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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition

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1. Introduction

The recent Communication on the long-term competitiveness of the EU[1] identified Web 4.0 as a ground-breaking technological transition towards a world where everything is seamlessly interconnected. The European Council has called for the European Union to stay at the forefront of Web 4.0 development[2]. Virtual worlds are an important part of this transition to Web 4.0. They are already opening up a wide range of opportunities in many societal, industrial and public sectors. The concept of virtual worlds has been around for decades, but they have now become technically and economically feasible thanks to rapid technological advances and an improved connectivity infrastructure. Virtual worlds will be an important aspect of Europe's Digital Decade and will impact the way people live, work, create and share content, as well as the way businesses operate, innovate, produce and interact with customers[3,4,5,6]. This brings both opportunities and risks that need to be addressed.

What are we talking about?

Virtual worlds *are persistent, immersive environments, based on technologies including 3D and extended reality (XR), which make it possible to blend physical and digital worlds in real-time, for a variety of purposes such as designing, making simulations, collaborating, learning, socialising, carrying out transactions or providing entertainment.*

Web 3.0 *is the third generation of the World Wide Web. Its main features are openness, decentralisation, and users' full empowerment enabling them to control and realise the economic value of their data, manage their online identities and participate in governing the web. Semantic web capabilities allow linking data across webpages, applications and files. Decentralised technologies and digital twins enable peer-to-peer transactions, transparency, data democracy and innovation along entire value chains.*

Web 4.0 *is the expected fourth generation of the World Wide Web. Using advanced artificial and ambient intelligence, the internet of things, trusted blockchain transactions, virtual worlds and XR capabilities, digital and real objects and environments are fully integrated and*

[1] COM(2023) 168 final
[2] European Council conclusions, 23 March 2023
[3] Decision (EU) 2022/2481
[4] Council of the European Union, Metaverse – virtual worlds, real challenges, March 2022
[5] European Economic and Social Committee opinion Initiative on virtual worlds, such as the metaverse, April 2023
[6] Basdevant A, François C, Ronfard R, Mission exploratoire sur les métavers, October 2022

communicate with each other, enabling truly intuitive, immersive experiences, seamlessly blending the physical and digital worlds.

This Communication sets out the strategy and proposed actions on virtual worlds and Web 4.0. It builds on consultations with people, academia, civil society and businesses. The voices of EU citizens participating in the European Citizens' Panel on Virtual Worlds[7], organised as a follow-up to the Conference on the Future of Europe, have been particularly relevant given the direct impact of virtual worlds on the way people will engage in the new digital environments.

The accompanying staff working document provides background information on the stakeholder consultations, overall market trends, opportunities for the various industrial ecosystems, technological trends and the current regulatory framework. The report from the Citizens' Panel forms a separate staff working document accompanying this Communication.

2. What is at stake in this next technological development?

What is at stake for society?

Virtual worlds bring unprecedented opportunities in many societal areas, such as better health services, more engaging education and training, new forms of interaction and collaboration among people, or immersive cultural experiences. Public services can also engage with people for more personalised administrative services, provide remote assistance such as in remote and rural areas, and improve territorial planning and community life. In addition, virtual worlds are at the crossroads of technology and culture, with European cultural and creative sectors expected to play a key role as content providers.

Examples:

- By simulating emergency situations and surgeries or providing interaction with the human body in 3D, students and professionals can be trained for specific medical scenarios, risks of surgical complications can be reduced, and the accuracy of diagnoses can be increased[8].
- In education and training, a more experiential learning process can help learners grasp abstract or complex subjects more easily, accelerating their learning and understanding of the world.
- Digital twins can support the preservation or reconstruction of cultural heritage buildings, such as for Notre Dame Cathedral in Paris.
- Virtual worlds can help optimise traffic flows based on real-time simulations, thus contributing to the reduction of traffic jams and emissions.
- Virtual worlds can enhance democratic participation by offering new possibilities for people to voice their ideas, opinions and concerns in more engaging ways.

