Digitalization 5.0: Metaverse
Trends, Challenges, Roadmaps, and Standardization

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President-Elect, IEEE Standards Association
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Chair, IEEE VR/AR Advisory Board
Founding Chair, IEEE Metaverse Standards Committee (CTS/MSC)
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Co-founder, VerseMaker
Founder & CEO, 0xSenses

November 18, 2022
Before we share our opinions...

DISCLAIMER:
The opinions expressed herein are the opinions of me and not necessarily the opinions of IEEE or IEEE SA.
IN MEMORY OF

PROF. YUZHUO ZHONG
Founder of Multimedia Discipline in China
1938 - 2022

Metaverse is the ultimate form of multimedia.
What is the 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.

Second Life
Designer: Philip Rosedale
Initial release: June 2003

Roblox
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.

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The assumption that the Metaverse is primarily an AR/VR thing isn't crazy. In my book it's all VR. And I worked for an AR company--one of several that are putting billions of dollars into building headsets. But...
Dr. Yu Yuan’s 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").

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. In a narrow sense, metaverse may be simply defined as Persistent Virtual Reality (PVR). In a broad sense, metaverse is the advanced stage and long-term vision of Digital Transformation.

元宇宙是关于外界被用户（人类或非人类）感知为一个建立在数字技术之上的宇宙的一种体验，这个宇宙或者是与我们当下的宇宙不同的宇宙（“虚拟现实”），或者是我们当下的宇宙的一种数字扩展（“增强现实”），或者是我们当下的宇宙的数字对应物（“数字孪生”）。

元宇宙既然以宇宙命名，就必须是持久的，而且应该是巨大的、全面的、沉浸的、自洽的。元宇宙既然用“meta”来形容，就应该是逼真的、易用的、泛在的，并且可以是去中心化的。狭义上，元宇宙可以简单地定义为持久存在的虚拟现实。广义上，元宇宙是数字化转型的高级阶段和长期愿景。
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"To be is to be perceived."
George Berkeley (1685-1753)

Three types of metaverses

- Virtual Reality
- Augmented Reality
- Digital Twin

Source: Steve Mann, Tom Furness, Yu Yuan, et al., "All Reality: Virtual, Augmented, Mixed (X), Mediated (X,Y), and Multimediated Reality", arXiv:1804.08386, 20 Apr 2018
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<table>
<thead>
<tr>
<th>Shall be:</th>
<th>Should be:</th>
<th>May be:</th>
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<tbody>
<tr>
<td>Persistent</td>
<td>Massive</td>
<td>Decentralized</td>
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<td>Comprehensive</td>
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Dr. Yu Yuan’s Chronicle of Digital Transformation

Digitalization 1.0: Automation

Digitalization 2.0: Interconnection

Web 2.0 = Massive UGC + Personalized Recommendations

Digitalization 3.0: Personalization

Digitalization 4.0: Intelligentization

Digitalization 5.0: Realitization (Metaverse)

Digital Reality

Digitalization 1.0 – 5.0
Dr. Yu Yuan’s recommended practice for 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**

My preference 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".
The Metaverse vs. The Internet of Metaverses

《尸子》曰：「上下四方曰宇，往古来今曰宙。」
What is NOT the Metaverse

The concepts that are currently labeled as the Metaverse but are not actually the Metaverse

NFT is not the Metaverse

- Today, most NFTs have no use value but only the so-called collection value or investment value.
- Collecting and investing are only a small part of our real life today and will be the same in the Metaverse in the future.
- The mainstream demand of mankind for the Metaverse will never be collection and investment.

NFT is not a necessary element of the Metaverse

- Play for Fun vs. Play to Earn
  - These are two very different groups of users
- Transferring assets from one virtual world to another is NOT a rigid demand, but can be harmful
  - Why should you be allowed to bring a weapon from Call of Duty to PUBG?! Have you heard of the term “game balance”?
- Virtual economy does not have to be built on NFT
  - Examples: Second Life, Roblox
- Metaverses can be NFT-free
  - Industrial metaverses (Digital Twin / Augmented Reality / Virtual Reality for enterprise)
  - Consumer metaverses purely for fun
  - Consumer metaverses for different lives (“Life is elsewhere”)
What is NOT the Metaverse

The concepts that are currently labeled as the Metaverse but are not actually the Metaverse

NFT application scenarios in the Metaverse may be very limited
What is NOT the Metaverse

The concepts that are currently labeled as the Metaverse but are not actually the Metaverse

Web3 is neither the Metaverse nor a necessary element of the Metaverse

- A metaverse may be decentralized in terms of infrastructure or application scenarios, but it does not have to be.
- Centralized metaverses can do better than decentralized metaverses in many aspects.
- Web3 advocates like to talk about ownership, but **what really matters to users is use and service, not ownership.**
- Why should everyone own a portion of the Metaverse while being advised that they do not need to own their own house or car in the era of sharing economy?!
What is NOT the Metaverse

The concepts that are currently labeled as the Metaverse but are not actually the Metaverse

Web3 may not have a bright future at all

- **Web3 != Web 3.0**
  
  The term "Web3" was coined by Ethereum co-founder Gavin Wood in 2014, referring to a "decentralized online ecosystem based on blockchain".

- **Web != Internet**
  
  Every CS or EE student knows this
  
  If you are talking about the next generation of the Internet, you should say “InternetX” or “Internet X.0”

- **“Web1: read-only -> Web2: read/write -> Web3: read/write/own” is a fake history invented by Web3 advocates. Don’t get too excited about it.**
  
  The Internet was never read-only. Have you heard of BBS or MUD?

