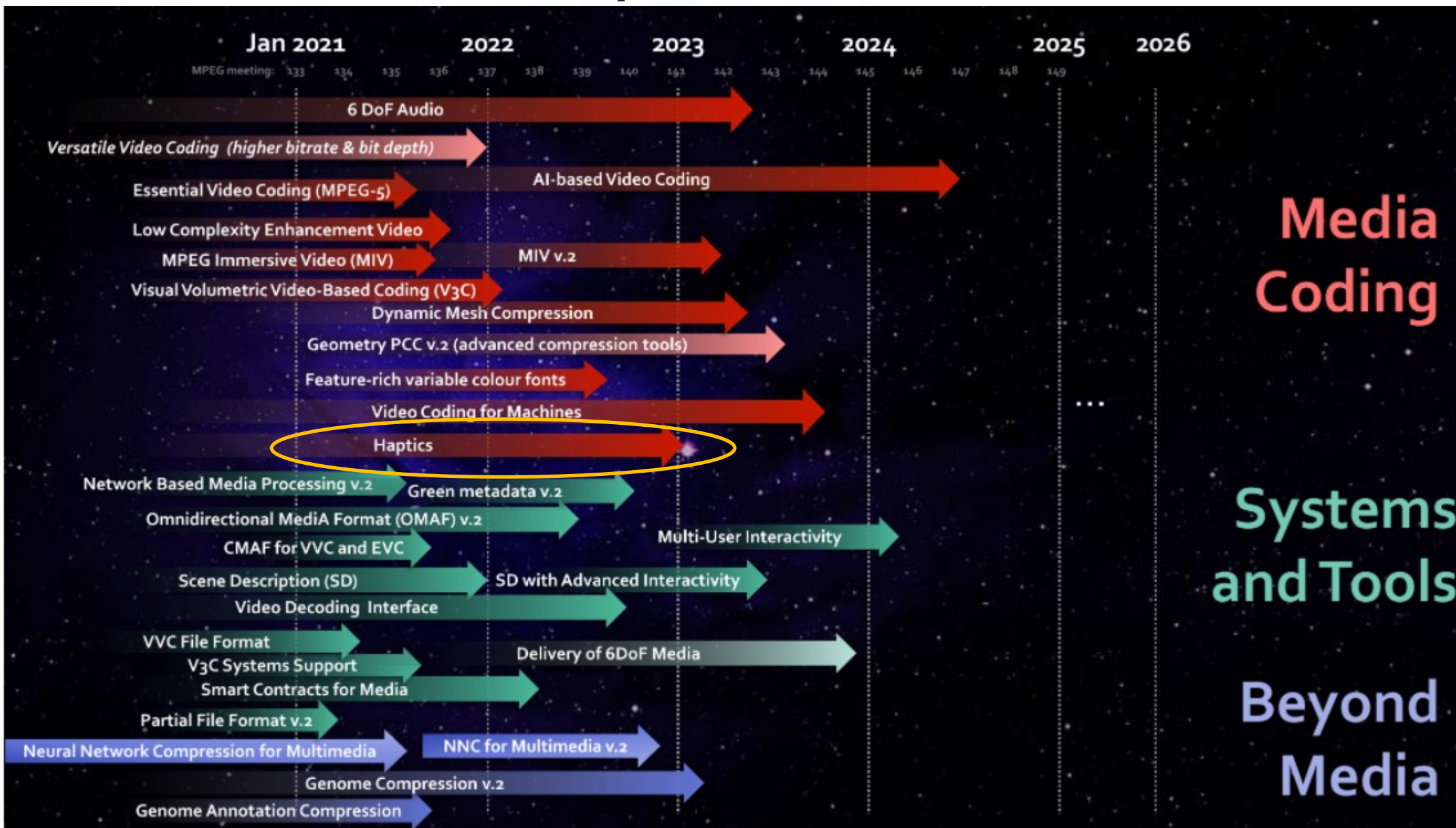
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Published Book