[7] https://citizens.ec.europa.eu/virtual-worlds-panel_en
[8] https://digital-strategy.ec.europa.eu/en/library/extended-reality-opportunities-success-stories-and-challenges-health-and-education

However, drawing from the lessons of the current internet, the development of virtual worlds is also likely to pose challenges to fundamental rights and important objectives of general public interest in a democratic society, for example in terms of rights of the child, protection of personal data and privacy, disinformation, cybersecurity, cybercrime, (gender-based) cyber violence, discrimination, exclusion and hate speech[9], as well as consumer protection and safety. Virtual worlds may also raise questions of responsibility, liability and contractual rules. In the area of employment, there is a risk of attempts to circumvent EU social standards, for instance by imposing lower ones on users of virtual worlds.

The development of virtual worlds raises the issue of their environmental impact, due to increased consumption of energy by devices, data centres and telecommunication networks. However, digital twins and immersive worlds also offer immense knowledge and understanding of how to optimise and redesign complex industrial processes, achieve more efficient production cycles, decrease the waste of materials, or adjust production based on demand. Virtual worlds also enable deeper and finer insights into climate change and help to better anticipate natural hazards.

What are the economic stakes?

The use of virtual worlds and advanced interfaces can enable faster, safer, and easier interaction between humans and machines in all EU industrial ecosystems. Industrial applications of virtual worlds will enable intelligent, resilient and connected operations, with new digital processes and digital models that are more efficient, cheaper and more sustainable than current industrial processes. On the other hand, workers will need to adapt to new technologies.

Many industrial sectors such as the automotive, advanced manufacturing or logistics industries already use virtual environments to design, develop, simulate and test new products, services or workflows, accelerate permitting, but also to optimise inventories down the production line.

As applications for virtual worlds expand, there is a wealth of opportunities for European businesses, to develop products, services and high-value content catering to the needs of different users, and take advantage of innovative new business models. Virtual worlds in video games already provide spaces where millions of people can create and monetise content, and explore and have meaningful interactions[10]. A range of new industrial applications is emerging focusing on different areas of production, such as product designs, quality testing, engineering, manufacturing, maintenance and training.

Overall market development forecasts are promising. For example, the size of the global market of virtual worlds is estimated to grow from EUR 27 billion in 2022 to over EUR 800 billion by 2030[11]. For specific sectors, such as the automotive industry, the forecasts predict a

[9] Europol (2022), Policing in the metaverse: what law enforcement needs to know
[10] European Media Industry Outlook, The European Media Industry Outlook
[11] https://www.bloomberg.com/press-releases/2022-07-13/metaverse-market-size-worth-824-53-billion-globally-by-2030-at-39-1-cagr-verified-market-research

rise from EUR 1.9 billion in 2022 to EUR 16.5 billion by 2030[12]. XR technologies, such as virtual reality (VR) and augmented reality (AR) are key building blocks of virtual worlds. The development of these technologies will have significant benefits for the job market, with an estimated 860 000 new jobs related to XR in Europe by 2025[13].

Examples:

- Human-machine interaction on the factory floor is often hazardous and requires safety measures that cost money, time, and space. XR technologies provide new safe ways of human-machine interaction that do not require close physical proximity. This enables humans to use their intelligence and dexterity without the risk of physical harm.
- Digital twins in the manufacturing and automotive industries enable businesses to model, prototype, and test large numbers of design iterations in real time and in an immersive, physics-based environment before committing physical and human resources to a project.
- Virtual worlds can benefit agriculture through remote assistance for using and repairing machinery and for a more precise and safer treatment of animals.
- Virtual worlds can boost the cultural and creative industry, from fashion to video games, cultural heritage, music, visual arts and design, by offering new ways to create, promote and distribute European content and engage with audiences.

3. Vision and strategy

The Commission aims for a Web 4.0 and virtual worlds that reflect EU values and principles and fundamental rights, where people can be safe, confident and empowered, where people's rights as users, consumers, workers or creators are respected, and where European businesses can develop world-leading applications, scale up and grow. Furthermore, the Commission aims for a Web 4.0 that is powered by open and highly distributed technologies and standards that enable interoperability between platforms and networks and freedom of choice for users, and where sustainability, inclusion and accessibility[14] are at the core of technological developments. The EU's Single Market, rich and diverse culture, creative content, strong industrial base, excellence in research, innovation and education, and robust legislative framework should be drivers to Europe's leadership, competitiveness and technological sovereignty in this field.

The EU's robust legislative framework

The EU has a robust, future-oriented legislative framework that already applies to several aspects of the development of virtual worlds and Web 4.0.