- Web is no longer the mainstream way to access the Internet
  
  Web -> Apps -> then what?

- "Web5", "Web6", and "Web7" have been coined. What’s next?

- **Can we find a better term to replace "Web3"?**
  
  Candidate terms: Decentralized Ownership & Governance (DOG), Internet of Rights (IOR)
What is NOT the Metaverse

The concepts that are currently labeled as the Metaverse but are not actually the Metaverse

NFT is not the Metaverse, nor a core element or a necessary element of the Metaverse. It can serve some useful purposes in the Metaverse, such as incentivizing content creators, but exaggerating its role is harmful. In particular, we have seen lots of misleading and confusing propaganda that couldn’t wait to add a metaverse label on NFTs that have no use value but only the so-called collection value or investment value. Collecting and investing are only a small part of our real life today and will be the same in the Metaverse in the future. **The mainstream demand of mankind for the Metaverse will never be collection and investment.**

Web3 is not the Metaverse either. A metaverse may be decentralized in terms of infrastructure or application scenarios, but it does not have to be. From both the technical perspective and the business perspective, there can be centralized metaverses, which in many aspects can do better than decentralized metaverses. Web3 advocates like to talk about ownership, but **what really matters to users is use and service, not ownership.** Today, it is increasingly being advocated that even transportation should be a shared service that does not require everyone to own a private vehicle, so why should everyone own a portion of the Internet or the Metaverse? In particular, we need to be wary of rip-offs in the name of decentralization. What is concealed under the banner of decentralization could be the centralization of wealth to a small group of speculators.

Given that NFT and Web3 have become too dominant in the metaverse-related public opinion field, it is necessary to reiterate: **NFT and Web3 are neither the Metaverse nor necessary elements of the Metaverse. They are no more than optional elements that may be useful to the Metaverse in some cases.**

—— Yu Yuan
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

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 best way to predict the future is to create it.

**The road to the Metaverse**

**Dr. Yu Yuan’s Metaverse Technology Outlook**

- **Virtual Senses/Actions**
  - Read-Only Brain-Machine Interface / Simple Actions
    - Today
  - Read-Only Brain-Machine Interface / All Actions
    - 2025 or earlier
  - Read/Write Brain-Machine Interface / All Senses
    - 2035 or earlier

- **Virtual Worlds**
  - Virtual Blocks
    - Today
  - Virtual Dust
    - 2024 or earlier
  - Virtual Elementary Particles
    - 2027 or earlier

- **Integration between Virtual Objects and the Real World**
  - Simple Interactions between Virtual Objects and the Real World
    - Today
  - Seamless Appearance of Virtual Objects in the Real World
    - 2024 or earlier
  - Complex Interactions between Virtual Objects and the Real World
    - 2026 or earlier
The road to the Metaverse

Grand Challenges:

Decentralization *(optional)*

Ethereum nodes are being run through centralized web providers like Amazon Web Services, which could become a central point of failure.

Source: Cointelegraph
The road to the Metaverse

Grand Challenges:

Decentralization *(optional)*

By contrast, as of 2013, BitTorrent had 15–27 million concurrent users at any time.
The road to the Metaverse

A Harvesting-While-Plowing Journey

Not ideal, but usable & useful
The road to the Metaverse

What’s Next

Are we living in a virtual universe?

- Spatial challenges
  - Indistinguishable Virtual Universe
  - Virtual Universe over Virtual Universe

- Temporal challenges
  - Oblivion
  - Overclocking
The road to the Metaverse
Special Food for Thought

Can we create consciousness by simulating human brain?

- If you are in a virtual universe, where is your consciousness?
  - In the brain of your avatar in this virtual universe?
  - In another universe that this virtual universe is built upon?
  - In another “soul-only” universe?

Virtual Universe

“Real” Universe
METAVERSE STANDARDIZATION NEEDS

Applications in Different Industries

Terminology, Definitions, Taxonomy

Content:
- Descriptors
- Ratings

Technologies:
- Interoperability
- Interfaces
- Formats
- Functions
- Performance
- Safety
- Security
- Identity
- Privacy

Social Implications:
- Ethics
- ESG
- SDG
IEEE METAVERSE CONGRESS

metaverse.ieee.org

A series of online or hybrid sessions

■ PILOT SESSION: FORUM ABOUT THE METAVERSE
  ■ 14 June 2022 | Hybrid (Toronto, Canada | Online)

■ SESSION 1: 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)

■ 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.
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

- **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
THANK YOU

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Dr. Yu Yuan's List of Recommended Movies and TV Shows about XR/Metaverse

- **Ghost in the Shell (2017)**
- **Blade Runner 2049 (2017)**
- **OtherLife (2017)**
- **Altered Carbon (2018–2020)**
  - S2, Ep1: Phantom Lady (2020)
  - S1, Ep1: Out of the Past (2018)
- **Free Guy (2021)**
- **Westworld (2016– )**
  - S3, Ep6: Decoherence (2020)
- **Black Mirror (2011–2019)**
  - S3, Ep2: Playtest (2016)
  - S2, Ep4: White Christmas (2014)
- **Avatar (2009)**
- **The Thirteenth Floor (1999)**
- **The Matrix (1999)**
- **Dark City (1998)**

(Updated 7/12/2022)