2

Industry Liaison Relationships

Haptics in MPEG



Media Coding

Systems and Tools

Beyond Media

Haptics in MPEG



- ***MPEG ISOBMFF (Haptics in ISO Base Media File Format)***
 - Establish haptics as a first-order media type, along with audio and video, in all ISO media files (e.g., MP4)
 - **DONE** – ISO/IEC 14496-12 7th edition – published January 2022
 - Next step: flesh out the haptic codec-specific header ‘boxes’ in ISOBMFF
- ***MPEG-DASH (Haptics in media streaming)***
 - Leverages the ISOBMFF standard above
 - Initial proposal made; waiting for haptic codec to be finalized
 - Will enable haptics to be part of all media streaming (Netflix, Hulu, etc.)
- ***MPEG-I (Haptics in Immersive Media – AR/VR/Gaming)***
 - Phase 1: Develop a basic haptic codec standard – **in CD ballot November 2022**
 - Phase 2A: Add support for spatial haptics, scene description – **CfP 1H 2023**
 - Phase 2B: Add support for interactivity, avatars, XR experiences (metaverse) – **CfP 1H 2024**

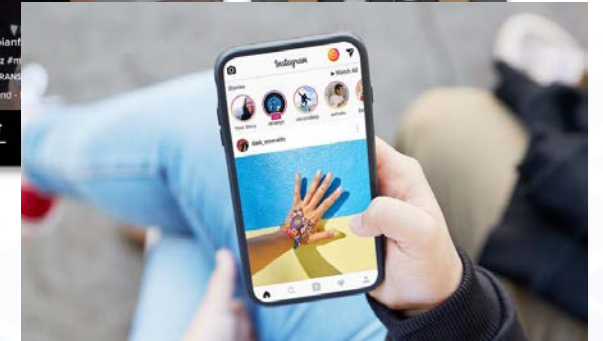
MPEG-I Phase 1 Exemplary Use Cases



Mobile Gaming