[12] https://www.globenewswire.com/en/news-release/2022/09/27/2523235/0/en/Metaverse-Market-for-Automotive-worth-16-5-billion-by-2030-Exclusive-Report-by-MarketsandMarkets.html
[13] *VR/AR Industrial Coalition - Strategic paper*, available at https://data.europa.eu/doi/10.2759/197536
[14] In line with the Strategy for the Rights of Persons with Disabilities 2021-2030, COM(2021) 101 final

In relation to the protection and enforcement of the rights of individuals and companies operating in virtual worlds, the Digital Services Act (DSA)[15] and the Digital Markets Act (DMA)[16] introduce a comprehensive system of accountability and obligations for online platforms. The Data Governance Act[17] and Data Act[18] establish horizontal rules for data-sharing and give users control over the data generated by their connected devices. The proposed AI Act will tackle risks emerging from artificial intelligence (AI) and will promote innovation in trustworthy AI.

The General Data Protection Regulation[19], which is technologically neutral, also fully applies to the processing of personal data in virtual worlds. In addition, users of virtual worlds are protected by EU consumer law, in particular the General Product Safety Regulation[20], as well as the Unfair Commercial Practices Directive[21], which provides protection against misleading marketing practices.

The newly adopted Markets in Crypto-Assets (MiCA) Regulation[22] covers crypto-assets not regulated by existing financial services legislation. It aims to increase transparency about the risks of crypto-assets, protect holders of such assets and ensure integrity of crypto-asset markets. The European Digital Identity[23] will give users full control over their digital identities.

For the protection of intellectual property rights and industrial property rights, the existing EU legal framework (such as the Directive on Copyright in the Digital Single Market[24], the Regulation on the EU Trade Mark[25] and the Directive on the Protection of Trade Secrets[26]) applies generally to Web 4.0 and virtual worlds.

Access by persons with disabilities to key digital services is addressed by the European Accessibility Act[27] and the Web Accessibility Directive[28].

In addition, persons based in the EU who will work in virtual words should be able to rely on the EU's labour standards, including the rules for health and safety at work, and social security systems. Effective mechanisms to enforce these rights will be key.

This strategy presents a range of actions to build the foundation for the long-term transition towards Web 4.0 and the development of virtual worlds. The actions are structured around the

[15] Regulation (EU) 2022/2065
[16] Regulation (EU) 2022/1925
[17] Regulation (EU) 2022/868
[18] Proposal for a Regulation COM/2022/68 final
[19] Regulation (EU) 2016/679
[20] Regulation (EU) 2023/988
[21] Directive 2005/29/EC
[22] Regulation (EU) 2023/1114
[23] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-digital-identity_en
[24] Directive (EU) 2019/790
[25] Regulation (EU) 2017/1001
[26] Directive (EU) 2016/943
[27] Directive (EU) 2019/882
[28] Directive (EU) 2016/2102

objectives of the Digital Decade policy programme and three of its cardinal points: **skills, business, and government**. The fourth cardinal point, infrastructures, is addressed by the Commission's connectivity package[29] and its broader efforts on computing, cloud and edge capacities[30] The strategy also addresses the global governance of virtual worlds and Web 4.0, as a specific strand of actions.

3.1. People and skills

Awareness, access to trustworthy information and digital skills are essential aspects for fostering user acceptance of technological developments and for empowering people of all ages, especially those with a low level of digital skills, to get involved in and use virtual worlds and Web 4.0. User acceptance emerged as a crucial aspect from the Citizens' Panel. Awareness-raising, improving technological literacy and skills, and increasing access to technology are key for public acceptance and retention[31,32].

The development of virtual worlds requires technological and creative skills[33]. There is a pressing need for specialists in core virtual world technologies such as XR. Companies struggle to find ICT specialists with advanced digital skills in Europe[34]. Moreover, the ICT sector suffers from a severe gender imbalance with only 1 in 5 ICT specialists being women[35]. It is crucial to have a talent pool to build the various layers of Web 4.0 to achieve the aspirations of the EU to pioneer the development of these technologies.

The action points below are proposed to address the above challenges.

