

Digitalization 5.0: Metaverse

Trends, Challenges, Roadmaps, and Standardization

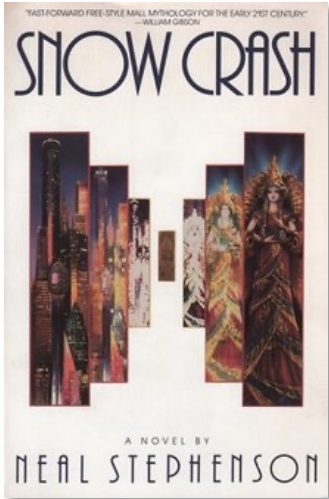
Yu Yuan, PhD

President, IEEE Standards Association

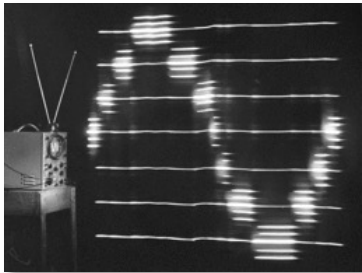
February 6, 2023

What is Metaverse?

A brief history



Author: **Neal Stephenson**
Publication: **June 1992**



Metavision

Inventor: **Steve Mann**

In **June 1974**, Steve Mann invented and coined the term "metavision" as extended reality using wearable computing.



Designer: **Philip Rosedale**
Initial release: **June 2003**



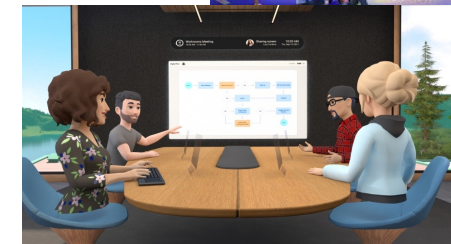
Initial release: **June 2005**
IPO: **March 2021**

Roblox's Prospectus (February 2021)

- **Identity.** All users have unique identities in the form of avatars that allow them to express themselves as whoever or whatever they want to be. These avatars are portable across experiences.
- **Friends.** Users interact with friends, some of whom they know in the real world and others who they meet on Roblox.
- **Immersive.** The experiences on Roblox are 3D and immersive. As we continue to improve the Roblox Platform, these experiences will become increasingly engaging and indistinguishable from the real world.
- **Anywhere.** Users, developers and creators on Roblox are from all over the world. Further, the Roblox Client operates on iOS, Android, PC, Mac, and Xbox, and supports VR experiences on PC using Oculus Rift, HTC Vive and Valve Index headsets.
- **Low Friction.** It is simple to set up an account on Roblox, and free for users to enjoy experiences on the platform. Users can quickly traverse between and within experiences either on their own or with their friends. It is also easy for developers to build experiences and then publish them to the Roblox Cloud so that they are then accessible to users on the Roblox Client across all platforms.
- **Variety of Content.** Roblox is a vast and expanding universe of developer and creator-built content. As of December 31, 2020, there were over 20 million experiences on Roblox, and in 2020, over 13 million of these were experienced by our community. There are also millions of creator-built virtual items with which users can personalize their avatars.
- **Economy.** Roblox has a vibrant economy built on a currency called Robux. Users who choose to purchase Robux can spend the currency on experiences and on items for their avatar. Developers and creators earn Robux by building engaging experiences and compelling items that users want to purchase. Roblox enables developers and creators to convert Robux back into real-world currency.
- **Safety.** Multiple systems are integrated into the Roblox Platform to promote civility and ensure the safety of our users. These systems are designed to enforce real-world laws, and are designed to extend beyond minimum regulatory requirements.