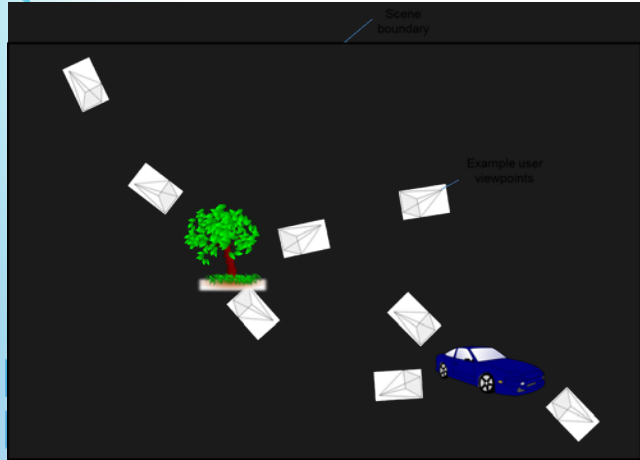


Instagram/TikTok



Mobile Streaming Media

MPEG-I Phase 2A Exemplary Use Cases



Intel True View



D-BOX Immersive Home Theater



Unity Metacast UFC fight on mobile

MPEG-I Haptics Phase 2B Exemplary Use Cases

Virtual hand based immersive VR

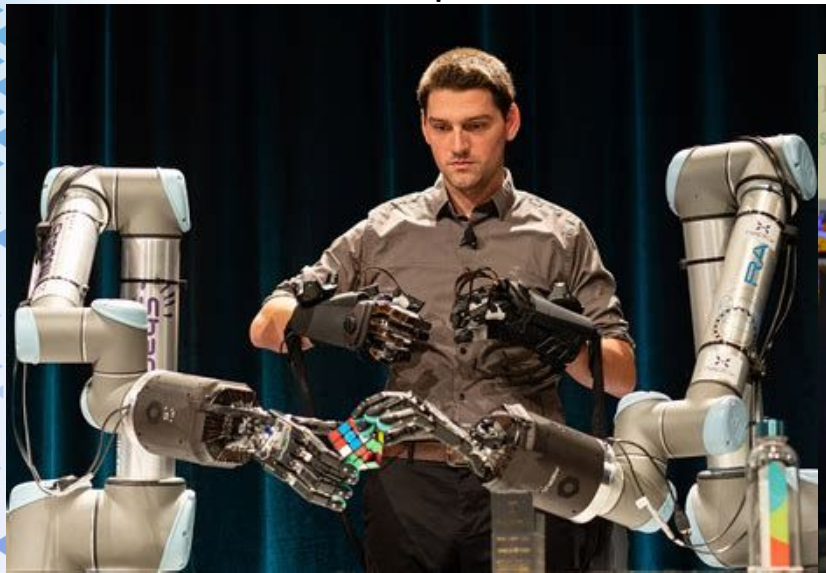


Tactile e-commerce



Corindus/YouTube

Tele-robotics with haptic feedback



Training and simulation



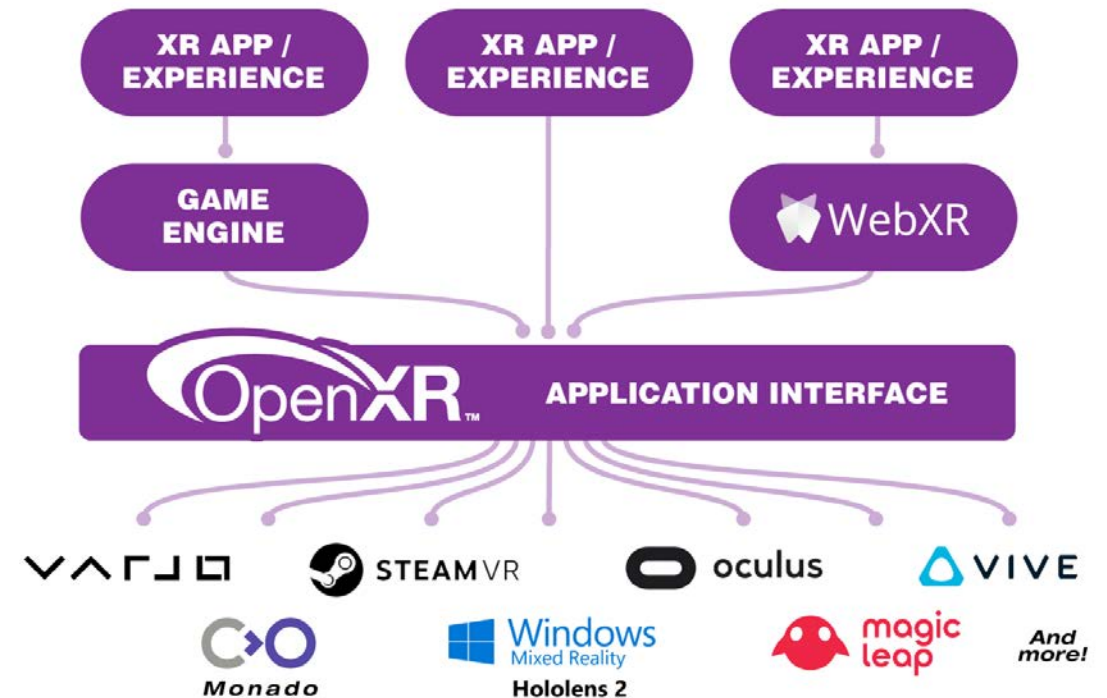
Interactive Video Calling

Khronos OpenXR

- OpenXR is a platform API intended to standardize the interface between app developers/game engines and XR hardware devices
- Haptic extensions to the OpenXR API will provide developer-facing haptic interfaces transportable across a variety of XR platforms.

• HIF Strategy

- Leverage XR expertise in HIF XR WG (InterHaptics, SenseGlove, Weart, Actronika, Immersion) to develop a haptics extension
- Target: Haptics extension submission by Q422, leveraging HIF liaison with Khronos



OpenXR provides a single cross-platform, high-performance API between applications and all conformant devices.