3.1.1. Building a talent pool of virtual world specialists

The European Year of Skills encourages people across the EU to learn new skills in key areas. Developing, attracting and retaining talent is one of the Commission's top priorities[36]. To this effect, the EU will use various funding programmes to invest in future ICT specialists in technologies related to Web 4.0 and virtual worlds, and in content creators for developing hyper-realistic virtual worlds[37]. In addition, the European Institute of Innovation and Technology (EIT) and its Knowledge and Innovation Communities (KICs) will partner up

[29] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_985
[30] Internationally, the Global Gateway strategy supports the transformation towards Web 4.0 through investments in partner countries in the deployment of digital networks and infrastructures.
[31] VR/AR Industrial Coalition – Strategic paper, Publications Office of the European Union, 2022
[32] Extended reality – Opportunities, success stories and challenges (health, education): final report, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2759/121671
[33] European Media Industry Outlook, The European Media Industry Outlook
[34] https://ec.europa.eu/eurostat/databrowser/view/ISOC_SKE_ITRCRN2__custom_6527549/
[35] https://ec.europa.eu/eurostat/databrowser/view/ISOC_SKS_ITSPS/
[36] New European Innovation Agenda, COM(2022) 332 final; Digital Education Action Plan, COM(2020) 624 final; proposals for Council Recommendations on the key enabling factors for successful digital education and training, COM(2023) 205 final, and on improving the provision of digital skills in education and training, COM(2023) 206 final; and Communication on Harnessing talent in Europe's regions, COM(2023) 32 final.
[37] For example, through the AccessibleEU resource centre, the Commission is contributing to the training of professionals including on digital accessibility to support implementation of accessibility requirements in EU policy and legislation and to prevent new accessibility barriers including in the Web.4.0.

with leading education institutions, research organisations and businesses to boost the EU's virtual technological capacity.

The EU will use the Digital Decade Board and relevant fora and expert groups to encourage Member States to take action. Furthermore, the EU will facilitate multi-stakeholder partnerships, through initiatives such as the Pact for Skills[38], to build support for skills development for virtual worlds at national and regional levels.

At international level, the EU will work to make the EU an attractive destination for top-level ICT specialists from non-EU countries, to expand the talent pool needed in the EU. The EU Blue Card Directive[39], in particular, lists ICT managers and professionals as a highly skilled occupation category covered by that Directive. This legal framework helps attract foreign talents. It was revised in 2021, when the EU Talent Pool[40] was introduced.

3.1.2. Virtual worlds toolbox for the general public

In response to the recommendations put forward by the Citizens' Panel on the need to better understand how to manage their virtual identities, their virtual creations, their virtual assets and their data, a toolbox will provide specific guidelines on the various aspects of participation and involvement in virtual worlds and remind people of their rights under applicable EU legislation. The toolbox will cover the use of trustworthy digital identity and digital wallet solutions for safe and secure authentication, virtual transactions, management of digital data and assets, data protection and privacy, consumer protection, cybersecurity, copyright and intellectual property.

Another crucial topic discussed during the Citizens' Panel is online disinformation. The toolbox will include tools for content verification and for empowering people to become active creators of trustworthy information. Synergies will also be sought with current initiatives, such as the European Digital Media Observatory[41] and the Code of Practice on Disinformation.

The Citizens' Panel specified a set of guiding principles for desirable and fair virtual worlds. These cover eight fundamental aspects of the European Declaration of rights and principles: freedom of choice, sustainability, human-centricity, health, education, safety and security, transparency, and inclusion. The Commission will promote these principles throughout this initiative. In relation to the guiding principle of health, the Commission will support research on the impact of virtual worlds on people's physical and mental health and well-being in line with the comprehensive approach to mental health.[42]

3.1.3. Empowered and protected children in virtual worlds

[38] https://pact-for-skills.ec.europa.eu/index_en
[39] Directive (EU) 2021/1883
[40] https://eures.ec.europa.eu/eu-talent-pool-pilot_en
[41] https://edmo.eu/
[42] COM(2023) 298 final

Children and young people are digital natives, but they need to better understand specific issues at stake in relation to their safety, security and privacy, protection of their personal data and other rights, and obligations in immersive environments. They have fundamental rights to such protection as is necessary for their well-being in view of their age and maturity, such as protection against online child sexual abuse. In line with the EU Strategy on the Rights of the Child[43], the rights of any child should be upheld in virtual worlds as in the real world, including through measures to ensure child safety and privacy by design.