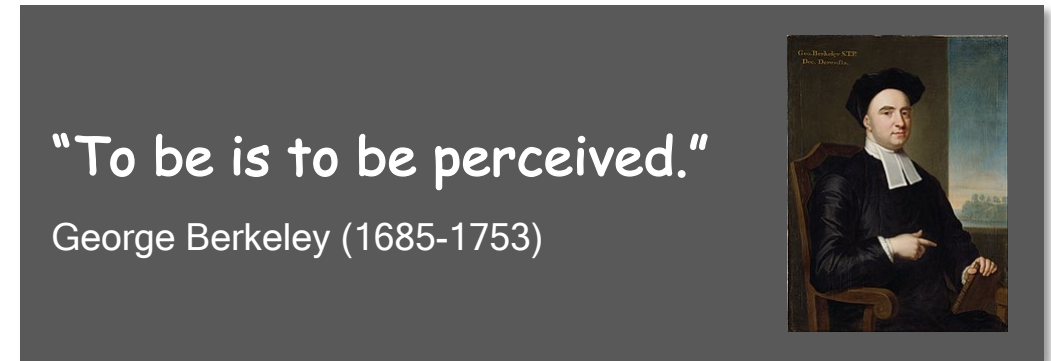
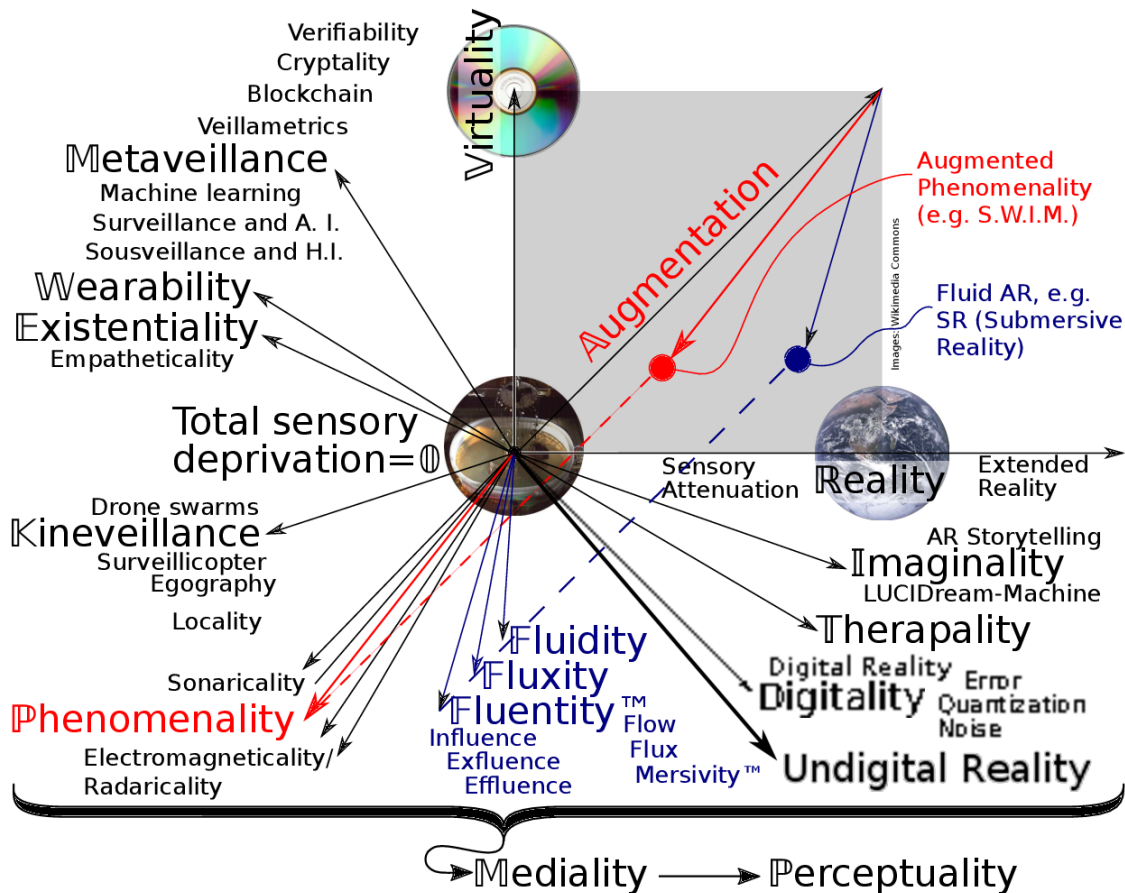


Founded: **January 2004**
IPO: **January 2012**
Name change: **October 2021**

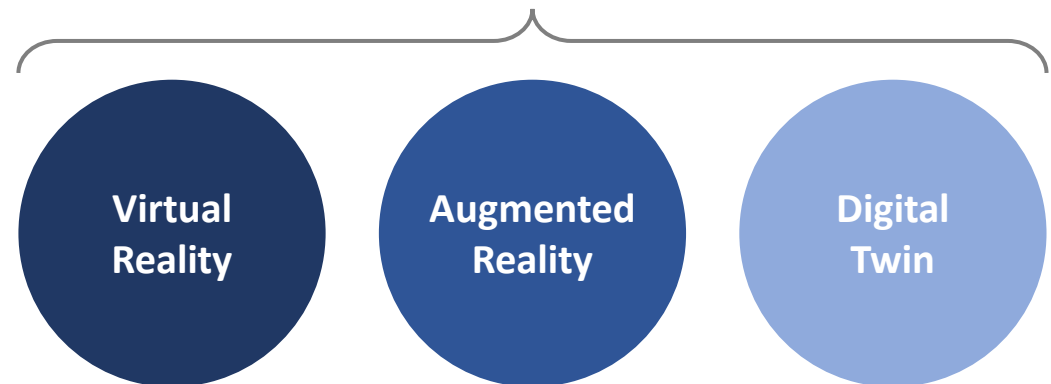


Definition of Metaverse

Metaverse refers to a kind of experience in which the outside world is perceived by the users (human or non-human) as being a universe that is built upon digital technologies as a different universe ("**Virtual Reality**"), a digital extension of our current universe ("**Augmented Reality**"), or a digital counterpart of our current universe ("**Digital Twin**").