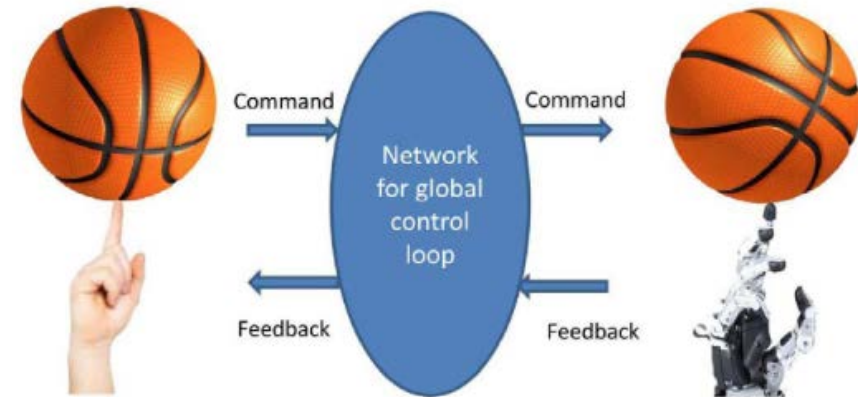
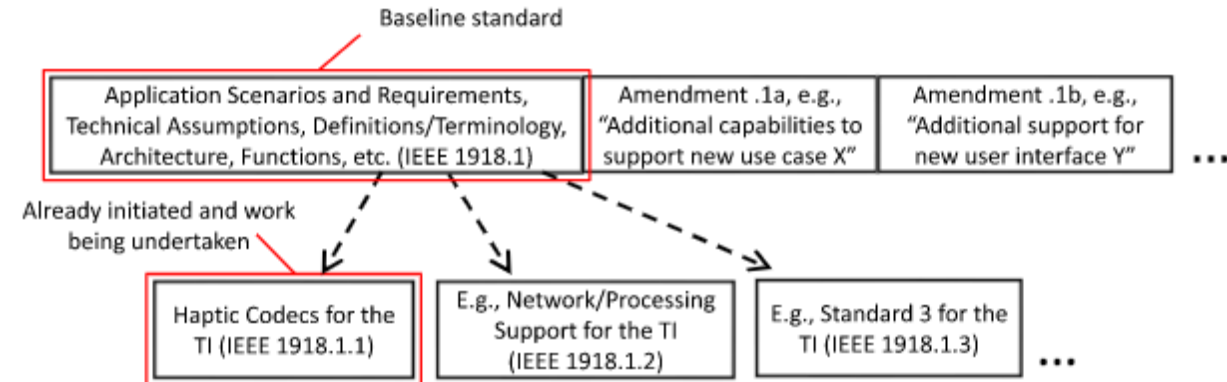
IEEE P1918.1 and P1918.1.1

■ IEEE P1918.1

- Tactile Internet for 5G Applications; started in 2016
- Telesurgery use cases mapped to TI Architecture
- Currently in ballot

■ IEEE P1918.1.1

- Haptic Codecs for Tactile Internet; also started in 2016
- Two kinesthetic codecs (with-delay and no-delay)
- Vibrotactile codec
- The IEEE codecs are:
 - Signal compression codecs with no descriptive elements
 - Actuator/hardware-specific
 - Not quite suitable for MPEG-I use cases