The new Better Internet for Kids (BIK+) strategy defines the EU's actions to protect and empower children in online and virtual environments. The planned code of conduct for age-appropriate design will contribute to child-friendly virtual worlds. The BIK Portal[44] will be used to provide educational resources on virtual environments for young people, parents and educators as well as awareness-raising activities by the Safer Internet Centres across the EU. The proposed recast of Directive 2011/93/EU on combating the sexual abuse and sexual exploitation of children will address prevention, investigation and prosecution of sexual abuse offences committed against children in and through virtual worlds.

The Commission will:

- *Action 1:* Support **skills development** for virtual world technologies (Digital Europe programme), including for women and girls, and for creators of digital content and audiovisual professionals (Creative Europe programme) [2024]; and promote the EU as an attractive destination **for highly skilled specialists from non-EU countries** [Q3 2023].
- *Action 2:* Promote the **guiding principles for virtual worlds** put forward by the Citizens' Panel and support **research** on the impact of virtual worlds on people's **health and well-being** through Horizon Europe, including specific research on the impact on **children's health and well-being** [Q4 2023].
- *Action 3:* Develop a **Virtual worlds Toolbox** for the general public, as well as resources on virtual environments for young people under the **Better Internet for Kids** strategy [Q1 2024].

3.2. Business: supporting a European Web 4.0 industrial ecosystem

Europe has a strong industrial potential in the field of virtual worlds and Web 4.0. It has promising regional hubs, located across the EU, with specific areas of specialisation, ranging from 3D modelling, to VR and AR content, gaming, and audio and optical technologies. However, the ecosystem is fragmented and faces challenges related to the uptake of new technologies and access to finance.

[43] COM(2021) 142 final
[44] http://betterinternetforkids.eu

To create a thriving and world-leading European industrial ecosystem for Web 4.0 and virtual worlds, there is an urgent need to boost and bundle technological capabilities, accelerate uptake of innovative solutions, and foster a supportive business environment.

3.2.1. Boosting the EU's technological capabilities

The EU is strong in research and innovation in middleware and software, with big players and high-end SMEs operating along the value chain, from device manufacturers to solution providers and content creators. Europe is also a continent of creativity, with the cultural and creative sectors representing 1.2 million businesses in the EU[45,46].

The Commission is currently exploring, in consultation with Member States, a new European Partnership[47] for key stakeholders to develop the technological building blocks for useful, inclusive, sustainable and trustworthy virtual worlds systems and applications. Such a partnership would build on the EU's major investments in: (i) all key cutting-edge technologies and applications at the heart of virtual worlds, such as XR, digital twins, artificial intelligence, blockchain and cybersecurity; (ii) common European data spaces; and (iii) the Next Generation Internet initiative, which funds digital commons. In addition, virtual realities technologies are cited among the potentially critical, deep and digital technologies which may benefit from the Commission's recently proposed Strategic Technologies for Europe Platform (STEP)[48], intended to unblock up to EUR 160 billion in additional investments across a number of strategic technology fields.

3.2.2. Accelerating the uptake of new business models and solutions

Building networks and connecting virtual world developers with industry users

The EU is home to several highly dynamic virtual worlds hubs across the EU, which are at the core of national and regional ecosystems. Member States may further support these national/regional ecosystems to attract private investment while complying with State aid rules. Virtual worlds hubs play a key role in facilitating collaboration between virtual world developers and industrial users. They would benefit from further support by competence centres and digital innovation hubs offering access to testing, experimentation and training opportunities.

Building on its cluster policies, the Commission will promote collaboration and exchanges among virtual worlds hubs. It will also step up the work with the Virtual and Augmented Reality (VR/AR) Industrial Coalition that brings together various industry players along the value chain. The Commission will foster matchmaking between virtual world developers and industrial users. In addition, the network of European Digital Innovation Hubs, funded under the Digital Europe programme, and the Enterprise Europe Network should act as catalysts,

[45] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Culture_statistics_-_cultural_employment
[46] COM(2020) 784 final
[47] As specified under the EU's Horizon Europe framework programme.
[48] COM(2023) 335 final

engaging a broad range of stakeholders to encourage the adoption of virtual world technologies.