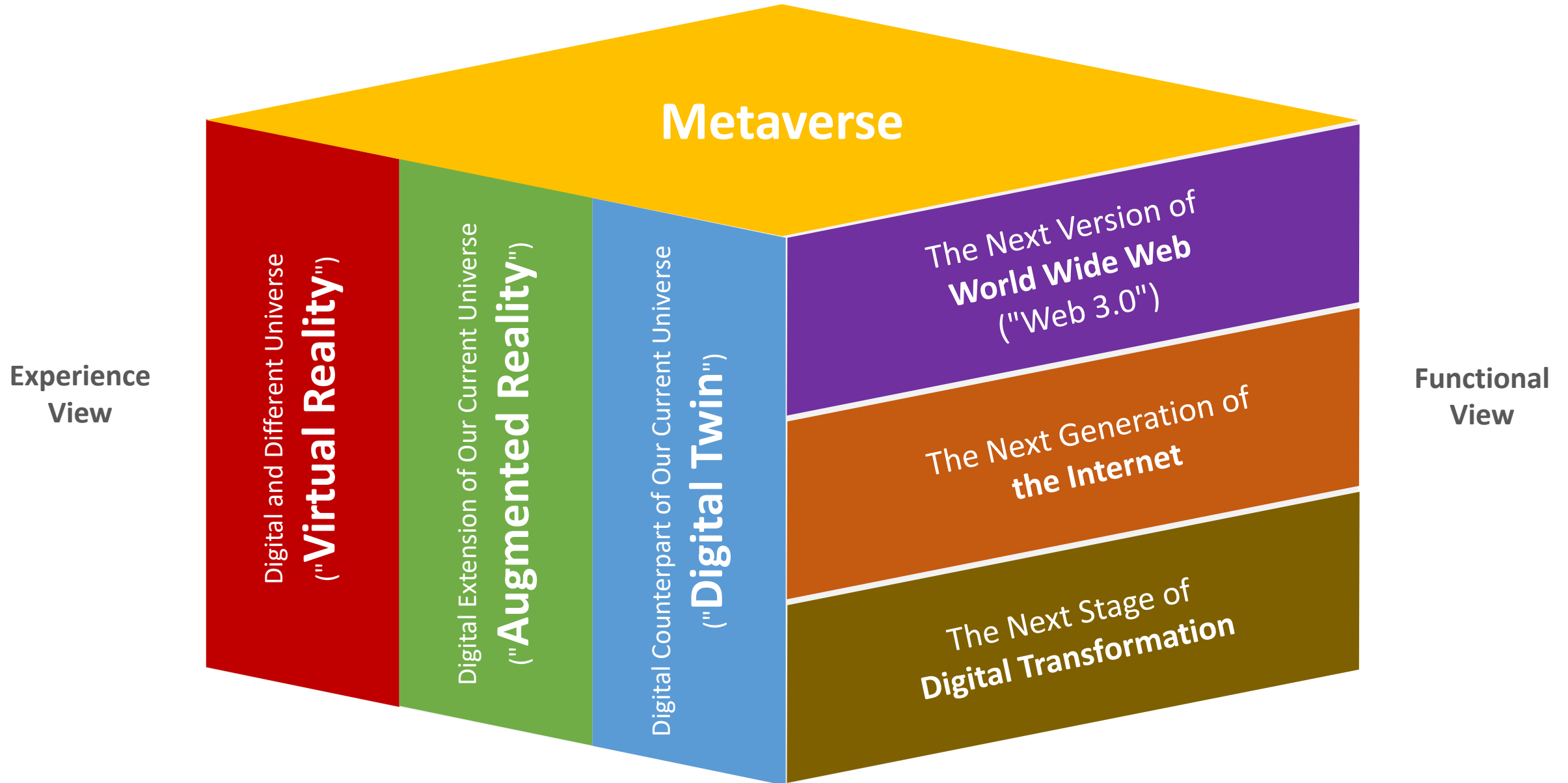


Three types of metaverses



Source: Steve Mann, Tom Furness, Yu Yuan, et al., "All Reality: Virtual, Augmented, Mixed (X), Mediated (X,Y), and Multimeditated Reality", arXiv:1804.08386, 20 Apr 2018

Metaverse as the Next Biggest Thing



Chronicle of Digital Transformation

Digitalization 5.0: **Realitization** (Metaverse)



Digitalization 4.0: **Intelligentization**



Digitalization 3.0: **Personalization**

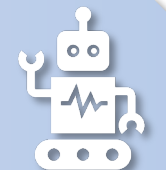
Web 2.0 = Massive UGC + Personalized Recommendations



Digitalization 2.0: **Interconnection**



Digitalization 1.0: **Automation**

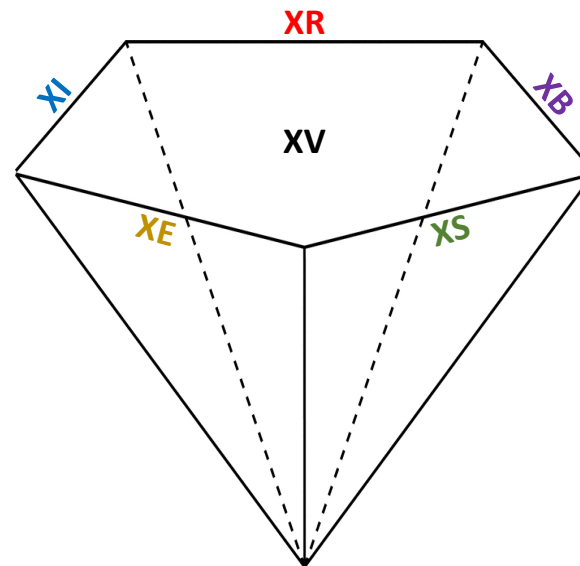
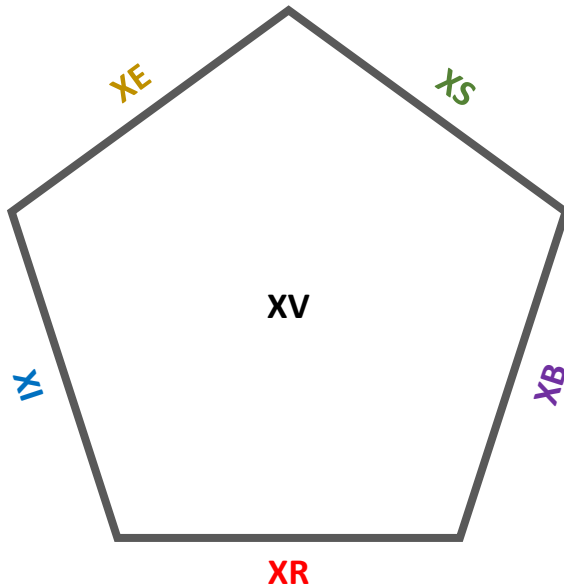


Digitalization 1.0 – 5.0

XV (eXtended meta/uni/Verse)

Proposed by Steve Mann and Yu Yuan in November 2022

XV (eXtended meta/uni/Verse) combines **XR** (eXtended Reality), **XI** (eXtended Intelligence), **XB** (eXtended Being, including Digital Twin), **XE** (eXtended Economy), and **XS** (eXtended Society) into a vision that covers the generally agreed scope of **metaverse** while extending the impacts and emphasizing the implications on our consciousness and humanity.