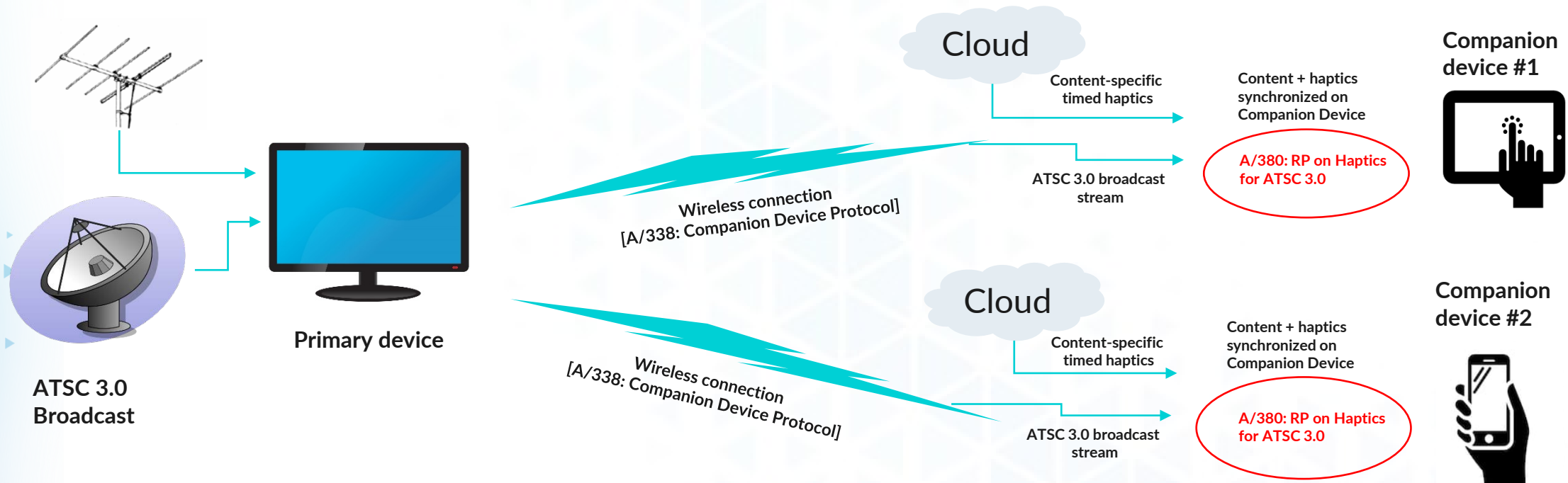
Remotely balancing an object through the TI

IEEE P2861.3

- Standard for Haptic Interface Enhancement for Mobile Gaming
- A new working group inside the IEEE Standards Association to develop a high performance mobile haptic API standard
- OEMs that implement this standard will be able to render TenCent gaming content, WeChat, etc.
- Standardization is ongoing



HAPTICS FOR ATSC 3.0



- Ideally, the haptics track would be incorporated into the broadcast content stream
 - Would require standardization of haptics in DASH/ROUTE and MPEG MMTP - a multi-year process
- Low-hanging fruit – sync up content with separate haptics file, leveraging existing ATSC 3.0 standards
 - Content-specific and device-specific haptics track retrieved from cloud during handshaking
 - Content stream and haptics played in synchronization on companion device

IETF: HAPTICS AS A TOP-LEVEL MEDIA TYPE



- **IETF – Internet Engineering Task Force**
 - Internet standards body, developing open standards through open processes
 - Top-level media types: application, audio, font, image, message, model, multipart, text, video
- **Immersion proposal: haptics as a new top-level media type**
 - Latest Internet Draft: <https://datatracker.ietf.org/doc/draft-ietf-mediama-haptics/01/>
 - Introduced at IETF 109 (Nov 2020)
 - Progressed to Proposed Standard at IETF 113 (March 2022)
 - Approval as a Standards Track RFC (STD) expected in 2H 2022
- **How does it help the haptics community?**
 - An IETF haptics RFC will be a **foundational, enabling** standard
 - Will enable proliferation of haptics media in a *standardized manner* in **all** internet media and communications
 - Will enable IANA registration of multiple haptic sub-types under the ‘haptics’ top-level type. Just a few (suggested) examples:
 - haptics/mp4 – MP4 files with just haptics in them
 - haptics/ivs – Immersion’s haptic format
 - haptics/ahap – Apple’s haptic format
 - haptics/hmpg – MPEG haptics distribution format
 - haptics/hjif – MPEG haptics interchange format
 - haptics/mih1 – MPEG haptics streaming format
 - haptics/hiev – IEEE P1918.1.1 vibrotactile coding format
 - haptics/hiekd – IEEE P1918.1.1 with-delay kinesthetic coding format
 - haptics/hiekn – IEEE P1918.1.1 no-delay kinesthetic coding format
 - Aligns perfectly with other haptics standardization activities (MPEG, OpenXR, etc.)
 - Will facilitate adoption of haptics by the industry – benefitting all stakeholders in the haptics value chain

Thanks for Listening!
Questions?