Access to finance to support creators and to scale up innovative business models

Through programmes such as Creative Europe, European creators in cultural and creative industries will be able to test innovative business models and creation tools in virtual worlds, and develop new sustainable business models and marketplaces. MediaInvest[49] will enable access to equity finance for companies seeking to scale up, and support the wider sharing, storage and monetisation of digital assets by media players in Europe. Cohesion funds are available to support innovation and creative industries, including start-ups and scaling up businesses throughout the EU. The reinforcement of the European Innovation Council Accelerator under the STEP proposal will allow equity-only support for non-bankable SMEs and small mid-caps with investments needs in the range of EUR 15 to 50 million for deep-tech sectors such as virtual realities where they have demonstrable strategic importance. InvestEU can be used to support the broader technological transition to Web 4.0, including by opening dedicated dialogues with the various InvestEU implementing partners, project promoters and financial intermediaries.

3.2.3. Fostering a supportive business environment

Encouraging innovation via regulatory sandboxes for virtual worlds and Web 4.0

Regulatory sandboxes can be useful schemes for testing novel solutions in a controlled real-world environment for a limited amount of time, while respecting regulatory safeguards, under the supervision of a competent authority. Given the novel features emerging in virtual worlds and Web 4.0, sandboxes would enable start-ups in the EU to experiment with new technologies, practices, services, applications and business models, while enabling regulators and public authorities to gain knowledge on various relevant aspects of virtual worlds, such as the tokenisation of virtual assets.[50] The Commission will work closely with Member States to identify specific topics where experimentation should be prioritised and to ensure a coordinated approach within the EU.

Supporting innovative SME and start-ups

Innovative start-ups will be drivers of the European Web 4.0 industrial ecosystem. In the Declaration on the EU Startup Nations Standard of Excellence (EU SNS), the Commission, Member States and other stakeholders have identified a number of best practices for a start-up-friendly environment. The European Startup Nations Alliance (ESNA) works closely with the countries that have signed the EU SNS Declaration to support them in sharing its best practices and in taking action at national level to implement them. Start-ups in virtual worlds

[49] https://digital-strategy.ec.europa.eu/en/news/commission-launches-mediainvest-boost-europes-audiovisual-industry

[50] Tokens, such as non-fungible tokens (NFTs), are important components of virtual transactions. They are unique and non-interchangeable units of data that provide a public certificate of authenticity or proof of ownership. The wider use of NFTs brings challenges, for instance related to taxation or to novel types of counterfeiting.

and Web 4.0 will benefit from horizontal measures to improve the EU's business environment for SMEs and to support start-ups, which will be reflected in the upcoming SME Relief Package.

Facilitating the rise of innovative cooperative models in industry

Cutting-edge technologies like blockchain and digital twins are paving the way for enhanced collaboration among enterprises, creators, consumers and citizens within decentralised digital contexts. New digital forms of organisations, such as decentralised autonomous organisations, are emerging and offering a different way of cooperating and working together. The Commission is launching a study to analyse and promote the business opportunities that this new form of digital cooperation offers and identify legal, administrative and economic barriers that prevent their uptake.

Intellectual property

The unauthorised reproduction and distribution of virtual assets can pose a significant threat to both consumers and intellectual property owners, eroding the trust and integrity of virtual platforms. For intellectual property owners, counterfeiting in virtual worlds presents a substantial risk of revenue loss and dilution of brand value. The Commission will create a toolbox against counterfeiting to give holders of intellectual property guidance and recommendations on how to enforce their rights both in offline and online environments, including in virtual worlds.

Interoperability and standardisation

Large distribution platforms (in both the business-to-business and business-to-consumer segments) are among the early movers in virtual worlds. These large market players have a heavy global presence, including in the EU. This market dynamic leads to two major concerns. First, large entities can contribute to a closed ecosystem by setting de facto standards. Second, they may become future gatekeepers of virtual worlds by exploiting network effects, thus creating new market entry barriers for SMEs and start-ups in the EU.

Standardisation will be key to enable interoperability between different platforms and networks, enabling the seamless use of identities, avatars, data, virtual assets, experiences or environments and the associated rights across platforms and networks.

Open standards are key to ensuring that the future Web 4.0 ecosystem will not be dominated by a select few, setting de facto standards and creating market entry barriers. The Commission, in cooperation with Member States and stakeholders, will engage with key organisations active in the development of standards for open and interoperable virtual worlds and Web 4.0. These efforts will feed into the EU Strategy on Standardisation[51] and will draw on the work of the High-Level Forum on European Standardisation[52].