“Ribes”
XV = X(RIBES)

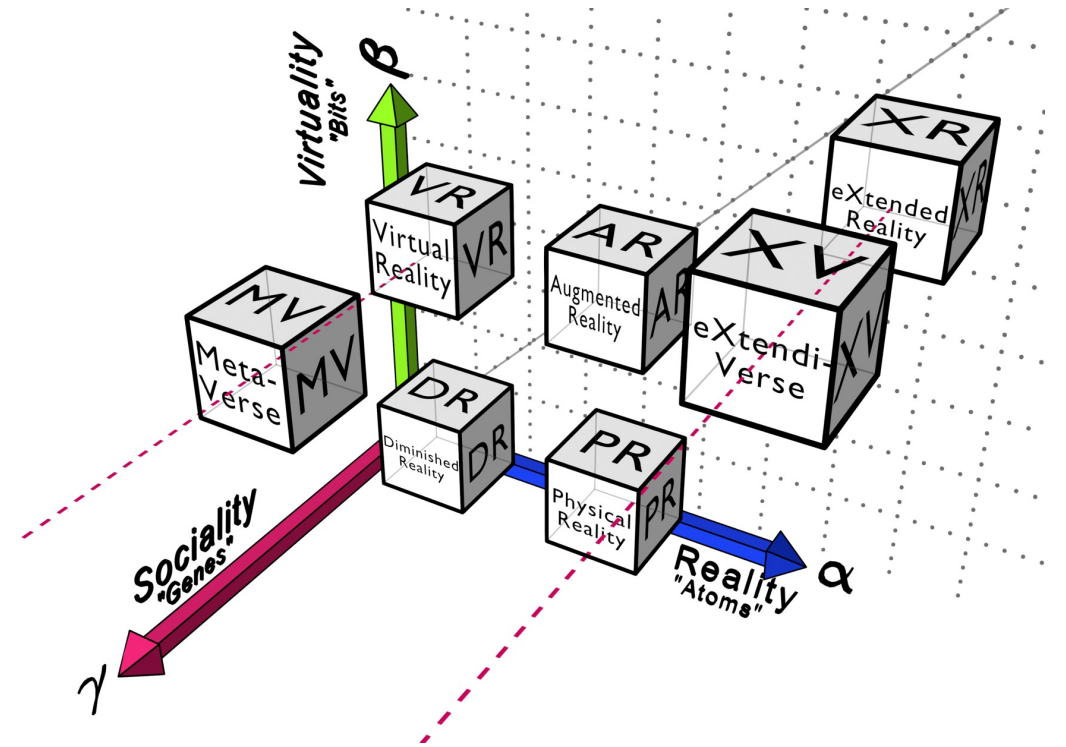
XV (eXtended meta/uni/Verse) = **XR** (eXtended Reality) * **XI** (eXtended Intelligence) * **XB** (eXtended Being) * **XE** (eXtended Economy) * **XS** (eXtended Society)

Beyond the Metaverse: XV (eXtended meta/uni/Verse)

Co-authored by Steve Mann, Yu Yuan, Tom Furness, Joseph Paradiso, and Thomas Coughlin in December 2022

Free download:

<https://arxiv.org/pdf/2212.07960.pdf>



Metaverse Technology Landscape

CORE TECHNOLOGIES

Senses/Actions (Virtual & Real)

Human / Creature

NPC / AI

Machine

Brain Machine
Interface

Body Machine
Interface

Programming
Interface

Virtual
Sensors/Actuators

Real
Sensors/Actuators

Persistent Virtual Worlds ("Persistent Computing")

Virtual
Map

Virtual
Scenes

Virtual
Objects

Virtual
Characters

Modeling/Design/DCC:
PGC, UGC, AI+PGC, AI+UGC, AIGC, DTGC, ...

Engines:
Physics, Graphics, Sounds, ...

Digital Finance & Economy

Digital Assets:
Virtual Assets, ...

Decentralization

Blockchain

SUPPORTING TECHNOLOGIES

Computation

Storage

Communications

Data

Intelligence

The road to the Metaverse

Grand Challenges:

Virtual Senses/Actions



How to achieve comprehensive and ultra-realistic virtual senses and actions?