[51] COM(2022) 31 final

[52]https://single-market-economy.ec.europa.eu/single-market/european-standards/standardisation-policy/high-level-forum-european-standardisation_en

Supporting the open-source community

The EU has a very strong and active community of open-source innovators that can contribute relevant digital commons to deliver on key features of virtual worlds. The Commission will further support open-source innovation for Web 4.0, such as in relation to the use of distributed ledger technology and other technologies needed for the authenticity, management and security of virtual objects and identities.

The Commission will:

- *Action 4:* Explore, in consultation with Member States, the launch of a new **European Partnership** to develop an industrial and technological **roadmap** [Q1 2024].
- *Action 5:* Support **EU Cultural and Creative Industries** to test new business models in virtual worlds through Creative Europe [Q1 2024]; foster **matchmaking** between virtual world developers and industrial users [Q1 2024]; and leverage the **European Digital Innovation Hubs** and **Enterprise Europe Network** to support virtual worlds hubs and to promote the uptake of new virtual world solutions [Q4 2023].
- *Action 6:* Support the development of **standards** for open and interoperable virtual worlds [Q4 2023]; explore the potential of new **digital cooperation models** [Q4 2023]; develop a **toolbox to fight counterfeiting** including in virtual worlds [Q4 2023]; and promote the use of **virtual worlds regulatory sandboxes** by Member States [Q2 2024].

3.3. Government: supporting societal progress and improving public services

Governments at national and regional level play a key role in leading the way towards Web 4.0: firstly, by constantly improving the design and delivery of public services and services of general interest in urban and rural environments through digitalisation, and secondly, by addressing major societal challenges such as health, climate change and ageing of the population. Governments should rigorously assess the costs and benefits of the development of services based on virtual worlds and Web 4.0, relative to traditional models.

Digital twins, primarily used in industrial manufacturing, are moving to various sectors linked to public services and areas of public interest. The EU is already investing in major initiatives, such as Destination Earth (DestinE)[53], local digital twins for smart communities[54], the European Digital Twin of the Ocean (European DTO)[55], the European Blockchain Services Infrastructure[56] and the digital twin of the European electricity grid[57]. This investment aims to enable public authorities to make informed public-policy decisions.

[53] https://digital-strategy.ec.europa.eu/en/policies/destination-earth
[54] C(2021) 7914 final, topic 2.2.1.2.3 of the Digital Europe work programme for 2021-2022
[55]https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters/european-digital-twin-ocean-european-dto_en
[56] https://digital-strategy.ec.europa.eu/en/policies/european-blockchain-services-infrastructure
[57] COM(2022) 552 final

Some forerunner cities are moving towards virtual worlds, but in general the uptake across the EU is slow. The work of the Innovation Friendly Regulations Advisory Group will inform future actions on delivering public services in virtual worlds[58].

The EU will support a flagship project of public interest, the European CitiVerse. This immersive environment will help allow to optimise spatial planning and management with due regard for the social, architectural, sustainable and cultural heritage dimension. Relevant common European data spaces will strengthen the flagship and pilot applications will be launched under the Horizon Europe programme.

The Cultural Heritage Data Space and the European Collaborative Cloud for Cultural Heritage will enable collaboration between cultural heritage professionals across the EU to safeguard cultural treasures through digitisation with potential applications for the development of virtual worlds.

Moreover, the Digital Decade policy programme for 2030 enables the launch of European Digital Infrastructure Consortia (EDIC), which may be used by Member States to speed up and simplify the setup and implementation of multi-country collaboration projects. EDICs, in particular in areas such as language technology and blockchain, can directly support the joint deployment of virtual solutions.

In the field of public health, the Commission will support the development of the European Virtual Human Twin[59], which will digitally replicate the human body, by bringing together cutting-edge digital technologies, access to high-performance computing and access to research and healthcare data facilitated by the European Health Data Space[60]. This Virtual Human Twin flagship will serve clinical decision-support systems, personal health forecasting tools and personalised medicine approaches.

The Commission will:

- *Action 7:* Support **public flagships** for smart and sustainable cities and communities, **CitiVerse**, and for the development of the **European Virtual Human Twin** under the Horizon Europe and Digital Europe programmes [Q4 2023]; and encourage **European Digital Infrastructure Consortia** (**EDICs**) in areas relevant to virtual worlds and Web 4.0 [Q4 2023].

3.4. Governance

3.4.1. Governance at the EU and global level

The technological shift ahead will not be business as usual. The sheer scale of technological development, technological integration and market developments requires close cooperation between the Commission and Member States. The Commission will launch an expert group to

[58] https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupId=3855&fromNews=true
[59] As underlined in Europe's Beating Cancer Plan, COM(2021) 44 final
[60] COM/2022/197 final

bring Member States together to share common approaches and best practices on the development of virtual worlds and the wider technological transition to Web 4.0.

Beyond the EU, this technological shift also involves new forms of global governance. The Citizens' Panel and the stakeholder consultations have strongly emphasised the need to ensure that virtual worlds are designed as open and interoperable from the outset to enable true user empowerment and diverse participation, including of under-represented groups, which in turn can foster innovation, collaboration and creativity.

To ensure that Web 4.0, starting with virtual worlds, is shaped as an open, secure space, respectful of EU values and rules, international engagement is needed on a broad scope of topics, from technological issues (such as standards for interoperability, identity management or connectivity) to content and practice (such as content access and creation versus disinformation, censorship versus freedom of speech, and surveillance versus privacy).

The Commission will support the creation of a technical multi-stakeholder governance process to address essential aspects of virtual worlds and Web 4.0 that are beyond the remit of existing internet governance institutions. This process will aim to address both the virtual world's interoperability system and the essential components underpinning the functioning of virtual worlds such as rights management, transactions in virtual worlds, and identity management, as well as topics related to the industrial uptake of virtual worlds solutions.

3.4.2. Monitoring the development of virtual worlds and Web 4.0

As virtual worlds will become more mainstream, it is all the more crucial to stay abreast of their impact on people, on various types of industry users, on market movements, and on new technological developments. Continuous monitoring, using exchange platforms or observatories, is essential for policy-makers, businesses and researchers to make informed decisions: (i) to identify and support new opportunities for growth and innovation, (ii) to better understand and encourage emerging practices and forms of cooperation such as digital cooperatives and the role of decentralised autonomous organisations and (iii) to identify and respond to challenges emerging from the use of virtual worlds especially in relation to ethics, societal well-being, fundamental rights, important objectives of general public interest in a democratic society and consumer protection.

Work under this strand will leverage the industrial ecosystems and draw on the expertise of the recently launched European Centre for Algorithmic Transparency[61], the EU Blockchain Observatory and Forum[62], the Joint Research Centre, the Europol Innovation Lab[63], the Industrial Forum, the Structured Dialogue on Transformation Technologies and studies with insights into new governance models.[64,65,66] European social partners will also be invited to give their views on the impact of virtual worlds on workers and businesses.

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[61] https://algorithmic-transparency.ec.europa.eu/index_en
[62] https://www.eublockchainforum.eu/
[63] https://www.europol.europa.eu/operations-services-and-innovation/innovation-lab
[64] Hupont Torres I *et al* (2023) Next Generation Virtual Worlds: Societal, Technological, Economic and Policy Challenges for the EU, JRC.

The Commission will:

- *Action 8:* Bring **Member States** together to share common approaches and best practices on the development of virtual worlds and the wider technological transition to Web 4.0 through an **expert group** [Q4 2023].
- *Action 9:* Engage with existing **multi-stakeholder internet governance** institutions to design open and interoperable virtual worlds [from Q4 2023]; and support the creation of a **technical multi-stakeholder forum** to address certain aspects of virtual worlds and Web 4.0 beyond the remit of existing internet governance bodies [from Q1 2024].
- *Action 10:* Launch a structured approach to **monitor the development of virtual worlds** across all industrial ecosystems together with Member States and stakeholders [from Q1 2024].

4. Conclusion

The development of virtual worlds and the longer-term transition towards Web 4.0 will open new avenues of growth for European businesses and safe, trustworthy, inclusive and fair applications and services for people to work, learn, socialise and fulfil their potential.

The EU should act now to become a major player in nascent markets related to Web 4.0 and virtual worlds, upholding EU values and fundamental rights and ensuring that people are protected and empowered.

The Commission invites the European Parliament and the Council to endorse the strategy and work together on its implementation. The Commission calls on the Committee of the Regions and the European Economic and Social Committee to promote the vision put forward by the Commission in its dialogues with local and regional authorities, economic and social stakeholders and civil society.

[65] Craglia M *et al* (2021) Digitranscope: Key findings, JRC.
[66] Millard J (2023) Impact of digital transformation on public governance, JRC.