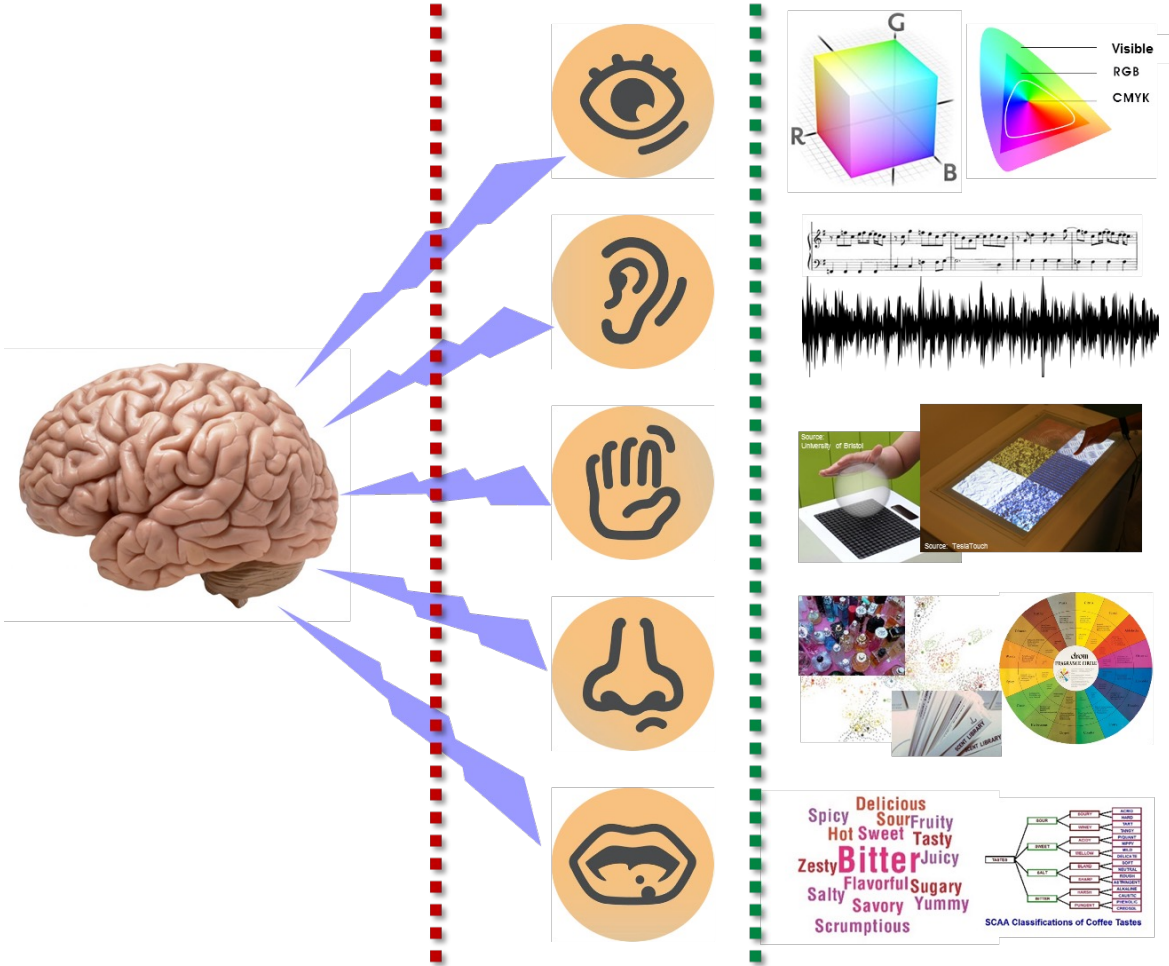
For example, when we can simulate not only the look, smell, and taste of beer, but also the dopamine and pleasure produced after drinking alcohol.



The road to the Metaverse

Grand Challenges:

Virtual Senses/Actions



The road to the Metaverse

Grand Challenges: Virtual Worlds



Steve Mann (“Father of Wearable Computing”) in Lake Ontario



Whalers Cove, Lake Washington

How to build a persistent, large-scale, fine-grained, and physically self-consistent virtual world?

For example, when a lake in a virtual world can not only glint like water, but also be so fine-grained that every virtual water molecule conforms to physical laws. Whether boating on the lake, jumping into it for swimming, or washing your face with a handful of water, the interaction between virtual water and other virtual objects can be completely in line with physical laws such as fluid mechanics, and even physicists can't find any flaws to tell that this is a virtual world.

The road to the Metaverse

Grand Challenges:

Virtual Worlds



Source: SecondLife.com



Source: Minecraft.net



Source: Improbable.io

The road to the Metaverse

Grand Challenges:

Integration between Virtual Objects and the Real World

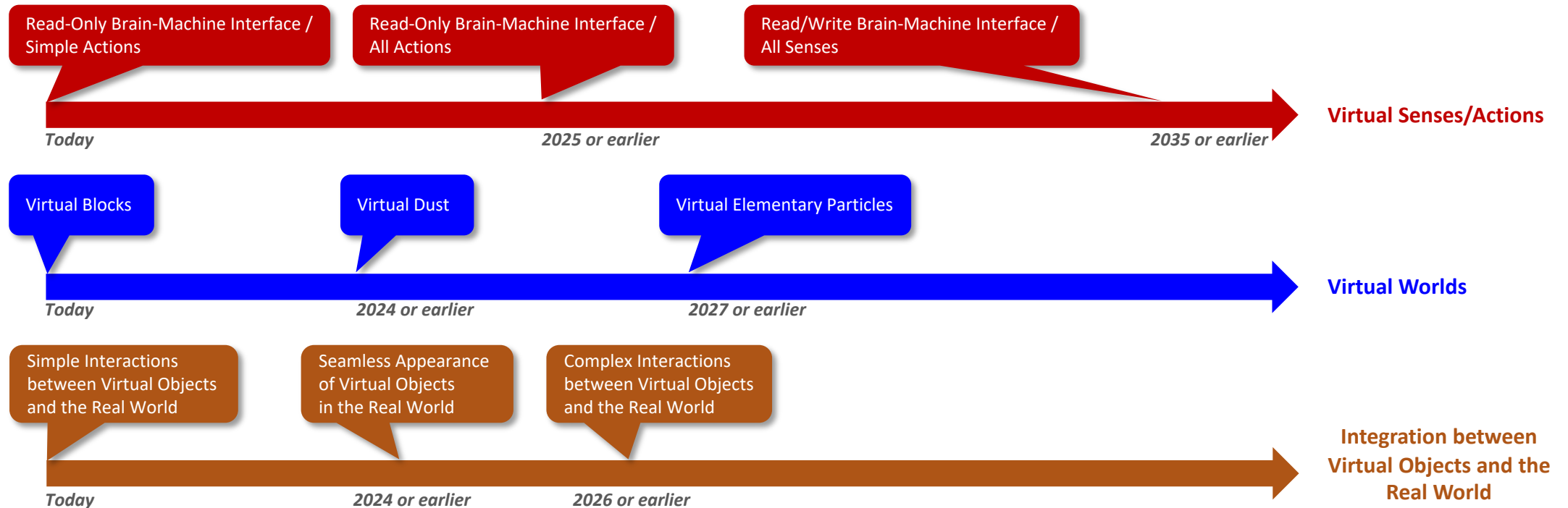


Source: "Blade Runner 2049" (2017)

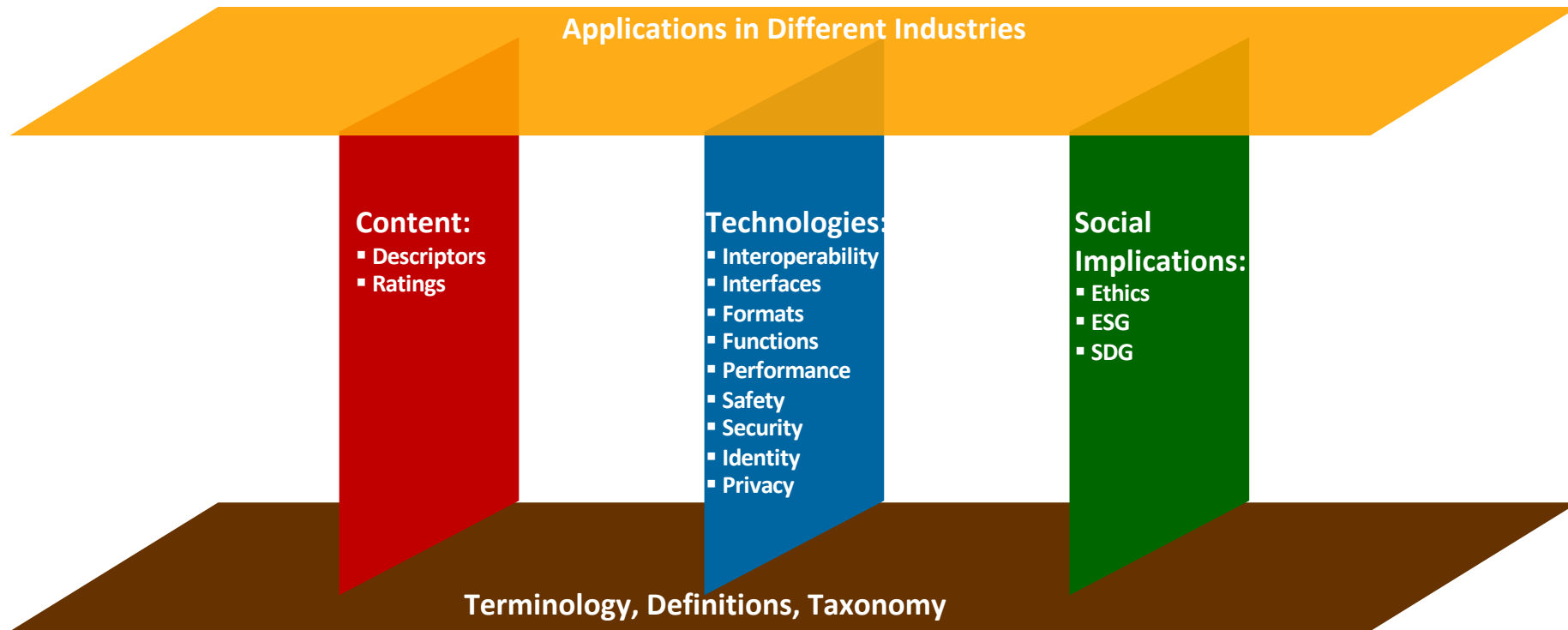
The road to the Metaverse

Dr. Yu Yuan's Metaverse Technology Outlook

The best way to predict the future is to create it.



Metaverse Standardization and Ecosystem



Usage of the Word “Metaverse” in English

In terms of how to use the following variants:

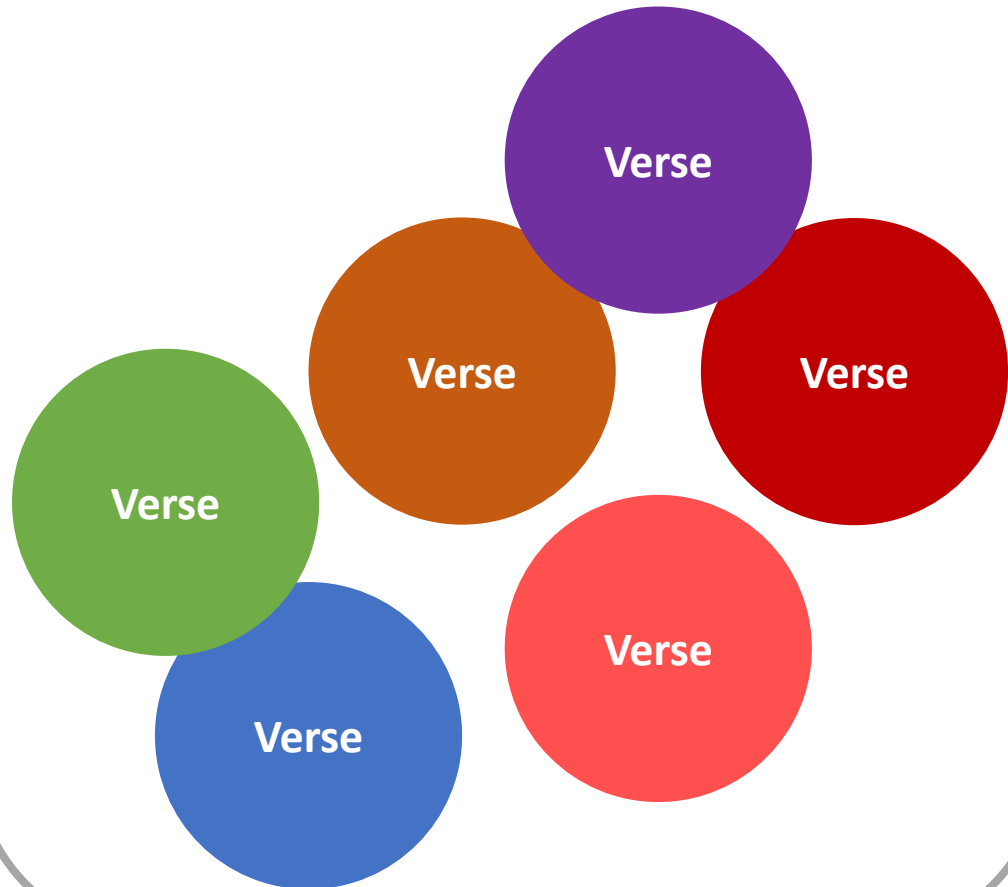
1. **metaverse**
2. **a metaverse**
3. **metaverses**
4. **the metaverse**
5. **the Metaverse**
6. **Metaverse**

Our recommended practice is:

- 1 should be used in most cases like when we are using other technical terms (virtual reality, cloud, blockchain, etc.) while not having to capitalize them.
 - Example: “... projects relevant to **metaverse** interoperability ...”
- 2/3/4 should be used to refer to specific implementations (or embodiments) of metaverse.
 - Example: “... **the metaverse** created by her company is **a decentralized metaverse**.”
- 5 should be used to refer to the entire metaverse industry or the sum of all metaverses, similar to “the Internet”.
 - Example: “... we believe that **the Metaverse** will have a profound impact on everything.”
- 6 should be used in proper nouns, such as “**Metaverse** Standards Forum”.

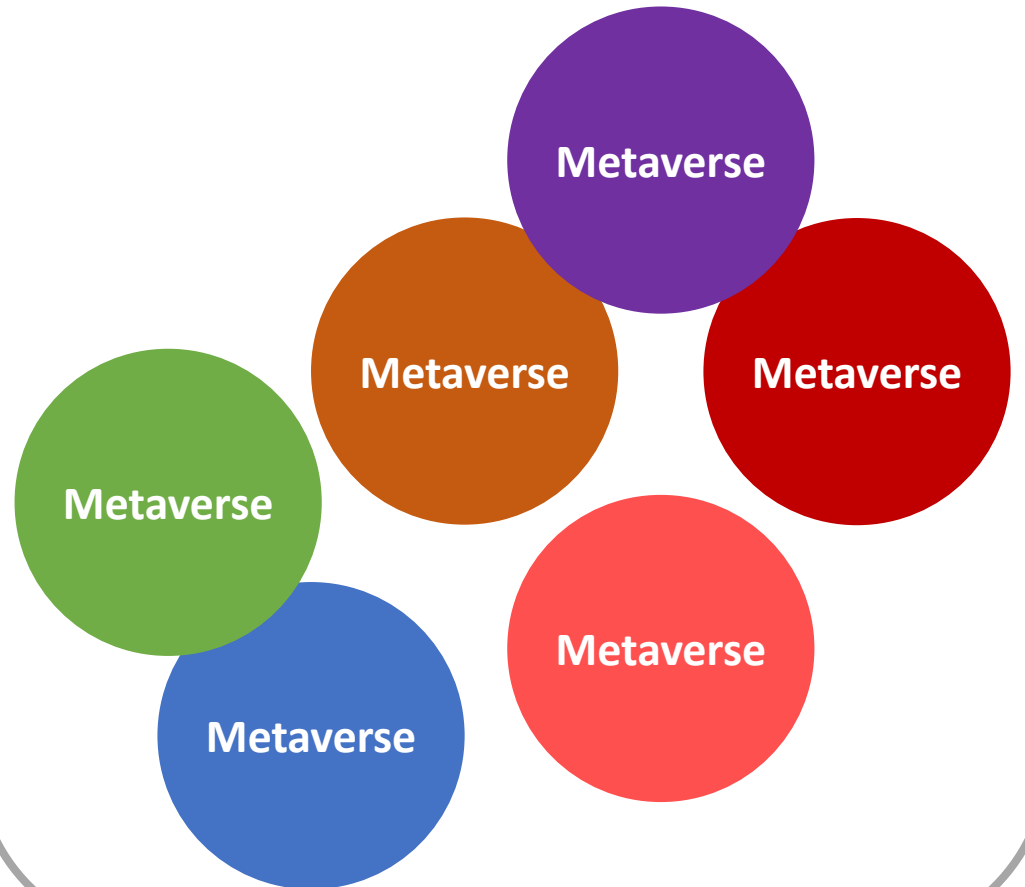
One Metaverse or Many Metaverses

One Metaverse



VS.

The Internet of Metaverses



Features of Metaverse

Named after the universe, a metaverse shall be **persistent** and should be **massive**, **comprehensive**, **immersive**, and **self-consistent**. Described as "meta", a metaverse should be **ultra-realistic**, **accessible**, **pervasive**, and may be **decentralized**.

Shall be:

Persistent

Should be:

Massive

Comprehensive

Immersive

Self-consistent

Ultra-realistic

May be:

Decentralized

INTERNAL ("Universe of Bits")

EXTERNAL ("Universe of Atoms")

Accessible

Pervasive

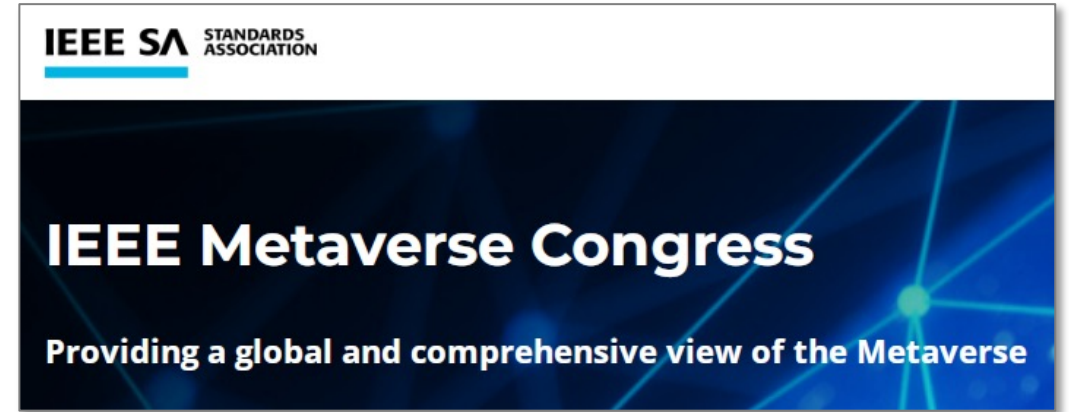
IEEE DRIVES STANDARDIZATION EFFORTS TO PAVE THE ROAD TO THE METAVERSE

IEEE METAVERSE CONGRESS

metaverse.ieee.org

A series of online or hybrid sessions

- SESSION 0 (PILOT): **FORUM ABOUT THE METAVERSE**
 - 14 June 2022 | Hybrid (Toronto, Canada | Online)
- SESSION 1 (KICKOFF): **DEMYSTIFYING AND DEFINING THE METAVERSE**
 - 6 July 2022 | Online
- SESSION 2: **THE METAVERSE AND ITS RAPID GROWTH IN CHINA**
 - 9 July 2022 | Online
- SESSION 3: **DEVELOPING AND DEPLOYING THE METAVERSE**
 - 27 September 2022 | Online
- SESSION 4: **NEW OPPORTUNITIES FROM THE METAVERSE AND THE NEW WAVE OF DIGITAL ECONOMY**
 - 30 September 2022 | Hybrid (Shenzhen, China | Online)
- SESSION 5: **BEHIND AND BEYOND THE METAVERSE**
 - 8 December 2022 | Online
- SESSION 6: **BEHIND AND BEYOND THE METAVERSE – YEAR-END WRAP-UP**
 - 27 December 2022 | Online
- SESSION 7: **DAVOS SPECIAL SESSION**
 - 17-19 January 2023 | Hybrid (Davos, Switzerland | Online)
- More to come...



IEEE METAVERSE STANDARDS COMMITTEE (CTS/MSC)

The first standards committee on metaverse in major global/international SDOs

- Formerly **IEEE Virtual Reality and Augmented Reality Standards Committee (CTS/VRARSC)**

- Name change and scope change

 - Committee approval: 16 May 2022

 - IEEE SASB approval: 21 September 2022

- New scope:

 - The scope of the Standards Committee is to develop and maintain standards, recommended practices, and guides for **metaverse**, virtual reality and augmented reality, using an open and accredited process, and to advocate them on a global basis. Its technical scope is intended to be flexible and is ultimately determined by the sum of its approved PARs.

IEEE STANDARDS AND PROJECTS FOR METAVERSE

Many metaverse-related standards and projects are NOT listed here if their titles do not explicitly include “metaverse”

■ P2048 Standard for Metaverse: Terminology, Definitions, and Taxonomy

■ Status: Approved by IEEE SASB on 10 November 2022

■ P7016 Standard for Ethically Aligned Design and Life Cycle of Metaverse Systems

■ Status: Approved by IEEE SASB on 10 November 2022

■ P7016.1 Standard for Ethically Aligned Educational Metadata in Extended Reality (XR) & Metaverse

■ Status: PAR submitted to IEEE SA

■ P3812.1 Standard for General Requirements for Identity Framework for Metaverse

■ Status: Approved by IEEE SASB on 3 December 2022

■ IC22-012 Persistent Computing for Metaverse Initiative

■ Status: Approved by IEEE SA CAG on 12 October 2022

■ IC22-015 Decentralized Metaverse Initiative

■ Status: Approved by IEEE SA CAG on 12 October 2022

■ See also “Why Are Standards Important for the Metaverse?”

■ <https://standards.ieee.org/beyond-standards/industry/technology-industry/why-are-standards-important-for-the-metaverse/>

IEEE-ISTO METAVERSE ACCELERATION & SUSTAINABILITY ASSOCIATION

In preparation

- Roadmaps
- Standards
- Pilot/Reference Implementations
- Conformity Assessment & Certification

THANK YOU

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